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Air Quality and Urban Prosperity: An Analysis of Municipal Composting and Urban Agriculture as Air Pollution Reduction and Mitigation Policies for Winnipeg

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Air Quality and Urban Prosperity: An Analysis of Municipal Composting and Urban Agriculture as Air Pollution Reduction and Mitigation Policies for Winnipeg.

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Introduction

Urban air pollution[1] has serious implications for physical wellbeing and socioeconomic prosperity in cities (Mabahwi et al., 2014, p. 222; Mankiw et al., 2023, p. 127; Revi et al., 2014, p. 575; Salmond, 2018, p. 1). Although air pollution is an amorphous and borderless threat, municipalities have unique powers and responsibilities to address environmental degradation, such as land-use planning and waste management, that make cities a critical site for pollution reduction strategies (Eidelmen et al., n.d., p. 1). This paper focusses on a single city to consider the following research question: how can Winnipeg, Manitoba decrease emissions and mitigate existing air pollution to improve urban air quality? This paper analyzes municipal composting and urban agriculture[2] as potential policies for Winnipeg. While there are various policy options for air quality improvement, these policies are more immediate and simpler than high complexity, high reward emissions reduction strategies like transportation reform and thus, warrant significant contemplation (Winter, n.d., pp. 4-9). This paper places each policy within Winnipeg's political landscape to highlight the most important and complex topics influencing their potential implementation. It ultimately finds that municipal composting and urban agriculture are viable air quality improvement strategies for Winnipeg. However, the successful execution of each policy depends on the adequate recognition and accommodation of their

[1] This paper defines air pollution as "contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere" (World Health Organization, 2024). Air pollutants can include, but are not limited to, carbon monoxide and dioxide, ozone, methane, nitrogen dioxide, sulfur dioxide, and fine particulate matter, some of which are components of smog or are greenhouse gasses and all of which are harmful in excess (Canadian Council of Ministers of the Environment, n.d.; Environment and Climate Change Canada, 2024; World Health Organization, 2024).

[2] Urban agriculture is the local, decentralized, community-based production of agricultural goods in urban areas (Horst et al., 2017, p. 280; Regeneration, 2023). Municipal composting programs are city-wide programs for the sustainable disposal of household organic waste (Galchen, 2020; O2 Compost, 2023). See below in "Policy Options: Municipal Composting and Urban Agriculture" for further elaboration.

associated social and political challenges, along with the intentional development of the social infrastructure critical to supporting municipal composting and urban agriculture programs.

To investigate these policies in detail, the paper is structured as follows. It first establishes the degree and impact of air pollution in cities to contextualize the problem of urban air pollution. Next, it explains the methodology of the policy analysis before outlining municipal composting and urban agriculture as policy options. The paper then analyzes the policies in three broad parts. "Part 1: Alignment with Existing Laws and Policies" investigates whether the proposed policies adhere to the City of Winnipeg Charter Act, Winnipeg's official plan *OurWinnipeg 2045*, and Winnipeg's secondary plan *Complete Communities Direction Strategy 2.0*. "Part 2: Capacity and Resources for Implementation" considers the availability and procurement of land and funding. "Part 3: Public Engagement" explores sociopolitical challenges and the role of public education and participation in municipal composting and urban agriculture programs. The paper further divides each part into smaller subsections, identifying potential routes and barriers to action and discussing stakeholder involvement. Its structure highlights the most important topics for consideration in deciding to pursue or reject municipal composting and urban agriculture as policy options. This paper analyzes these policies in tandem instead of one after another to avoid the repetition of overlapping content. Following the analysis, it discusses key strengths and weaknesses of each policy and then moves to its concluding remarks.

Prevalence and Growth of Urban Air Pollution

Although cities occupy just 3% of the Earth's land, urban areas house over 50% of the global population and are responsible for 75% of carbon emissions (United Nations, 2020; UNEP, 2023). Additionally, as cities generate 80% of the global GDP, the concentration of wealth in urban areas encourages urban migration such that cities will house 70% of the global

population by 2050 (Cheshmehzangi & Dawodu, 2019, p. 2; World Bank, 2023). Densification increases urban activity and thus, emissions production, worsening air pollution in cities – Winnipeg being no exception. Air Quality Health Index (AQHI) historic data illustrates the negative relationship between urban activity and air quality in Winnipeg (Weather Stats Canada, 2023). In 2019, Winnipeg experienced an AQHI of 1.5 which Environment and Climate Change Canada classifies as low health risk (Environment and Climate Change Canada, 2021; Weather Stats Canada, 2023). In 2020, the Covid-19 pandemic isolated thousands of Winnipeggers causing a sharp decline in urban activities, such as idling in traffic, and a related drop in the AQHI to 1.3 (Weather Stats Canada, 2023). However, as lockdown lifted and city life returned to pre-Covid-19 conditions, the AQHI increased alongside urban activity, rising to 1.7 in 2021 and then 2.1 in 2023. (Weather Stats Canada, 2023). Thus, there is a clear correlation between urban living and air pollution production. Should this trend continue, Winnipeg's AQHI is on track to exceed 3.0 in the near future, posing a moderate and eventually, severe health risk to Winnipeggers (Environment and Climate Change Canada, 2021). As city populations and urban activity increase, the impact of severe air pollution on city life warrants further discussion.

Implications of Urban Air Pollution

Air pollution negatively impacts the health, safety, and socioeconomic stability of city populations (Mabahwi et al., 2014, p. 222; Mankiw et al., 2023, p. 127; Revi et al., 2014, p. 575; Salmond, 2018, p. 1). Several scholars link air pollution to various acute health effects and the World Health Organization estimates that it causes 7 million premature deaths annually (Mabahwi et al., 2014, p. 222; Salmond, 2018, p. 1; 2023). Activities and operations in urban areas regularly release harmful pollutants into city residents' air supply (Gouldson et al., 2018, p. 42; Salmond et al., 2018, p.1). For example, landfills emit methane and carbon dioxide that act as

asphyxiants as well as particulate matter, ozone, and sulfur dioxide that cause asthma, emphysema and bronchitis. Fang at al. also associate long-term inhalation of air pollutants with heart disease, stroke, lung cancer, chronic obstructive pulmonary disease, and respiratory infections (2018, p. 1).

In addition to harming the health of city residents, air pollution threatens their physical safety. It exacerbates the greenhouse effect which triggers extreme climate disasters that endanger human lives (US EPA, 2023a; Salmond et al., 2018, p. 2). When heat from the sun enters the Earth's atmosphere, the land and oceans absorb it and eventually, release the heat back into space (US EPA, 2023a; Government of Australia, 2023). However, excess greenhouse gasses like atmospheric carbon and methane capture a portion of the heat meant to naturally leave the atmosphere which warms the planet and accelerates climate change (US EPA, 2023a; Government of Australia, 2023). The result is increased storm intensity, heavy flooding, drought, and severe wildfires – all of which compromise human safety (EPA, 2023a; Salmond et al., 2018, p. 2; United Nations, n.d.).

Beyond physical wellbeing, air pollution jeopardizes the socioeconomic stability and prosperity of cities (Salmond et al., 2018, p. 4). Climate disasters can cost billions of dollars in damaged critical infrastructure and cause food insecurity, job losses, and housing destruction that eliminate the livelihoods of entire communities (Revi et al., 2015, p. 556; United Nations, n.d.). For example, a severe drought could decrease the supply of farming jobs and kill crops that feed a nearby city, or a hurricane could destroy coastal roads and buildings. Furthermore, as a population inhales pollutants and suffers increasingly severe health problems, its labour force becomes weakened and unreliable, which decreases its economic growth rate and ability to provide essential services like health care (Revi et al., 2014, p. 575). The preceding evidence

therefore indicates that air pollution negatively impacts health, safety, and socioeconomic stability in cities. The threat of air pollution to urban prosperity presents an opportunity for municipalities to protect and improve city residents' quality-of-life. To effectively seize said opportunity, policymakers must consider the legal, logistical, and political aspects of implementing policies for emissions reduction and mitigation.

Methodology

This paper investigates municipal composting and urban agriculture as policy options for air quality improvement in Winnipeg. The analysis draws on sources such as peer-reviewed journal articles, textbook chapters, newspaper articles, United Nations reports, city planning documents, provincial legislation, City of Winnipeg by-laws, and case studies of cities with successful municipal composting and urban agriculture programs. All example cities are Canadian to ensure due consideration of the complexities of executing municipal policy within the Canadian federal system. An extensive review of the listed academic and grey literature enables the development of an analytical framework that targets the most important and complex topics to consider in implementing municipal composting and urban agriculture in Winnipeg. The framework organizes said topics within three broad categories – alignment with existing laws and policies, capacity and resources for implementation, and public engagement – to highlight routes and barriers to action and the nuances of stakeholder involvement in municipal composting and urban agriculture in Winnipeg.

Policy Options: Municipal Composting and Urban Agriculture

Municipal Composting

Municipal composting initiatives are city-wide programs for the sustainable disposal of household organic waste (Galchen, 2020; O2 Compost, 2023). They involve the safe and hygienic storage of compostable materials in designated green bins until their removal on an assigned collection day (Galchen, 2020; City of Calgary, 2023a). Composting is environmentally preferable to landfilling or garbage burning because it produces less greenhouse gas emissions than conventional waste management (Gouldson et al., 2018, p 42). To illustrate, food waste produces 58% of landfill methane emissions (US EPA, 2023b; Gouldson et al., 2018, p. 42; Vasarhelyi, 2021). Organic waste in landfills is buried beneath a mountain of other garbage which forces its anaerobic decomposition and production of methane (US EPA, 2023b; US EPA, 2023c). If diverted to a composting facility where it is regularly exposed to oxygen, organic waste can aerobically decompose which reduces emissions because methane producing microbes "are not active in the presence of oxygen" (US EPA, 2020).

Municipal composting also offers several co-benefits in addition to pollution reduction. As environmental policies are often low-priority or excluded from policy agendas, one must consider their positive externalities to capture their full value and enable them to compete with other government policy priorities. (Hough, 2018, p. 150). Some co-benefits of municipal composting are top-soil production, job generation, and landfill longevity. Municipal composting produces nutrient-rich topsoil that can help restore the supply of healthy soil which is depleting at nine times its natural replacement rate (EPA, 2023c; Farhidi et al., 2022, p. 2). As industrial scale composting produces large quantities of topsoil, it can be sold as a marketable product to rural and urban farmers (McIllfaterick, 2017, p. 26). Municipal composting programs also

generate both green and conventional jobs such as drivers, processors, supervisors, manual labourers, administrative staff, inspectors, scientists, and technicians (Farhidi et al., 2022, p. 3). Farhidi et al. estimate that every $10 million of investment into American composting facilities supports twice as many jobs as landfills and seventeen times that of incinerators (2022, p. 3). Furthermore, diverting organic waste to composting facilities extends landfill life, deferring the capital costs of a new landfill and preventing expansion onto productive land (Ragan et al., 2018, p. 13; EPA, 2023c).

Winnipeg can reference several Canadian cities, such as Edmonton, Saskatoon, Calgary, Ottawa, and Halifax, as examples of functional municipal composting programs (Gordichuck, 2023, p. 6). For example, the Calgary Green Cart Food and Yard Waste Program collects organic waste from single family homes (City of Calgary, 2023a). It was financed and delivered through a design-build-finance-operate-maintain partnership (DBFOM) in which the city owns the composting facility but contracts all project duties to a private actor (The Canadian Council for Public Private Partnerships, 2023; Gordichuck, 2023, p. 6; UN-OHLLRS, 2021, p. 13). The municipal government pays the private actor in installments based on operations and performance (The Canadian Council for Public Private Partnerships, 2023; UN -OHLLRS, 2021, p. 13). To accumulate funds, Calgary implemented a green cart fee of $9.03 monthly, or $108.36 annually, for green cart and kitchen pail provision, collection, facility operations, and education campaigns (City of Calgary, 2023). Edmonton has a similar program and also increased their utility fees to secure funds (City of Edmonton, 2023). However, they financed and delivered it through a build-own-operate (BOO) model in which a private actor builds, owns, and operates the facility and at the end of a given period, renegotiates the terms of its service contract with the city (Gordichuck, 2023, p. 3; UN-OHLLRs, 2021, p. 12). Although program details vary with

location, characteristics like increased utility fees and public-private finance and delivery models are consistent across multiple cities (City of Calgary, 2023a; City of Edmonton, 2023; Gordichuck, 2023, p. 3). Overall, the various benefits of municipal composting and its frequency across Canadian cities indicates its potential feasibility as an emissions reduction policy for Winnipeg.

Urban Agriculture

Urban agriculture is the local, decentralized, community-based production of agricultural goods in urban areas (Horst et al., 2017, p. 280; Regeneration, 2023). It is a fluid policy that manifests as individual or community gardens in various settings such as parks, rooftops, and balconies (Regeneration, 2023). Gardeners use their harvests for various purposes including personal consumption, as foodbank donations, and to sell in local markets (Horst et al., 2017, p. 281; Regeneration, 2023; Santropol Roulant, 2021a). Like other forms of urban greening, urban agriculture mitigates air pollution via photosynthesis (McGill Office of Sustainability, n.d., p. 5; Stancil, 2015). Crops absorb carbon dioxide and water which react in the presence of sunlight to produce glucose and oxygen, subsequently reducing atmospheric carbon levels (Basham & Lambers, 2023).

In addition to its capacity for pollution reduction, both scholars and gardeners associate a range of co-benefits with urban agriculture (Egerer et al., 2018, Horst et al., 2017, p. 281; Regeneration, 2023; Santropol Roulant, 2021a). Urban farming increases community food security when gardeners share, donate, and consume the produce that they grow (Horst et al., 2017, p. 281). In Seattle, families engaging in urban agriculture offset their produce needs by 30-40% (Horst et al., 2017, p. 281). Community garden participants in California and Colorado also cite improvement of health and community vitality as positive effects of urban agriculture

(Egerer et al., 2018, pp. 8-9; Tieg, 2009, p. 1117, 1121). They explain that crop cultivation provides physical exercise, that gardens are spaces for relaxing and decompression, that urban agriculture keeps cultural practices and traditional foods alive, and that community gardens are a nexus for "a sense of community that you don't find in other places" (Egerer et al., 2018, pp. 8-9; Tieg, 2009, p. 1117, 1121). Furthermore, urban farms are sites for youth education and workforce entry programs that contribute to the long-term development of human capital (Horst et al., 2017, p. 281). Youth can learn valuable life skills like planning, scheduling, decision-making, and organizing (Rogers, 2018, p. 222). For example, the Freeport Highschool Student Farm and Orchard combines springtime vegetable production courses with summertime employment to teach students business and agricultural skills through classes, cultivation, and the operation of a weekly market stand (Rogers, 2018, p. 222).

Winnipeg may draw information and inspiration from multiple Canadian cities with established urban agriculture programs (City of Winnipeg, 2015, p. 11; Ville de Montreal, 2023a). Montreal is a world leader in urban agriculture and continues to build its program through the city's official urban agriculture strategy. *Stratégie d'agriculture urbaine 2021-2026* pursues a shared vision of urban farming crafted with input from the city, stakeholders, and communities (AIPH, 2023). Local NGOs, schools, and community members are responsible for on-site leadership and implementation while the city reduces barriers to procuring agricultural space, leads education campaigns, creates funding opportunities for ecological transition and garden renovation, connects gardeners with experts, and creates governance frameworks (AIPH, 2023; McGill Office of Sustainability, n.d., p. 6). Urban agriculture in Montreal largely depends on public advocacy and grassroots activity – its success is attributable to community participation. Non-profit organizations like Santropol Roulant, local businesses like Lufa Farms,

and schools like Concordia University and McGill University are responsible for developing cornerstone projects in Montreal's urban agriculture network such as the Edible Campus and the Sustainability Projects Fund (McGill Office of Sustainability, n.d., p. 6). Due to significant citizen engagement, Montreal committed to $10 million over 10 years to urban agriculture (Ville do Montreal, 2023b, p. 13).

In their *Budget 2023 et PDI 2023-2032,* Montreal explicitly states that municipal financial commitment is in response to citizen enthusiasm for urban agriculture (Ville de Montreal, 2023b, p. 13). This implies that to reap the social and ecological benefits of urban agriculture policies, Winnipeggers must internalize and participate in urban agriculture as a community-led initiative supported by government resources. The development of official urban agriculture plans in cities like Toronto, Edmonton, and Vancouver indicate that successful urban agriculture need not be unique to Montreal and may be viable in Winnipeg as well (City of Winnipeg, 2015, p. 11).

Municipal Composting and Urban Agriculture in Winnipeg

While the benefits of municipal composting and urban agricultural are substantial and there are numerous cases of successful programs across Canada, their feasibility as air quality improvement policies in Winnipeg requires further consideration. Factors like citizen attitudes, culture, population, size, and GDP per capita create unique contexts within individual cities (City of Calgary, 2022, p. 18, 95; Statistics Canada, 2021a; Statistics Canada, 2021b; Statistics Canada, 2021c). As such, although policies in other Canadian cities are useful points of reference, they cannot be directly transplanted into Winnipeg's political climate. Subsequently, this paper turns to a three-part analysis to address critical topics for consideration in deciding to implement municipal composting and/or urban agriculture in Winnipeg.

Analysis Part 1: Alignment with Existing Legislation and Policies

The assessment of existing provincial legislation and municipal policy frameworks necessarily precede discussions of capacity, resources, and public opinion. Doing so determines whether legal structures and policy direction encourage or restrain the implementation of these policy options in Winnipeg.

1.1 The City of Winnipeg Charter Act

The City of Winnipeg Charter Act determines the purpose, general authority, and legal powers of Winnipeg's municipal government (The City of Winnipeg Charter Act, 2003, explanatory note). According to the Act, Winnipeg has complete authority to implement municipal composting and urban agriculture (The City of Winipeg Charter Act, 2003, sect. 135(1), 135(2), 139(j), 209(1)(a), 209(2)(c), 209(2)(i), 211, 236(1), 236(2)(a), 236(2)(r), 236(2)(t), 255). Section 209(1) states that the city may establish, extend, improve, and maintain facilities and utilities within or outside Winnipeg (City of Winnipeg Charter Act, 2003). Thus, the Winnipeg may independently introduce municipal composting as a new utility or service and build the necessary facilities to do so (City of Winnipeg Charter Act, 2003). To fund such endeavours, council has the power to set and collect fees for services, such as green bin collection, and engage in partnerships with public or private actors at their discretion (The City of Winnipeg Charter Act, 2003, sect. 209(1)(a), 209(2)(c), 209(2)(i), 211).

The Charter also grants the city several powers that legally enable the development of urban agriculture programs. Council has the authority to set zoning by-laws on "standards, criteria or requirements respecting the subdivision of land in the city" (City of Winnipeg Charter Act, 2003, sect 255(1); Province of Manitoba, 2015, p. a-2). Sections 135(1) and 135(2) further

specify that council "may pass by-laws respecting people, activities and things in, on or near public places or places open to the public" including parks, recreation and leisure facilities, and community centres – all of which are viable spaces for urban agriculture (The City of Winnipeg Charter Act, 2003; Regeneration, 2023). The City of Winnipeg Charter Act therefore establishes the legal power and tools required for the city to adopt municipal composting and urban agriculture. Winnipeg may implement these policies without the added complexities of provincial-municipal partnerships, although intergovernmental collaboration may be necessary to secure funding. Nevertheless, should municipal composting and urban agriculture align with Winnipeg's official policy priorities, council may act autonomously in their pursuit.

1.2 OurWinnipeg 2045

OurWinnipeg 2045 (OurWinnipeg) is Winnipeg's official plan and reflects its policy direction for the next 22 years (OurWinnipeg By-law, 2020, p. 8). As section 235 of the City of Winnipeg Charter Act requires that "development within the city be consistent with *OurWinnipeg* policies", investigation of alignment between potential policy options and the official plan is critical (OurWinnipeg By-law, 2020, p. 5). *OurWinnipeg* conceptualizes Winnipeg's future development under six broad goals (OurWinnipeg By-law, 2020, pp. 8, 21). Each goal is further broken down into measurable objectives for its achievement as well as several high-level policy direction statements (OurWinnipeg By-law, 2020, pp. 8, 21-23). *OurWinnipeg*'s goal of environmental resilience encompasses municipal composting and urban agriculture – both policy options explicitly align with several of its objectives and policies (OurWinnipeg By-law, 2020, pp. 21-23). To illustrate, municipal composting and urban agriculture contribute to the following development targets: objective 4 to "minimize and divert waste from the landfill", objective 5 "to protect and value ecosystems as essential components of

life", policy 2.7 for "air quality conservation", policy 2.16 for "waste minimization", policy 2.20 for leveraging green infrastructure, and policy 2.22 for local food security via urban agriculture and local food systems (OurWinnipeg By-law, 2020, pp. 22-23). As municipal composting and urban agriculture closely adhere to *OurWinnipeg,* their implementation could help advance Winnipeg towards its official development goals.

1.3 Complete Communities Direction Strategy 2.0

Complete Communities Direction Strategy 2.0 (Complete Communities) is Winnipeg's secondary plan that guides "growth, development and land use" within the city. It coordinates the physical structure and characteristics of Winnipeg with the policy direction outlined in its official plan (Complete Communities Direction Strategy 2.0 By-law, 2020, p. 6). As such, to achieve the official development goals in *OurWinnipeg*, municipal composting and urban agriculture must also align with the spatial development framework in *Complete Communities* (Complete Communities Direction Strategy 2.0 By-law, p. 6; OurWinnipeg By-Law, 2020, p. 5). *Complete Communities* is organized into 24 sections, each with its own high-level vision statement, goals to set policy direction, and policies to guide the achievement of each goal (Complete Communities Direction Strategy 2.0 By-law, 2020, p. 4-5). While the policies in *Complete Communities* promote urban agricultural activities, they are significantly less compatible with municipal composting initiatives. For example, Section E2. "Rural and Agricultural", reflects intent to create physical space for urban agriculture. It does so through policy 3.1 to permit specialized agricultural activities where urban development is unlikely to take place and policy 3.4 to support initiatives that provide access to local and sustainable food choices (Complete Communities Direction Strategy 2.0 By-law, 2020, p. 117).

Alternatively, policies promoting the construction of a municipal composting facility are absent. Section G2. “Strategic Infrastructure and Resources”, goal 2, aims to “limit potential risks to health and safety [from landfills] and limit land use conflict between active landfills and new development” (Complete Communities Direction Strategy 2.0 By-law, 2020, pp. 133-134). Nevertheless, no policy within *Complete Communities* suggests setting aside land for the development of an industrial composting facility. The policy most closely aligned with municipal composting is Section G2. “Strategic Infrastructure and Resources”, policy 3.2, which suggests restoring “closed landfills for recreational or other appropriate uses” – a somewhat insubstantial connection (Complete Communities Direction Strategy 2.0 By-law, 2020, p. 133). Should Winnipeg decide not to allocate land for a composting facility within city limits, the city may choose to haul compostable materials to a location in another municipality, similarly to Toronto’s previous externalization of waste to Michigan. However, the City of Winnipeg has not stated intent to pursue such a strategy and thus, despite recent council approval for a curbside organic pick-up program, facility location remains undetermined (City of Winnipeg Executive Policy Committee, 2023, p. 3; Complete Communities Direction Strategy 2.0 By-law, 2020, pp. 133-134; Gordichuck, 2023, pp. 18).

An investigation of existing legislation and policy reveals that Winnipeg has the power and legal tools to autonomously implement municipal composting and urban agriculture programs. It further indicates that the policy options strongly align with official plans for urban development in Winnipeg. Although commitment to land allocation for a composting plant remains outstanding, Winnipeg generally expresses desire to pursue environmental resilience and air quality improvement through municipal composting, urban agriculture, and similar green

policies. While the legislative and policy outlook is encouraging, questions of capacity, resources and public engagement remain.

Analysis Part 2: Capacity and Resources for Implementation

Questions of capacity consider the resources that Winnipeg already has and still requires to facilitate the implementation of municipal composting and urban agriculture. This portion of the analysis addresses land and funding requisites for these policy options and explores routes and barriers to procuring space and financial support for operations.

2.2 Land Requirements, Capacity, and Procurement

While municipal composting and urban agriculture differ in their land-use needs, zoning by-laws critically influence the supply of land for both policy options. An examination of zoning by-laws is the first step in identifying obstacles and pathways to land attainment for municipal composting and urban agriculture. Winnipeg zoning by-laws generally enable land acquisition for municipal composting programs (City of Winnipeg, 2023a; Winnipeg Zoning By-law No. 200/2006, 2008, pp. 25, 49, 77). Municipal composting requires a large block of undivided land to house an industrial composting plant. For refence, the Calgary Composting Facility consists of three buildings that occupy 0.5km^2 of land (City of Calgary, 2023b). Additionally, facility land must be zoned for "garbage incineration and reduction" which is currently permissible in only two Winnipeg zoning districts: Manufacturing Heavy (M3), and under specific conditions, Agricultural (A) (Winnipeg Zoning By-law No.200/2006, 2007, pp. 49, 77). Significant areas of land larger than 0.5km^2 are zoned as M3 and A and thus, could serve as sites for a composting plant (City of Winnipeg, 2023b). However, one should note that existing developments on appropriately zoned land limit available space (City of Winnipeg, 2023b). Redefining

"composting" under Winnipeg Zoning By-law No.200/2006 could increase the availability of land zoned for industrial composting activities. Currently, the definition "garbage incineration and reduction" refers to a facility that treats, burns, compacts, composts, or disposes of solid waste (Winnipeg Zoning By-law No.200/2006, 2008, p. 25). As a result, although humans may live closer to a composting facility than a conventional waste disposal site without experiencing negative health effects, the definition limits potential locations for a composting plant to those of a landfill or incinerator (Ward & Weins, 2018, p. 5). Ultimately, Winnipeg zoning by-laws permit municipal composting in several areas across the city. However, existing developments in M3 and A zoning districts and the legal definition of composting restrict the supply of viable land for an industrial composting facility within city limits.

Winnipeg zoning by-laws not only permit but encourage urban agricultural practices. Unlike municipal composting, urban agriculture operations do not require a large area of uninterrupted land (Regeneration, 2023). Program location is flexible as crops can grow in various unconventional locations like balconies, rooftops, and vertical farms (Regeneration, 2023). Despite this, both scholars and gardeners report land procurement as a major barrier to urban agriculture (Huang & Drescher, 2018, p. 2; Syvixay, 2017). Voigt elaborates that outdated zoning by-laws may impede urban agriculture and prohibit cultivation on fertile and accessible land (2011, p. 538). In response to such issues, Winnipeg amended its zoning by-laws in 2021 to remove unnecessary restrictions on urban agriculture (City of Winnipeg, 2023c). The amendment adds definitions for "urban agriculture, indoor" and "urban agriculture, outdoor" to existing zoning by-laws to clarify and expand the land available for urban agricultural activities (City of Winnipeg, 2023c). As a result, indoor urban agriculture can occur in industrial areas and select commercial areas and outdoor urban agriculture is unconditionally permissible across most

zoning districts except M3, Manufacturing General, and select downtown districts (By-law to amend the Downtown Winnipeg Zoning By-law and the Winnipeg Zoning By-law to facilitate urban agriculture, 2021, pp. 1-4). Given this amendment to city zoning by-laws, there is a significant supply of land zoned for urban agriculture in Winnipeg that may help new programs flourish.

Although Winnipeg zoning by-laws permit municipal composting and encourage urban agriculture, land obtainment is not guaranteed. In addition to existing developments limiting available land zoned for these activities, municipal composting and urban agriculture may struggle to compete against powerful developers for land procurement. Milgrom cites the development of Waverly West to illustrate the influence of private developers on urban development in Winnipeg (2011, pp. 95-97). He explains that in 2006, the official plan in effect "called for the creation of a compact city with a "downtown first" policy" (Milgrom, 2011, p. 95). Despite this official policy goal, council approved the development of Waverly West, a "sprawling suburb", also in 2006 (Milgrom, 2011, p. 95). Council's approval was influenced by skewed housing and population data prepared by the landowner's planning consultant and by input from a "neighbourhood advisory committee" of which representatives from the housing and transportation industries were members (Milgrom, 2011, pp. 96-97). The case of Waverly West illustrates that private developers and industries have significant power in Winnipeg and can cause decision makers to deviate from *OurWinnipeg* policy directions. Subsequently, while municipal composting and urban agriculture are *OurWinnipeg* policy goals and there is land in Winnipeg zoned for their operations, there is no promise of their successful competition against powerful private actors proposing more immediately profitable projects.

2.2 Funding Requirements, Capacity, and Procurement

Municipal composting and urban agriculture are alike in their source of existing funds. As they are entirely municipal policies, should Winnipeg choose to independently finance municipal composting or urban agriculture programs, city revenues would serve as their monetary support (Eidelman et al., n. d., p.2). Key revenues contributing to the City of Winnipeg 2023 budget include property tax, frontage fees, business taxes, transfers from various reserves, and "pandemic-related funding" from the federal and provincial governments (City of Winnipeg, 2023d). However, the provincial and federal collection of sales and incomes taxes limits municipal revenue and thus, capacity for program delivery (Eidelman et al., n. d., p. 2). As a result, Winnipeg may require supplementary financial assistance to fund municipal composting and urban agriculture in addition to its ongoing programs.

As Municipal composting requires significantly more financial resources than urban agriculture, routes to additional funding vary between the two policies. Municipal composting expenditures include green bins, kitchen pails, facility construction, facility operation, a city collection fleet or collection contract with a private operator, and education campaigns (Kives, 2017; MacLean, 2023a). Winnipeg conservatively estimates $17 million in capital costs and $22 million in operating costs for a total municipal composting budget of $39 million (Gordichuck, 2023, pp. 16-17). As done in Calgary and Edmonton, Winnipeg can raise its waste diversion fee (WDF) to support program implementation (City of Calgary, 2023a; City of Edmonton, 2023). The public service recommends that the waste diversion fee increase by $8.00 in 2024 to fund the "initial deployment and management of green carts and kitchen pails" (Gordichuck, 2023, p. 3). An additional $88.00 increase to the waste diversion fee in 2030 would pay for the operational costs of a municipal composting program for a net increase of $96.00 per single

family residence by 2030 (Gordichuck, 2023, p. 3). This rate assumes no external financial contribution and aims to cover estimated costs with WDF revenue and existing equity from the Waste Diversion Reserve (Gordichuck, 2023, pp. 3, 16-17).

The city may pursue several potential financing strategies to help manage the costs of a municipal composting program. To finance the construction and operation of a composting plant, Winnipeg may engage in a public-private partnership – a popular approach among Canadian cities including Edmonton, Saskatoon, Calgary, Ottawa, and Halifax (Gordichuck, 2023, p. 7). Although there are several styles of public-private partnerships, based on an assessment of program costs and the "organics processing market in Canada", the public service recommends a BOO approach to financing and delivering composting services to Winnipeggers (Gordichuck, 2023, p. 3). In this model, a private actor builds, owns, and operates the facility and contracts out its services to Winnipeg (Gordichuck, 2023, p. 3; UN-OHLLRs, 2021, p. 12).

To supplement municipal revenue and reduce WDF increases, Winnipeg may secure additional financial resources through the provincial and federal governments. A municipal composting program could receive provincial financial support through the Strategic Municipal Investment Fund (Government of Manitoba, 2023). The 2023-2024 Strategic Municipal Investment Fund sets aside $137.9 million of unconditional operating funding and $89.8 million of conditional capital funding for Winnipeg (Province of Manitoba, 2023a). While this fund could support a municipal composting initiative, the allocation of capital funding depends on provincial strategic infrastructure goals – provincial priorities trump municipal priorities (Province of Manitoba, 2023a). Municipal composting programs are also eligible for federal support through programs, grants, and funds (Gordichuck, 2023, p. 17). For example, the Low Carbon Economy Challenge program is available to a range of actors pursing projects that reduce

greenhouse gas emissions, including not-for-profits, provincial governments, municipal governments, and others (Environment and Climate Change Canada, 2023). Select recipients receive a federal contribution equal to 25-75% of eligible costs for a maximum total of $25 million (Environment and Climate Change Canada, 2023). Overall, despite the financial commitment required for municipal composting policies, there are several options for financing and securing external funds to support implementation.

Procuring additional funding for urban agriculture is simpler than doing so for municipal composting because the former does not require an industrial-sized facility and typically depends on volunteer-based labour (Horst et al., 2017, p. 282; McGill Office of Sustainability, n.d., p. 6; Santropol Roulant, 2021a; Van de Schans, 2015, p. 5). As such, while urban agriculture expenditures include gardening supplies, potential property rents, education campaigns, and product transportation to local markets, they often exclude gardener wages and major capital expenses (McGill Office of Sustainability, n.d., p. 6; Santropol Roulant, 2021a; Wageningen University, 2023, p. 5).

Although urban agriculture initiatives are low maintenance in comparison to alternative pollution reduction policies, they often lack central funding and direction (Horst et al., 2017, p. 282; Santropol Roulant, 2021b; Ville de Montreal, 2023b; Van der Schans, 2015, p. 5). While urban agriculture is a long-term investment in communal wellness, individual wellness, and human capital, its short-term monetary profits are limited and cannot financially justify the creation of a municipal urban agriculture department (Horst et al., 2017, p. 282; Plumer, 2016). As urban agriculture programs in Montreal and Seattle indicate, government funds and participation are difficult to secure without an established network of grassroots activity or a green space levy (City of Seattle, n.d.; Ville de Montreal, 2023b, p. 13). As a result, urban

agriculture initiatives commonly rely on grants and fundraising for financial support and NGOs and community leaders for on-site delivery (City of Seattle, n.d.; Horst et al., 2017, p. 282; Santropol Roulant, 2021b; Ville de Montreal, 2023b; Van der Schans, 2015, p. 5).

There are several grants available to Winnipeggers that can enable engagement in urban farming practices and the creation of new initiatives. For example, urban agriculture programs are eligible for provincial grants through various funds such as the Conservation and Climate Fund, Winnipeg Foundation grants like the Nourishing Potential Grant, and the Winnipeg Food Council's Urban Agriculture and Community Gardens Small Grants Program (Province of Manitoba, 2023b; Winnipeg Food Council, 2023; Winnipeg Foundation, 2023). While municipal funding of urban agriculture may initially be minimal, as community leaders and NGOs obtain grants, the foundation of urban agriculture in Winnipeg may grow and eventually warrant consistent government funding (Ville de Montreal, 2023b). Until then, the municipal government can make targeted financial contributions through grant provision and assistance with education campaigns to promote budding urban agriculture programs. Thus, although steady, central financial support for urban agriculture is unlikely at this stage – grants, fundraising, and strategic municipal support are routes for procuring financial resources.

A review of Winnipeg's capacity to implement municipal composting and urban agriculture and the resources required to do so indicates that Winnipeg could feasibly pursue these policies. However, barriers to land procurement like competition with developers, and obstacles to funding such as limited municipal revenues, may complicate this process. That said, barriers to implementation may vary with the degree of public support for municipal composting and urban agriculture. To ensure a robust assessment of these policy options within the context of Winnipeg, the third part of this paper turns to discussions of public engagement.

Analysis Part 3: Public Engagement

The third and final portion of this analysis establishes the importance of public engagement in implementing municipal composting and/or urban agriculture. As the success of both policy options rely on public participation, acknowledging potential points of dissatisfaction and identifying strategies for leveraging public support and involvement is critical.

3.1 Social and Political Issues

Social and political debate surrounding municipal composting can influence its viability as an emissions reduction policy for Winnipeg. Key social and political issues related to municipal composting concern waste diversion fee increases, perception of problematic smells, and waste collection challenges. A City of Winnipeg survey shows that 45% of Winnipeggers opposed to municipal composting cite increased taxes as the primary reason for their dissent, and 11% cite smell (City of Winnipeg, 2020, pp. 24-26). While some Winnipeg residents are unwilling to pay a more expensive waste diversion fee, others may face financial pressures that impede their ability to take on additional taxes. As the leading argument against municipal composting in Winnipeg, dissatisfaction and distress over WDF increases require consideration in decisions about program implementation (City of Winnipeg, 2020, pp. 24-26). Additionally, although compost may smell without proper care, maintaining its correct nutrient balance prevents unpleasant odours (Galchen, 2020). Fears that composting facilities omit uncontainable smells are often rooted in misperception (Glachen, 2020). Nonetheless, such worries are relevant regardless of substance as they influence public support for municipal composting. Lastly, recent debate among city officials on solid waste collection may also impact the delivery of curbside compost collection. Currently, private contractors are responsible for all residential waste collection in Winnipeg (MacLean, 2023b). With contracts expiring in 2027, council is

considering a mixed model in which the city collects 1/5 of residential waste to help control service costs, create competition in the private sector, and provide a back-up collection option should problems arise with a private actor (MacLean, 2023b). Furthermore, city councillor Russ Wyatt recently brought a motion before the Water and Waste Committee suggesting that garbage, and in the future, compost collection, shift from weekly to bi-weekly pick-up to reduce fleet emissions (MacLean, 2023b). Although Wyatt's motion was denied, discussion was postponed to spring 2024 indicating that the responsibility for waste collection and frequency of service provision remain points of debate in Winnipeg politics.

There is also a unique set of social and political issues that may influence the pursuit and implementation of urban agriculture as an air quality improvement policy in Winnipeg. The primary social and political tensions surrounding urban agriculture relate to inclusion, urban sprawl, and soil contamination. Case studies in Denver and New York indicate intersecting class and race divisions in urban farming (Horst et al., 2017, p. 284; Plumer, 206; Reynolds, 2014, p. 252). In many instances, white gardeners build gardens in neighbourhoods predominantly populated by people of colour (POC) but fail to include and share the benefits of urban agriculture with POC community members (Horst et al., 2017, p. 284; Plumer, 206; Reynolds, 2014, p. 252). An African American gardener from New York reports isolation and inequity between white and African American operations, expressing concern that "people of colour are being pushed to the side … [while] the people with the most power, the most voices, are getting the money and the people who can't speak as well are [not]" (Reynolds, 2014, p. 252). Although urban agriculture can be socially advantageous, without an awareness of possible divisions between different demographics, urban farms can become places of exclusion. Urban agriculture also stimulates anxieties about urban sprawl and soil contamination (Brown et al., 2015, p. 26;

Kaiser et al., 2015, p. 2075; Mok et al., 2013, p. 38). If urban agriculture develops without integration into city planning practices, farms may drive urban sprawl (Mok et al., 2013, p. 38). For example, if a community garden occupies a space better suited for a building, there is a risk that the building will be located at the edge of the city and increase urban land consumption (Mok et al., 2013, p. 38). Effective urban planning can avoid such inefficiencies but requires an awareness of the issue to do so. Finally, Kaiser and Brown et al. highlight concerns about lead contamination in urban agricultural products (2015, p. 2075; 2015, p. 26). This may be a point of deterrence for Winnipeggers because some urban-agriculture sites are located near old rail infrastructure which can contaminate soil with aromatic hydrocarbons and heavy metals (Wilkomirski et al., 2011). While plant absorption of industrial contaminants and heavy metals like lead is low, perceived health threats can deter potential participants (Brown et al., 2015, p. 30).

In addition to their individual sources of social and political tension, as environmental policies, both municipal composting and urban agriculture involve navigating climate denialism politics. The complexity, uncertainty, and delayed consequences of climate issues are barriers to adopting and garnering citizen participation in environmental policies (Dunlap, 2013, p. 691; Hough, 2018, p. 150). This issue is particularly important to municipal composting and urban agriculture because their success depends on citizen engagement. For example, the city can supply green cart services but if Winnipeggers refuse to sort their waste because they do not believe in climate change, the program will be ineffective. Similarly, Winnipeg can supply funding for urban agriculture, but if communities are skeptical about its social and environmental benefits, they will not build their own community gardens. As such, recognizing and responding to the challenge of climate denialism is central to the proposed policy options.

Policymakers should note the social and political issues related to these policy options and adjust their decision-making accordingly. While existing areas of tension are not symbolic of implausible policies, they affect the nature of program delivery. Furthermore, education may ease contention on issues tied to misperceptions such as smell, soil contamination, and climate denialism.

3.2 Education and Marketing

Education and marketing strategies can help overcome misperceptions about municipal composting and urban agriculture and leverage the citizen participation critical to successful policy implementation. A City of Winnipeg survey shows that 7% of Winnipeggers opposed to municipal composting said they do not have enough food waste to justify city-wide composting and 5% said they do not have enough information (City of Winnipeg, 2020, p. 25-26). This data is indicative of a need for an education campaign detailing the impacts of urban air pollution, benefits of pollution reduction, and program operations. Montreal reports a similar need for education to build the social infrastructure that supports urban agriculture (Ville de Montreal, 2023a). However, while the distribution of informative materials can combat misperceptions, it may be insufficient in stimulating public participation.

To garner further engagement, Winnipeg can use social marketing to present municipal composting and urban agriculture as personally desirable products instead of environmental policies. The city may reference recycling programs as examples of targeted social marketing strategies based on product planning, pricing, communication distribution, and marketing research (Shrum et al., 1994, p. 395). Throughout the 1990s and 2000s, recycling programs crafted persuasive communications to convince citizens "that the importance of recycling (benefits) outweighs the inconveniences (costs)" (Folz, 1991, p. 226; Shrum et al., 1994, p. 407).

Then, to circulate such messaging, municipalities signed contracts with advertising firms to develop promotion campaigns and released advertisements on televisions, radios, and billboards; today, social media provides additional marketing platforms to those listed (Folz, 1991, p. 225). Similar strategies may help overcome social issues and barriers to participation in municipal composting and urban agriculture policies. As such, education and marketing are central to the implementation and success of these policy options in Winnipeg.

Discussion and Conclusion

This analysis establishes urban air pollution as a threat to the physical wellbeing and socioeconomic prosperity of cities and considers municipal composting and urban agriculture as two policy options for emissions reduction and mitigation in Winnipeg. It investigates each program in relation to existing legislation and policy, capacity and resources for implementation, and public engagement to highlight the nuances of adopting the proposed policy options. The analysis reveals several key findings that may influence the decision of policymakers to pursue municipal composting and urban agriculture.

Both policies are attractive in their abundant co-benefits and alignment with existing legislation and policy. The municipal government can autonomously implement either policy, and in doing so, actively advance official Winnipeg policy direction. However, implementing municipal composting and urban agriculture grows more complex with considerations of capacity, resources, and public engagement. While supportive zoning laws create a degree of land capacity for either program, the availability of, and willingness to commit to, a large portion of land for a composting plant remains unclear. Furthermore, as environmental policies, municipal composting and urban agriculture may struggle to compete in Winnipeg's political climate against powerful developers with more profitable projects. Alternatively, should these

policies procure land, the city has several options for securing financial resources to assist with implementation. That said, there are several areas of social and political debate associated with each policy including, but not limited to, opposition to WDF increases. While certain social and political issues require careful navigation and program adjustments, such as WDF increases in municipal composting and inclusion in urban agriculture, education may ease others like climate denialism and concerns about soil contamination.

Overall, given their alignment with existing legislation and policy and the available capacity and resources for implementation, this analysis considers municipal composting and urban agriculture viable air quality improvement policies for Winnipeg. Nevertheless, it cautions policymakers to adequately address and accommodate social and political concerns surrounding each policy and direct significant effort towards building the social infrastructure on which municipal composting and urban agriculture depend.

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