# NAMUR-HIPPODROME

## ECOLOGY *AND* PUBLIC SPACE

Assignment 2C
URBP 623 - Studio 2

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# GUIDING PRINCIPLES

## ECOSYSTEM SERVICES

Ecosystem Services (ES) refers to the benefits to human life and activity bestowed by the natural ecosystems within which we live. Also referred to as 'nature-based solutions', scholars tend to categorise these services into three broad groups: provisioning services, such as the support of food systems, pollination, timber, or drinking water; regulating services, such as climate stabilisation, the maintenance of biodiversity, or air pollution mitigation; and cultural services, such as recreation, the support of human culture, and intellectual enrichment. In urban contexts, the quality, quantity, and diversity of ES are tied explicitly to the health and wellbeing of residents, making the cultivation of ES a key strategy for practitioners seeking to build resilience in the face of climate change and socioeconomic inequality. Therefore, the Namur-Hippodrome site offers a rare opportunity for the City of Montreal to pursue a bold, large-scale strategy that places ES and nature-based solutions at the centre.

## CIRCULAR ECONOMIES TO REDUCE ECOLOGICAL IMPACTS

Closed loop and circular economy designs aim to reduce or eliminate waste in the production and consumption cycles of our economy. Recycling valuable resources can limit the negative impacts inflicted on the natural environment. In practice, this includes optimising resource efficiency and recirculating products and materials, which can in turn help regenerate nature (Ellen Macarthur Foundation website; Garcés-Ayerbe et al. 2019). In urban contexts, the key contributors of ecological impacts include energy, water, and solid wastes. Hence, these systems will be the main focus of circular economy designs on the Namur-Hippodrome site.

## A LIVABLE COMMUNITY FOR ALL AGES

Despite the rapidly aging population in Quebec, a large number of young families are on the waiting list for affordable housing in Montreal. Current plans for the Namur-Hippodrome site include a significant number of units dedicated to decommodified housing. Therefore, planning livable communities for all ages is another important principle that will allow us to meet the dynamic needs identified by the Community Demand group (Zhang et al 2019). In practical terms, this means designing public spaces that are both walkable and safe, and that provide appealing areas for activity and play (Warner 2019). Seasonality is also an important consideration, which influences how spaces will be used year-round.

# SIX ACTION AREAS

1. PARKS AND PUBLIC SPACE
2. BIODIVERSITY
3. WATER MANAGEMENT
4. URBAN AGRICULTURE
5. DISTRICT HEATING AND COOLING
6. WASTE MANAGEMENT

# PARKS AND PUBLIC SPACE

Parkland is an important consideration when planning for a new development due to its positive effect on quality of life and its contribution to the neighborhood environment. When a lot is subdivided for development, a municipality can require up to 10% be reserved for parks; the design of the Hippodrome park lands pushes the envelope on the amount of green space each resident should have access to near their home. In the proposed plan, green corridors, parks, and the wetland represent 13 hectares of land, or close to 30% of Montreal's Hippodrome property. This is close to 20 square meters of land per residence, not counting the biodiversity corridor planned on CP land, or the courtyard greenspace of each building. Including these brings the total expected greenspace to 21 hectares or 31 square meters per residence.. Of course, the amount of land reserved for green space does not ensure the quality of the spaces within this area. Therefore, key elements prioritized in the park design are accessibility, sustainability, connectivity, and activity.


SITE OVERVIEW


PARK OVERVIEW

1. ACCESSIBILITY ensures all residents can take advantage of the spaces within the park lands, while creating a safe environment.

2. CONNECTIVITY provides links between different areas of the neighborhood and enables active transportation. It also implies a park which serves as a space to connect with others and encourage encounters.

3. SUSTAINABILITY gives space to active transport and sources local materials when possible. It also means encouraging carbon capture where possible.

4. ACTIVITY promotes physical and mentally stimulating pastimes within the parklands, year round.

## HIPPODROME PARK

The Hippodrome Park is designed as a versatile space through the 4 priorities of park design, the first of which is accessibility and guides multiple interventions within the proposed park.

## ACCESSIBILITY

Accessibility is firstly addressed through the inclusion of at-grade access points, avoiding the need for steps to enter, and this concept of gradients or slopes taking precedence over straight edges continues throughout the park, ensuring a cohesive style with a greater impact on accessibility through permanent elements. These smooth transitions instead become inherent to the park's design and feel, which whenever possible excludes built structures such as fences or traditional jungle gyms. A major accessibility feature is the design of playgrounds, taken from Harper's Playground, an initiative from Portland Oregon which created a movement of radically inclusive playgrounds. This design allows for access throughout by incorporating a hill, with a wheelchair accessible spiral path, leading to two double width slides allowing for a caretaker's accompaniment down if needed. Traditional swings are replaced with platform swings, which are universally usable with caretaker assistance. Although some other features such as a bouldering wall are included, they complement the natural aspect of the park despite not being accessible to all.

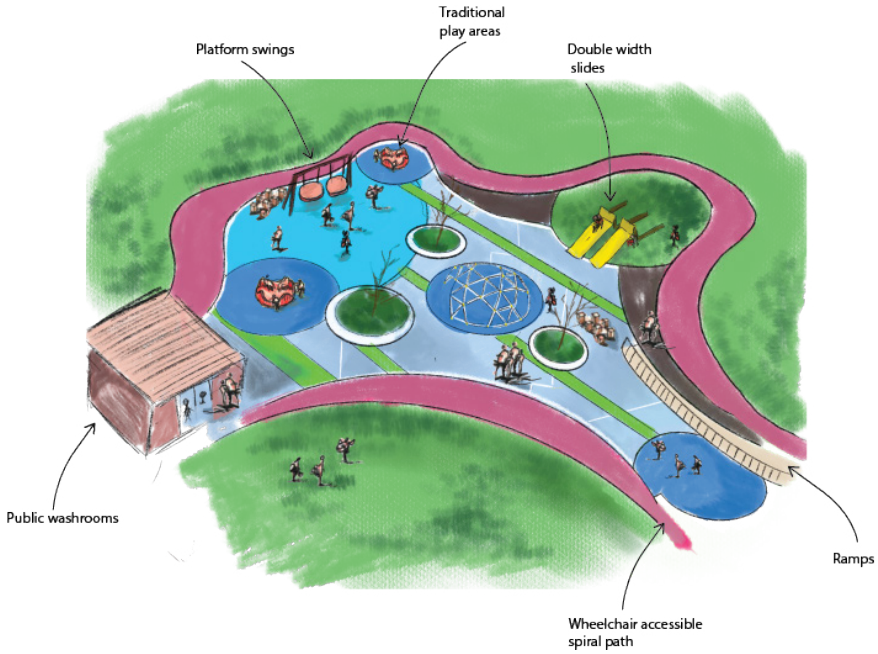
Additional infrastructure such as benches and picnic tables promote inclusivity by having back rests and a wheelchair overhand respectively. Similarly, two public restrooms with water fountains on either side of the park allow for it to be enjoyed by all, without requiring visitors to have access to a private restroom nearby.

Ensuring safety within the park is also an integral part of accessibility, which is why walking paths should be fitted with lights. Additionally, since the park is large, it is infeasible to create 'eyes on the street' throughout its entirety; a perimeter path instead offers the ability to enjoy the park while remaining close to residential buildings. The promotion of a variety of activities year-round within the park as will be later discussed also aids in ensuring passive security.

## CONNECTIVITY

Connectivity within the park is firstly achieved by the numerous entry points, and the valuable paths between them, notably the diagonal connecting the southwest to the northeast, which is an important route to the entry point of the neighborhood or the Namur metro station. Direct paths between proximate key destinations improve flow throughout the park, while movement throughout the park is aided via public art and maps. Due to the large number of entry points and intersections within the park, many of these locations will include public art, each of a local animal such as a fox. This enables easier communication between residents through defining locations by animals, while also serving as landmarks throughout the park to inform wanderers of their current location. Areas within the park such as the soccer field seating or playground facilitate connections between members of the neighborhood by providing activities in which they can participate together. These activities are at the core of what the park can provide in terms of connection opportunities.

SOCCER FIELD AT THE HIPPODROME PARK




PLAYGROUND AT THE HIPPODROME PARK

## SUSTAINABILITY

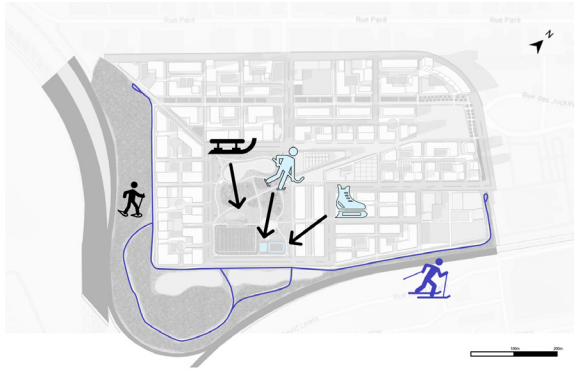
The design language of the park creates a basis for sustainability by avoiding structural elements whenever possible. Simply put, a grassy mound or robust hedge will last considerably longer than a chain link fence, such is the proposal to border the soccer field, increasing both the visual appeal and longevity of the park. A similar approach
is taken to the bleachers adjacent to the field, which will instead be stone seating embedded in a hill built from excavated material resulting from construction. Despite the additional efforts in construction, the resulting seating structure is long-lasting and creates opportunity for additional activities as will be discussed in the ‘activity’ priority section. Natural landscaping features such as the pond include vegetated sloped sides and thus don’t require containment through concrete. The emphasis on green space allows for the establishment of a cool micro-climate,

providing relief from the surrounding heat island. Plant choices related to biodiversity are interrelated to sustainability and are discussed in the biodiversity section. An additional sustainability feature is the inclusion of LED lighting to minimize power consumption, and light shields to minimize light pollution. Multi-use pathways throughout the park encourage active transportation and bike racks at key locations such as the playground and soccer field provide ease of access for bicycle users, minimizing the need for a motor vehicle.

## ACTIVITY

A variety of sports can be played within the park. Structured ones such as soccer and football have a dedicated space, but open space provides the possibility for informal sports such as Frisbee and yoga. Multi-use pathways allow for other informal activities such as rollerblading, biking, running, etc. The soccer field doubles as an additional venue within the neighborhood for concerts or theater, as a stage can be set and the built seating resembles that of an agora, providing a valuable community activity open to all. The hill on which seating is placed provides an additional use in the winter as its backside acts as a tobogganing hill. Additional winter activities within the park include skating or hockey and cross-country skiing. Providing for a variety of winter activities ensures the park remains in use all year for more than just commuting. Picnic tables and benches throughout the site offer the opportunity to gather and enjoy the outdoors for an extended period. Lastly, learning opportunities are placed throughout the site in the form of information panels on the flora and fauna, but also in a 'find them all' activity aimed at children, through which they must find and identify all the animal art installations.

TOPOGRAPHY MAP OF HIPPODROME PARK



HIPPODROME WINTER ACTIVITIES

## GREEN CORRIDORS

Green corridors create a loop around the entirety of the hippodrome site, but their design differs throughout. Thus, the green corridors are broken up into sections described below, highlighting the priorities which they feature prominently. There are aspects of the green corridors that are consistent throughout their entirety, but together

the green corridors prioritize accessibility, connectivity and sustainability by ensuring access throughout the site as well as transportation. Activity throughout the entirety, or most of the green corridors include walking, biking, and cross-country skiing, which have their respective spaces within the corridor.

A green corridor, measuring 25m in width, will be placed in the northern portion of the site, running along an east-west axis. A bicycle and walking path will be added to create a streamlined route to the Namur metro station, with a tree-lined meridian separating the paths. A wet swale will be incorporated in order to restore wetland activity in the area and increase opportunities for biodiversity. The corridor will also contain areas for agriculture, allowing more dynamic use of the space. Guild planting will help create a visually interesting environment, with picnic tables being placed along the paths. This will make the corridor accessible to people with reduced mobility by offering locations for rest.

The southern portion of the green corridor, about 25 meters in width follows the railway. It features pollinator grasslands and serves as a buffer between the residential development and the rails. This portion also contains dense trees and hedges on the southern side to provide a visual, and to some extent, sound barrier against the rail. In terms of connectivity, this portion of the green corridor loop serves the southern residences with a pleasant pathway to get to metro Namur, the walking trail in the southwest of the site, or to the Hippodrome park. The eastern portion is 20m in width and acts as a buffer to the large private parking lots adjacent to the site, thus it contains a more dense amount of trees and greenery. The path visually opens onto the


NORTH GREEN CORRIDOR


SOUTH GREEN CORRIDOR

housing and school to the west of it, allowing for a more pleasant walking environment. The school also benefits from a more pleasant environment by having this strip of greenery in place. When cutting through the plaza near the Rue Jean-Talon O and Rue des Jockeys intersection, the corridor contains more paths for crossing through it perpendicularly easing access to and from the site. In this area, the corridor contains less greenery and instead has a more formal park style to allow more traffic in the area.

The western portion is adjacent to the biodiversity corridor, acting as a further extension of this forested area. Additionally, there is a bike path and walking path. In the northwest portion, a diagonal section aims to connect the Hippodrome park to areas outside of the site. This section is an important addition due to the potential for additional redevelopment of surrounding regions.

# BIODIVERSITY

Southern Quebec faces numerous anthropogenic ecological challenges. The Saint Lawrence Lowlands are not only the site of particularly high biological diversity within the province but are the most densely populated parts of the province as well. In the region, 45% of pre-Columbian wetlands have been lost – and this number rises to 80% in the Montreal region. In their White Paper on a “Plan Sud pour le Quebec”, a working group of Quebec ecology experts identify several major challenges for biodiversity in this part of the province. Of these, three fall directly within the purview of urban planners. These include habitat fragmentation, ecosystem degradation, and competition from invasive species.

BIODIVERSITY CORRIDOR

## HABITAT FRAGMENTATION

Landscape connectivity is an essential component of any functioning ecosystem. By facilitating healthy migration and breeding patterns, landscape connectivity allows for the maintenance of genetic diversity and enables species to better adapt to changing climates by moving northward to habitats that meet their needs. Unfortunately, habitats can become fragmented due to human activity, such as urban sprawl, the construction of major transportation infrastructure (such as roadways and highway exchanges), and the installation of dams. Some human-initiated infrastructure, however, can have mediating effects on habitat fragmentation, thereby facilitating landscape connectivity; examples of such infrastructure include railroads and hydro corridors, the legal framework of which both result in relatively wide, linear corridors which can connect disparate habitats.

## ECOSYSTEM DEGRADATION

In addition to the sequestration of ecosystems through habitat fragmentation, the ecosystems that remain are often highly degraded in their quality and ability to provide a home to species. Since 1970, urban sprawl in Quebec has increased ninefold (Auzel 2021), further increasing ecosystem degradation. This sprawl contributes to ecosystem degradation via pollution, littering, logging and soil degradation (such as through dog waste, which introduces foreign nutrients to soils). On the Island of Montreal, which has been continuously occupied and developed for several centuries, almost no original, undegraded ecosystems remain, but there are many opportunities for restoration. Indeed, one such opportunity identified by the Communauté Metropolitain de Montréal lies in the furthest southern edge of the Hippodrome Site. Habitat categories which are candidates for restoration or re- establishment on the Island include wetlands, deciduous forests, and grassland.

## COMPETITION FROM INVASIVE SPECIES

The propagation of invasive species, introduced into ecosystems beyond their natural habitat by humans or by environmental disruption, present another important threat to biodiversity in southern Quebec. By causing a disequilibrium in habitat systems (often having no natural predators or other limits to population growth), these species can degrade ecosystems and compromise their long-term function. Some invasive species in southern Quebec include the Emerald Ash Borer, alder buckthorn, European buckthorn, and phragmites – the latter of which is found abundantly throughout the Hippodrome site.

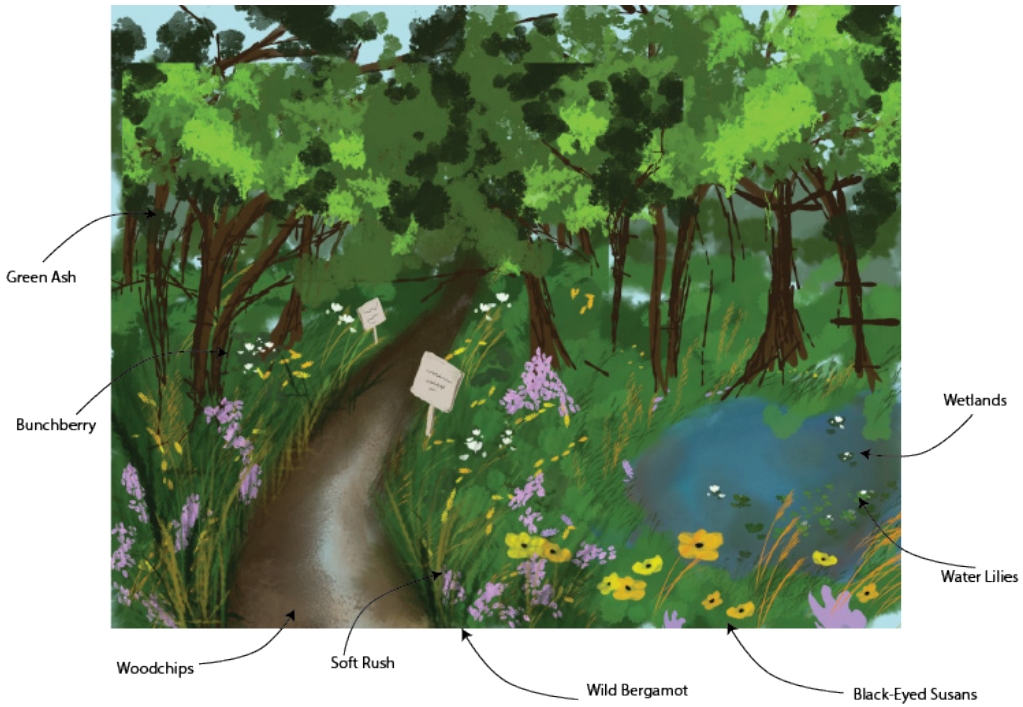
On the Island of Montreal, the three issues above have combined to result in 60% species loss and over 90% forest loss. These issues led the authors of the White Paper to call for a “rethink of our relationship with nature and recognize that land is a finite resource” and to recommend a “strict integration of biodiversity conservation into land use planning” (Auzel 2021).

## STRATEGIC GOALS TO PROMOTE BIODIVERSITY

The development of the Hippodrome site presents an opportunity to strengthen the ecological wellbeing of the region and weave the site into the fabric of biodiversity interventions already underway on the Island of Montreal. Our strategy for the Hippodrome site will reconnect fragmented habitats by creating new ecosystems at the neighbourhood scale which prioritize native species. These overarching goals will form the basis of the recommendations in the following section. First, each concept will be briefly introduced with case studies from Montreal and around the world.

The creation of ecological networks to restore opportunities for movement between species' habitats represents a promising strategy to slow and even reverse the loss of biodiversity; corridors of even small sizes (such as 1-2 kilometres) can have a significant impact on biodiversity. The scope of the task at hand is not only limited to reconnecting fragmented landscapes on the Island of Montreal for terrestrial species, but also to wider the wider ecological context in Southern Quebec. This means both a north-south axis at the metropolitan scale to restore Montreal's place within the Monteregian hills to the south and Laurentian mountains to the north, and an east-west axis at the city and borough scale to stitch together fragmented parks and green spaces on the Island.

Fortunately, two efforts to achieve these exact axes are already underway in the form of the Ville Saint-Laurent biodiversity corridor and the Darlington biodiversity corridor. The Ville Saint-Laurent biodiversity corridor stretches from Brook Creek and the Bois-de-Liesse Nature Park in the north to the intersection of Cavendish Boulevard and the Trans-Canada Highway in the south. Like the strategy for the Hippodrome presented below, Ville-Saint Laurent's biodiversity corridor aims to reconnect disparate habitats by creating new ecosystems at the neighbourhood scale. It identifies five "linear identities" which consist of ecosystems tailored to the existing environmental conditions found throughout Ville Saint-Laurent, ranging from pollinator meadows to woodlands. Similarly, the Darlington biodiversity corridor seeks to provide contiguous connections for species currently boxed into the confined of Mount Royal by linking the University of Montreal's mountainside campus with its satellite campus in Outremont and the Bertrand Creek in Ville-Saint Laurent. It does so primarily by following existing rights of way along the east-west CP rail corridor and by planting new flora species along Darlington Avenue in Cote-des-Neiges. The Darlington biodiversity corridor plan explicitly notes the incorporation of the Hippodrome site as a key aspect of its implementation.




BIODIVERSTY CORRIDOR PATHWAY

## BIODIVERSITY CORRIDOR

The largest-scope intervention we recommend for the Hippodrome is the creation of a 20-hectare biodiversity corridor comprising the southern and western edges of the site. This biodiversity corridor will contain two components, a forested component which will be discussed here, and a wetland component which will be discussed below. In the narrower southern portion, the biodiversity corridor will have a minimum width of 40m, while in the wider western portion it will have a width of approximately 104m, forming a noise and air pollution buffer between the active CP rail line and the new Hippodrome residential neighbourhood, while also providing ecosystem services by acting as a carbon sink and a mitigator to urban heat island effects. The biodiversity corridor at the Hippodrome site will serve as a conduit between the existing north-south Ville-Saint-Laurent biodiversity corridor and east-west Darlington Biodiversity corridor, building on their existing ecosystem services.

The forested component of the biodiversity corridor will use native flower, shrub, and plant species to eventually create a morphologically complex environment providing habitats to a wide range of species. As this sort of environment takes decades to grow, however, assisted natural regeneration efforts in the forested component of the biodiversity corridor should begin with shade intolerant pioneer species, such as trembling aspen, yellow poplar, Virginia birch, and paper birch. More shade tolerant tree species, such as sugar maple, red maple, green ash, or white oak, should be planted later. For the forest floor, flowering species such as bunchberry and bloodroot and shrub species such as serviceberry and Canada elderberry can be used. Two important invasive species to be vigilant for in this forested area are buckthorn and the emerald ash borer. Dealing with the emerald ash borer is complex, and will be discussed further in the “Pollinator Fields and Street Trees” section below; buckthorn management can be pursued either through mechanical, biological, or chemical control methods.

This intervention will provide habitat for bird species such as the pileated woodpecker, the tree swallow, the Swainson’s thrush, and the eastern

wood pewee. Increased connectivity with other green spaces will provide access to new habitats for species such as the red fox, the grey wolf, and the brown snake. Human access to the site will be provided for via a single wood-chipped pathway running the length of the corridor from the southeast corner of the site to the northwest corner of the site, but the area is intended to be used most often by non-human species.

## WETLANDS

Smaller than the forested component of the biodiversity corridor, the wetlands component of the biodiversity corridor will occupy approximately 3-5ha of space directly southwest of the large traditional park. Wetlands provide a host of important ecosystem services such as carbon sequestration, toxin filtration (also referred to as phytoremediation), and rainwater management. In addition to the designated wetland component of the biodiversity corridor, the wet swales discussed below will provide rainwater management ecosystem services at smaller, targeted scales near residential buildings.

Native flora species should be prioritized for the wetland ecosystem. Potential grasses and semi-terrestrial plants include soft rush, spike rush, and sensitive fern. Aquatic plants species include the small yellow pond lily, the fragrant water lily, and the common duckweed. Some small build interventions can also contribute fruitfully to biodiversity, such as by constructing insect hotels which provide habitats for important insect species. Native species served by the wetlands component of the biodiversity corridor include the American toad, the green frog, the blue-spotted salamander, eastern garter snake, and brown snake.

WILD BERGAMOT

BUNCHBERRY

BLACK EYED SUSAN

WATER LILY

SOFT RUSH

## POLLINATOR FIELDS AND STREET TREES

Comprising the smallest-scale interventions, pollinator fields and street trees provide scattered stands of habitats for many important species while also providing value for humans in the form of cooling shade and aesthetic beauty. Pollinator fields can be achieved by installing planters full of pollinator-friendly native flora at key locations throughout the site, such as in the large traditional park, along the green corridors, and even in or near the wetlands. Native flowering plants suitable for use in the pollinator fields include the black-eyed Susan, wild bergamot, common milkweed – whose nectar provides essential nutrients for butterfly survival – and New England aster – which has a prolonged flowering period providing food for pollinators late into the season; grasses such as red fescue, switchgrass, and Canadian wildrye can be used to provide visual variety and different seasonal blooming. Beneficiary pollinator species native to Southern Quebec include the yellow-banded bumblebee, the monarch butterfly, and the common eastern bumblebee.

For street trees located throughout the site, diversity and variety is key. 20th-century planning decisions to line streets with monocultural stands of elm or ash, while visually stunning, leaves urban tree canopies vulnerable to sudden arrivals of disease or invasive species. Particularly in the context of the emerald ash borer which has critically threatened the keystone Green Ash species that provides habitats for many smaller species, street tree planting must be undertaken with longevity in mind. Balsam poplars, northern white cedars, swamp white oaks, and Dutch elm disease-resistant cultivars of American elm have all been studied as replacement trees for ash individuals that have suffered from the borer. In addition, new Green Ash saplings can be planted throughout the site, provided they are treated to prevent future infestation. Street trees should be planted between 20-30 feet apart from one another to encourage a more natural, upright canopy and maximize the cooling effect from shade.

# WATER MANAGEMENT

As a larger percentage of people relocate to urban areas, water management strategies have become critical to ensuring the development of sustainable communities. These strategies take into account the entire water cycle, from precipitation to evaporation, ensuring that water is managed efficiently through built infrastructure, as well as nature-based solutions. They also include well-designed policies to ensure plans are sustainable in the long term. The water management strategy for the Hippodrome combines six key strategies in order to reach its objectives. This includes the incorporation of wetlands, wet swales and bioswales, rainwater harvesting barrels, greywater systems, automatic sprinklers, and the reduction of impermeable surfaces.


HIPPODROME BLUE GRID

## URBAN WATER

Urban water can be defined in many ways, including surface water, groundwater, drinking water, wastewater, stormwater, and sewage. It also includes natural waterways located in urban areas, such as streams, estuaries and wetlands. Learning how to properly collect, filter, and manage these various forms of water is an important step towards creating cities that are resilient to the negative effects of climate change. Comprehensive water management strategies can protect both residents and local ecosystems through the design of livable areas where urban form and the environment work together.

| STRATEGY | OBJECTIVES |
|---|---|
| WETLANDS | Store excess water and restore the Saint-Pierre basin |
| BIOSWALES AND WET SWALES | Filter pollutants from runoff and separate stormwater from wastewater |
| RAINWATER HARVESTING | Collect water that can be reused for irrigating communal areas |
| GREYWATER SYSTEMS | Recycle water for secondary purposes to reduce potable water consumption |
| REDUCING IMPERMEABLE SURFACES | Reduce the amount of urban runoff by increasing water absorption |
| AUTOMATIC SPRINKLERS | Irrigate green spaces responsibly without wasting water |

WATER MANAGEMENT STRATEGIES

## THE HIPPODROME AND WATER MANAGEMENT

The Namur-Hippodrome report has identified the site to be transformed into a progressive éco-quartier with a low ecological footprint. Therefore, a comprehensive water management strategy will be key to helping the Hippodrome achieve its ecological goals. The benefits of such a plan include increased water security, reduced flooding risks, mitigating runoff pollution, and restoring the environment. The Hippodrome currently faces two major barriers, however. These are:

1. An absence of underground water infrastructure, including pipelines and sewers
2. Adjacent sewer systems that are already operating at full capacity

The site will require creative solutions to address these problems. Examples include the addition of accumulation areas that can delay the passage of water during storm events. Nature-based solutions can also play an important role in reducing the amount of urban runoff. This may include the addition of trees, parks, and wetlands.

The estimated water consumption per person on the future site is estimated to be around 320 liters per day. To address the rising needs of water consumption, the new strategy should incorporate water harvesting techniques and greywater treatment systems that will allow residents to recycle water. By taking an integrated approach, the Hippodrome will be able to successfully manage its water resources.

## TOPOGRAPHY OF THE SITE

The Hippodrome contains many natural features that can inform the design of its water management system. Prior to 1907, the land was used for agricultural purposes. The site is located in the watershed of the former Saint-Pierre river, which ran to the Saint-Lawrence river via the Saint-Pierre basin. The restoration of the basin would provide an alternative solution to traditional water infrastructure. The Hippodrome constitutes the highpoint of the watershed, where excess water could flow downstream to supply the Saint-Jacques eco-territory further south.

The biodiversity corridor running along the Canadian Pacific Railway provides a great opportunity for water management and ecological restoration. Preserving the natural tree canopy located at the south western border of the site would help with water absorption and the filtration of pollutants from urban runoff. It also provides space for the creation of a wetland that could be used to capture excess water. Currently, the corridor is found at the highest elevation point of the site. To follow best drainage practices, green areas should be less elevated than residential areas in order to capture and filter as much runoff as possible. Therefore, the northern portion of the site will need to be elevated during the construction phase.

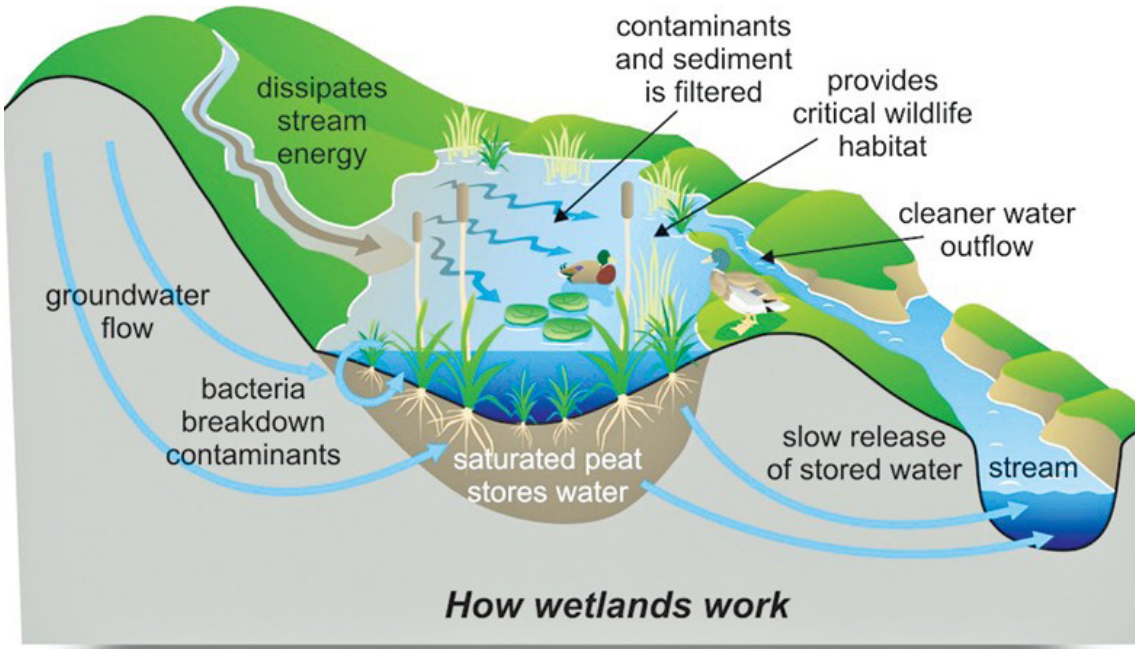
## WETLANDS

Wetlands are a productive component of Montreal's ecosystem. Moreover, they offer a unique opportunity for the Hippodrome to recreate and restore its former environment. These areas are at risk, however, where nearby wetlands are facing development pressure.

Several wetlands have been identified near the site. They are located west of the Hippodrome, on Canadian Pacific Railway property, as well as on Hydro-Quebec property further south. The Technopark wetlands near the Trudeau International Airport also contribute to the local ecosystem. A wetland on the Hippodrome site could extend this network and improve the overall functioning of the bio corridor.

It should be placed in the southwest corner of the site, where it can help restore the Saint-Pierre water basin. The proposed addition of a train station at Décarie Square would need to be taken into consideration, however. Drilling large holes destabilizes the soil, which risks drying wetlands and creating sinkholes.

As a major component of the site's blue grid, the wetland will act as a storage tank for excess water. It will also act as an accumulation area to slow water flow. A two-pipe system should be used to separate stormwater from wastewater, in order to prevent sewers from overflowing. This will mitigate the amount of pressure placed on the existing combined sewer system of Côte-des-Neiges. Instead of using traditional sewer drains, stormwater will enter a network of bioswales running from the main arterial street and park, which will then feed into the wetland. From there, excess water can be directed towards the Saint-Pierre basin.




HOW WETLANDS WORK
Image souce: https://wmap.blogs.delaware.gov/2019/05/15/wetlands-are-magicians-of-water-quality-improvement/

## BIOSWALES AND WET SWALES

Bioswales are channels that collect, convey and filter stormwater. They also help with infiltration, which is the process of groundwater moving from the surface to the soil. Vegetation planted in bioswales can help absorb runoff water. Mulch can be used between the plants and a gravel base should be added beneath to help remove more pollutants from the water. A perforated pipe is normally placed inside of the gravel base to help collect and convey excess water. Wet swales are similar to bioswales, but there are a few key differences. Water is managed in a wet swale by evaporating and draining through the roots of plants. Vegetation may also differ between a wet swale and a bioswale. Wet swales are meant to mimic the environment of wetlands by containing a shallow pool of water in their design. Bioswales may be more practical for urban areas, however, because there is less risk of flooding nearby infrastructure.

A combination of wet swales and bioswales should be used on the Hippodrome to manage stormwater. A bioswale will be included next to street sidewalks along the main arterial road, as well as the central park, to carry excess water towards the

wetlands in the bio corridor. Additionally, a wet swale will run next to the paths along the green corridor. The benefits of this will be two-fold: it will help integrate biodiversity on site, and help restore the former Saint-Pierre river by ensuring a consistent source of water. A sewer pipe currently exists near the river's path, however, which may be a missed opportunity.

## RAINGWATER HARVESTING

Considering the significant population growth that will occur after development, rainwater harvesting will provide a reliable and renewable water source that can help reduce potable water consumption. These systems work by collecting rainwater from roofs and storing them in tanks for future use, where each square foot of a rooftop can collect roughly 0.6 gallons of water per inch of rain. Rainwater capture also mitigates runoff with pollutants that may harm natural areas.

Rainwater barrels should be installed to collect water that will be used for local agriculture on the Hippodrome. These will be located next to the community greenhouses and near agricultural plots along the green corridor. The required barrels are relatively modest in size and easy to set up. They should be located at the downspouts of building gutters, where rain can enter and fill the barrels. Additionally, drain hoses should be added in order to manage overflow. Barrels must be emptied and disconnected from gutters in the winter in order to prevent damage from freezing.

## GREYWATER RECYCLING

Greywater refers to domestic wastewater that has not been contaminated by fecal matter. These systems divert and recycle water from sources such as dishwashers and sinks, which can then be used for secondary purposes. Greywater may also be used for household appliances, such as washing machines and toilets. To build a greywater system, main drain points need to be located. Pipes should be fitted to appliances so that water can be conveyed to a large storage tank. It should not be stored for too long though, in order to avoid quality degradation. Water from the tank is then filtered and pumped for use in other destinations, like sprinklers. Greywater may affect plants and soil chemistry differently, however. Therefore, it is advisable to monitor areas using greywater.

Larger buildings present a greater challenge. Commercial developments and large residences on site may find it simpler to combine greywater and blackwater for treatment prior to reuse. This may include the use of a membrane bioreactor or a living machine. Although it may appear as an added difficulty, investing in these types of systems can significantly reduce the need for city water consumption.

## IRRIGATION

Irrigation is one of the largest consumers of water, using approximately 70% of the world's freshwater resources. The Hippodrome must consume water responsibly if it hopes to become a leading sustainable community. Future residences on site will need to follow the city's guidelines in order to prevent wasted resources. Residences will be permitted to water on even or odd numbered days only, depending on their civic address. Watering hard surfaces and objects is also prohibited by the city. Sprinklers should be set to automatic times in order to prevent excess watering. Moreover, water sensors should be installed to avoid watering greenspaces during downpours. Recycled water from rainwater harvesting and greywater systems on site should be used whenever possible. Water derived from these sources can be used to water the park, bioswales, and gardens on site.

## REDUCING IMPERMEABLE SURFACES

Managing how green spaces interact with the built environment is an important area to consider. Several design solutions exist that can help improve overall site permeability. Minimizing parking spaces and reducing street widths can help reduce impermeable areas that create urban runoff. Discouraging car use on the site can also reduce pollutants that are found in urban water. Building codes should also promote the use of water efficient systems.

The inclusion of greenery will be another focus point. Increasing the number of trees planted on each lot, as well as sidewalk gardens and bioswales, can help restore the soil's water table. Although groundwater is mostly invisible to residents, it is used in nearly 90% of Quebec's inhabited areas. Therefore, protecting this resource is crucial to ensuring the revitalization of the Hippodrome's natural ecosystems. The Hippodrome should avoid groundwater pumping that disrupts natural systems. Building basements should also be watertight in order to prevent flooding.

# URBAN AGRICULTURE

In the face of a growing population, food security is becoming an ever growing concern. Since the 1990s, there has been a surge in the interest of neighborhood accessibility to healthy food.  Past studies have shown that almost 60% of inhabitants of the Island of Montreal live in spaces with very low or low accessibility and almost 20% live in potential food deserts indicating that those spaces are both socially deprived and have low accessibility to supermarkets. Food deserts represent severe socio economic issues within our system and showcase the lack of buying-power in low-income neighborhoods. The Hippodrome is placed in one such neighborhood. Throughout history, urban agriculture practices have been a key part of the solution to food insecurity with the recent and on-going COVID-19 pandemic being a prime example.

VERTICAL FARMING

## BENEFITS OF URBAN AGRICULTURE

The pandemic led to a series of events that resulted in supermarket shortages, perceived risks to commercial food systems and even a desire for physical activity due to the pandemic's restrictions. All in all, this has led to a resurgence in urban gardening and farming. Some of the benefits of Urban Agriculture (UA) practices are as follows:

1. Reduction of the urban heat island effect;
2. Stress reduction and improved mental health;
3. Job creation
4. Ecosystem services such as water and air purification
5. Reduction of poverty and hunger
6. Reduction of the city's carbon footprint

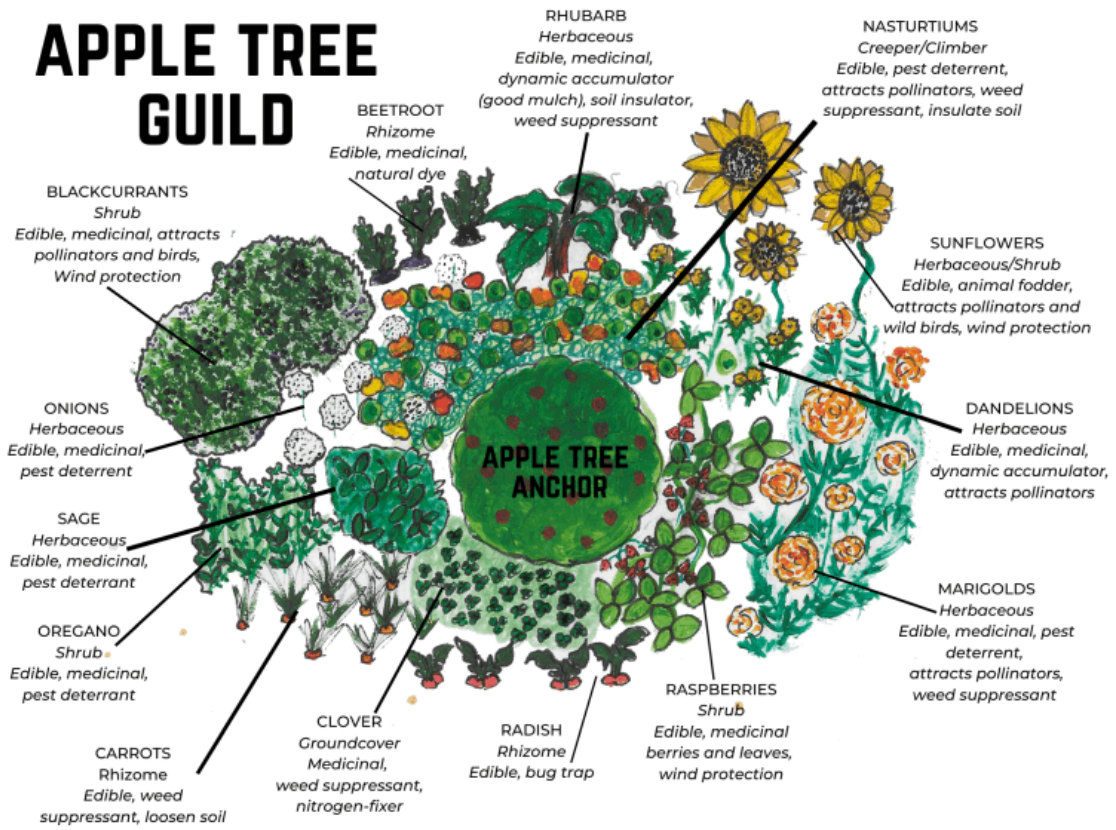
The Hippodrome site represents an opportunity to create an inclusive space that incorporates a union between the built and natural environment. In order to achieve this, sustainable urban agriculture is key to the plan.

UA can be implemented in many forms and by people with varying levels of expertise and techniques, and one such practice is through permaculture design. The term permaculture was coined by Bill Mollison who defined it as :"The conscious design and maintenance of agriculturally productive systems which have the diversity, stability, and resilience of natural ecosystems". In other words, permaculture is a holistic, living-in-harmony-with-nature worldview with a range of practical solutions for a better and more sustainable world. In the 1970s this concept evolved into a concrete set of twelve design principles by David Holmgren as seen in the figure above. At its heart of these twelve are three very simple tenets: care for the planet, care for the people and ensure fair share.

## VERTICAL FARMING AND ROOFTOP GREENHOUSE

Part of the permaculture philosophy is to use as little space as possible. As the less space is used, the more the natural environment is left untouched. As such, our first intervention would be the implementation of vertical farms in a rooftop greenhouse. Rooftop gardens have been seen to offer many benefits to an urban area. They can reduce energy demand on space conditioning, and hence GHG emissions, through direct shading of the roof, evapotranspiration and improved insulation values. While rooftop greenhouses are often more expensive to install than a green roof or container system, they provide year-round use for growers in four-season climates. By having a controlled environment, the greenhouse would offer a suitable microclimate for plants and make possible growth and fruiting, where it is not possible in open fields. Additionally, crops are resistant to weather disruptions because of their placement indoors, meaning fewer crops are lost to extreme or unexpected weather occurrences. Historically, this intervention has proven to be successful in Montreal with Lufa farms introducing the largest rooftop greenhouses in Canada at 5,000 meters squared. Ideally, the installation of a greenhouse would be implemented on one the rooftop's of neighborhood's community center facilities.

Given its location the greenhouse design will be an accessible gardening space for all members of the community. It's location will also allow for maximum solar exposure due to south facing exposure and it's position relative to its neighbouring properties. The greenhouse would feature double-paned glass as they are designed to be the most energy efficient and have half the heating costs associated with single pane glass greenhouses. The greenhouse will also include two sets of energy-saving screens for improved insulation, and its




EXAMPLE OF GUILD PLANTING

integration with the building below provides additional thermal benefit to both structures.

Vertical farming would be applied in tandem with the greenhouse in order to maximize crop yield per unit area of land. Vertical farming is the practice of producing food on vertically inclined surfaces. A sought after advantage of utilizing vertical farming technologies is the increased crop yield that comes with a smaller unit area of land. While vertical farming costs are high, the method uses various sustainable features to offset this and in fact uses 95% less water than other farming techniques.

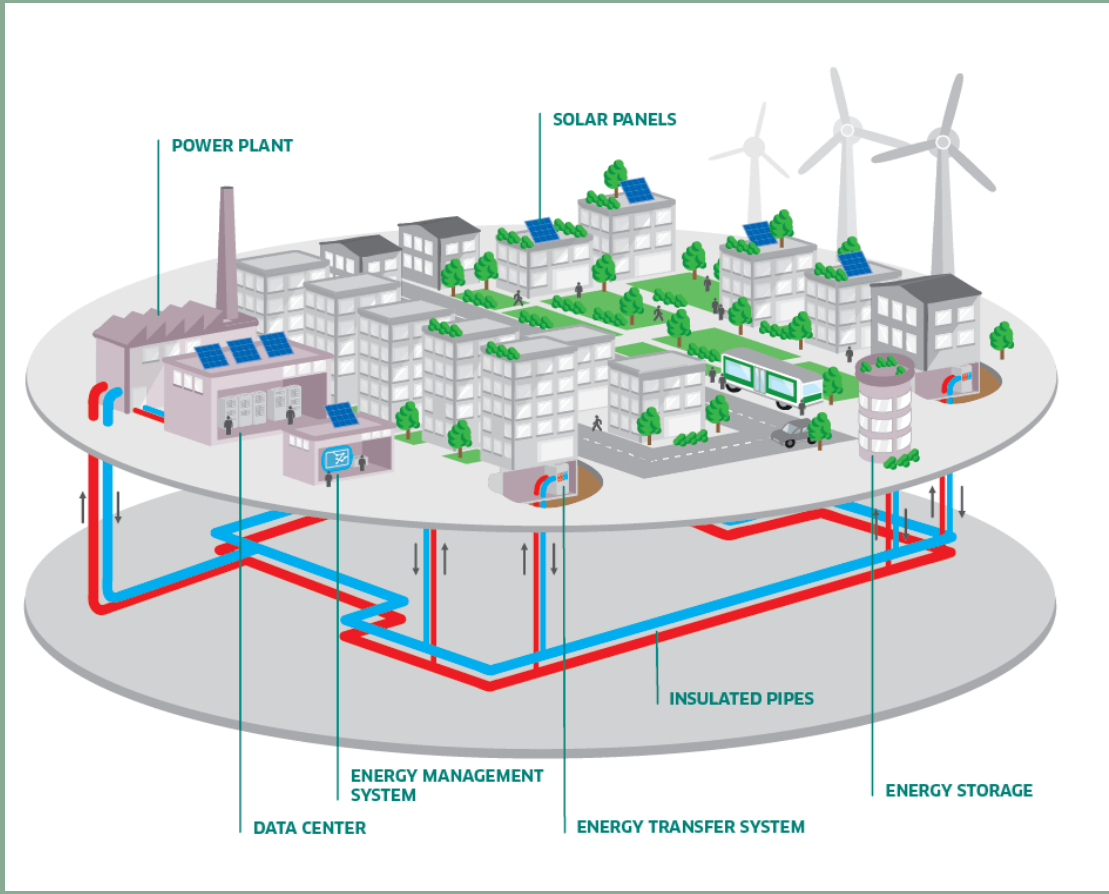
## GUILD PLANTING

To complement the greenhouse, the second intervention would be the introduction of planting guilds. Guild planting is a permaculture design term for stacking and planting different species together to maximize the vertical space and the resources available. These different species of plants would mimic a forest pattern and would work together in providing physical support, nutrient and protection. Planting guilds are very popular in permaculture design as they're able to enhance the environment for the main crop grown and still allow for a diversity of other plants and crops. Guild plants are chosen for their ability to fertilize, mulch, attract pollinators, deter pests, and more. Often, a plant is chosen because it is multifunctional, i.e., stacking functions to reduce the number of plants needed underneath the fruit tree.

Planting guilds are low-maintenance, healthy, and high-yielding gardens that can thrive in even smaller pots of lands such as courtyards. This intervention would have planting guilds placed in the residential courtyards throughout the neighborhood. As the guild depends entirely on the space available, dwarf fruit trees or berry bushes would serve as the main element of the guild for smaller pots of land.

# DISTRICT HEATING AND COOLING

District heating is a relatively ancient technology, which made a successful entry into the commercial market in 1877 in Lockport, New York. Modern district heating and cooling systems (DHCS) combine the production of heat and cooling in a central facility or satellite facilities, which get transferred to connecting buildings via a subterranean pipe network. The resource efficiency of DHCS is much higher than household or building scale systems [1]. Additionally, DHCS can be powered by a wide range of energy sources, such as natural and bio gas, electricity, or other renewables. For these reasons, the International Energy Agency (IEA) describes DHCS as an essential solution to decarbonization for urban communities.




DISTRICT HEATING AND COOLING
Image Source: https://www.engie.com/en/businesses/district-heating-cooling-systems

# Hippodrome District Utility

Affordability - Resilience - Low Carbon

**Hi-DU is a provider of centralized heating and cooling /air-conditioning services**

### \\ Technology

Ambient temperature network
Internal heat exchange

### \\ Energy Cocktail

Natural Gas
Electricity
Waste Heat (sewage & factories)
Geothermal

### \\ Location

3 storeys - 3900 m^2
Southwest Corner
Fronting Jean-Talon Ouest
Minimum Nuisance

### \\ Highlights

5th generation technologies that maximizes resource efficiency and minimize network energy loss

**Up to 43 %**

LESS energy production costs compared to traditional household and building scale facilities

A bold objective to attain 70% of service delivery using renewable energy sources in the long term



HiDU DISTRICT UTITILITY

## AMBITIONS FOR THE HIPPODROME

Recent technological and design innovations in DHCS have considerably improved resource efficiency while simultaneously reducing energy loss, the cost of energy, and carbon emissions. Developing a state-of-the-art DHCS on the Hippodrome site is an integral part of the global strategy to create a low-impact, ecologically friendly community. At the same time, it is essential to balance the technological ambition, which involves capital investments, with the goal to provide the majority of housing at an affordable price to families.

## IS DHCS COMPATIBLE WITH AFFORDABLE DEVELOPMENTS?

DHCS is capital-intensive and requires a long payback period. This means the involvement of the private sector is limited because private investors typically expect quick returns on investments. However, this does not mean DHCS is a bad investment. In fact, from a life-cycle perspective, DHCS can be much more cost-effective than traditional heating systems (Gudmundsson et al., 2013). With the rising awareness of DHCS and increasing involvement of the (quasi-) public sector, the number of DHCS has expanded rapidly in Canadian communities since the 2000s.

A preliminary feasibility study for building a DHCS in the Namur-Hippodrome sector has already been completed. It should be noted that the financial calculations in this study were modelled upon an assumption that only 2500 apartment units will be built on the Hippodrome site; whereas this development proposal includes 6000 units. However, these numbers serve as a valuable benchmark for our proposal.

The study showed that DHCS can be designed to be priced competitively against traditional systems for the Hippodrome development (Boisclaire & McCarry 2016). On one hand, the implementation costs associated with DHCS range between $37.4 M and $47.4 M, depending on design choices. On the other hand, it costs in the ballpark of $37.4 M to install heaters and chiller inside each building. The same study also underlined significantly lower energy or heat production costs for the DHCS model. Since heat production by DHCS benefits greatly from the economies of scale[2] , we can reasonably expect even lower energy costs in our 6,000 unit scenario. Energy cost savings (20% - 43%) accrued in the lifetime of DHCS can offset the additional implementation costs and potentially make DHCS more attractive than traditional systems.

Finally, large emissions reductions from DHCS can be monetized and traded on the regional or global carbon market. Carbon trade is another mechanism to compensate initial capital investments in the long term.

| IMPLEMENTATION CAPITAL COSTS ASSOCIATED WITH DIFFERENT OPTIONS OF DES | | | | |
|---|---|---|---|---|
| | AMBIENT LOOP | | HOT WATER AND CHILL WATER LOOPS | |
| OPTIONS | OPTION A | OPTION B | OPTION C | OPTION D |
| COSTS | $46M | $47.4M | $37.4M | $49M |

IMPLEMENTATION CAPITAL COSTS WITH DIFFERENT DES OPTIONS

| ENERGY COSTS ASSOCIATED WITH DES VS. TRADITIONAL ENERGY SYSTEMS | | | |
|---|---|---|---|
| | DES | CENTRAL HEATING IN BUILDINGS | |
| | | ELECTRICITY (residential rate) | NATURAL GAS BOILERS |
| COSTS | $14.5 - 15.9 / GJ | $25.5 / GJ | $17.3 / GJ |

ENERGY PRODUCTION COSTS FOR DES VS. CENTRAL HEATING

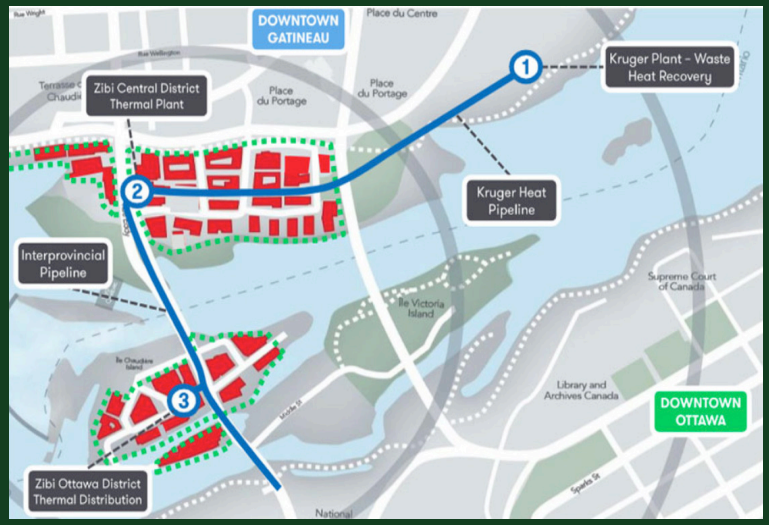
## HIPPODROME DISTRICT UTILITY (Hi-DU)

The design of the Hippodrome District Utility (Hi-DU) will pursue the 5th generation technologies, which efficiently combine heating and cooling in one integrated distribution network that relies on a low supply temperature (between 10 and 25 degrees Celsius). Each connecting building will have a high-efficiency heat pump installed in each dwelling and commercial unit. The "ambient loop" design makes possible the installation of an internal shared energy looping system and the incorporation of sustainable energy sources, which helps to propel the community closer to decarbonization. An internal looping system permits the exchange of hot and cold air between connected buildings. It eliminates the need to turn on the boilers or chillers on days when buildings' energy needs are opposite. Based on local conditions, the availability and the cost-effectiveness of different renewable energies, we highlight the potential to exploit waste heat in raw sewage and industrial production plants for heating.

Taking into consideration the energy cost and reliability, the Hi-DU will rely on a combination of natural gas, geothermal energy, and hydroelectricity. The latter will only provide power during off-peak periods due to supply constraints and unsustainable energy costs in Quebec, especially during winter peaks. Even though burning natural gas produces carbon emissions, the high efficiency of the Hi-DU considerably can reduce resource consumption and emissions by over 30% (Hast et al., 2018). However, we envision that proportion of renewable energy sources to increase in subsequent system expansions.

## SITING OF THE HIPPODROME DISTRICT UTILITY

A three-storey facility with a footprint of 1300 m^2 is proposed on the southern corner of the site fronting Rue Jean-Talon. Several considerations went into the selection of this location. Firstly, a medium-capacity natural gas pipeline already runs under Rue Pare, which will require minimum excavation activities to install the connection and lower costs. Secondly, this particular location provides convenient access to heavy maintenance and service trucks while restricting the effects of nuisances (noise, traffic,




Zibi Community Utility is a district energy system envisioned for a private waterfront development in Ottawa, which will be developed via a partnership with Hydro Ottawa. This system will be powered by recaptured effluent heat from industrial activities at the nearby Kruger production plant, which reduces the carbon footprint of space heating on the development to near-zero. For cooling during the summer months, the system capitalizes on the large cooling potential of the Ottawa River.

The False Creek Neighbourhood Energy Utility (NEU) in Vancouver relies a heavy portion of its energy source on recaptured waste heat in raw sewage to provide space heating and hot water to surrounding buildings. The system is self-funded and provides a return on investment in the form of reduced energy costs. NEU aims to derive 70% of energy from renewable sources with an emphasis on effluent heat. To this end, the city recently announced new investments in the expansion of the raw sewage recovery system, tripling its capacity in the years to come. The estimates that the implementation of this system already helped reduce the greenhouse gas emissions associated with heat provision in the service area by 60%

steam) on community life in the core of the site. Thirdly, in phase 2 expansion of the Hi-DU, we envision the system to be connected to a second facility on the other side of the Jean Talon that serves the industrial sector. We also envisage a connection between these two adjacent Hi-DU facilities, which will enable the reutilization of waste heat from industrial production activities.

## OWNERSHIP AND GOVERNANCE

DES can operate under different ownership and governance models, including municipal (e.g. False Creek utility), private (e.g. Zibi utility), cooperative (e.g. Høje Taarstrup Fjernvarme). Each ownership model has its advantages and shortcomings. Ideally, the Hi-DU should be a municipal venture because the municipal government has larger borrowing power and a longer and more flexible amortization period at a lower interest rate. Thus, municipal ownership of the Hi-DU ensures financial stability and increases the predictability of energy costs. More importantly, municipal ownership of the system makes it easier to expand district energy services into surrounding sectors in Namur, which will be important for the renewable energy transition. The nearby industrial sectors are important renewable heat sources.

In terms of governance, a board of directors should include representatives from serviced communities to ensure transparency and collaboration. They can be board members of the Hippodrome Community Land Trust or staff of SDCC. Sharing of user data between the municipality and the serviced communities, like the Hippodrome, enables the latter to understand their consumption patterns and come up with strategies to promote sustainable consumption.

# WASTE MANAGEMENT

Solid waste management activities, including collection, transportation, sorting, treatment, disposal of waste, consume a large amount of energy, releasing GHGs as well as other forms of harmful pollution into the environment. In Quebec, an average resident sent 651 kg of solid wastes to landfills in 2016 (Environment and Climate Change Canada, 2020). The composition of municipal waste is very complex, containing a significant proportion of organic materials, which will decompose and contaminate the environment near landfill sites (ibid; Propp et al., 2021). Equally significant, residual materials from construction, renovation, and demolition (CRD) activities represented 41% of wastes sent to landfills in Quebec in 2008 (Boisvert et al. 2014).


WASTE SORTING BINS

## SUSTAINABLE SOLID WASTE MANAGEMENT

The golden standard of sustainable solid waste management is reflected in Recyc-Québec's "3RV-E" hierarchy, which can be translated into "reduce, reuse, recycle, recover, and eliminate". Reduction of wastes at the source should be prioritized wherever possible because it not only conserves raw materials but also circumvents energy consumption. High-level principles that can help communities achieve their waste reduction goal include designing out wastes' and closing the loop. Reusing and repurposing items that are no longer needed or used for their original purpose also helps avoid energy consumption and GHG emissions. Elimination of residual materials should always be considered the last resort.

## ACTION PLAN

We propose here three effective interventions that tackle the top levels of the waste hierarchy, namely, "reduce" and "reuse", and waste collection in the context of the Hippodrome site. These interventions particularly target CRD waste from a lifestyle perspective and garbage produced by businesses, institutions, and households.

## ZERO-WASTE BUILDING DESIGN

CRD waste can be reduced or salvaged for other purposes over the lifecycle of buildings is through adopting innovative building designs and construction methods that minimize the use of building materials and facilitate the recovery of building materials during repairs and at the end of the lifespan.

"Zero-Waste Building Design and Construction Practice Guidelines" have been developed to facilitate CRD waste reduction over the building life span. This document contains 4 approaches and 10 relevant strategies (Appendix). Each quantitative strategy related to standards is accompanied by a method of measurement, which needs to be further elaborated by experts in relevant domains.

The first approach is lean construction, which may result in 30% material savings. Modular construction strategy, which enables on-site assembly of building components that have been prefabricated off-site, is emphasized within this approach. This method represents an interesting solution for reducing errors in the construction process thanks to the strict standardizations. The second approach is reusing recovered building materials. The third approach is commercializing residual building materials through takeback programs. Repairs, renovations, and replacement at the end of their lifecycle account for the bulk of building-related wastes. The last approach is "design for deconstruction" (DfD), which targets the lifecycle of buildings. Design for deconstruction (DfD) makes possible layer-by-layer disassembly of buildings at the end of their usable life so that residual materials can be easily separated and recovered for reuse in other structures.

These guidelines are envisioned to serve as a useful reference for inspiring formal legislation or control on the part of the city and the community land trust. For instance, the council can invite technical and legal experts to transform these guidelines into verifiable standards and norms for development activities on the Hippodrome site. For example, these verifiable norms can be authorized as construction codes and building by-laws, mandatory conditions attached to land lease agreements, project selection criteria, or a combination of all the above.

## GREEN LEASES

Green leases are a progressive form of lease agreements that include environmental performance considerations in the list of conditions and responsibilities that bind the landlords and tenants. For example, a green lease may require the landlord to install energy- saving building systems and consumption tracking devices. It may also require the tenant to adhere to a maximum energy and water consumption quota. Waste management provisions can be included in green leases, which shall clearly outline the responsibilities of landlords and tenants.

Several cities in the U.S, including New York, Cleveland and Denver, have implemented programs to promote the adoption of green leases in the city's commercial spaces. In particular, the City of Cleveland is the first city government to be recognized as a green Lease leader (Green Lease Leader website). The city recognizes the utility of green leases for helping the city achieve its Climate Action Plan and has injected environmental clauses into the lease agreements for municipal properties. It has also collaborated with local business boards and chambers of commerce on drafting green leases to be adopted city-wide, as well as developing guides and educational materials for landlords and tenant businesses.

The Hippodrome development is an excellent opportunity for piloting a large-scale green lease initiative due to the presence of central authority presiding over commercial lease agreements. The City of Montreal should be inspired by the success of Cleveland and provide necessary financial and technical support to the Hippodrome Community Land Trust and its administrative

# Green Lease Agreements

### Tenants

Adopt sustainable procurement practices and work with suppliers to cut down plastic and single-use packaging.

Provide only paper or reusable bags to customers.

Provide reusables instead of single-use items (e.g. single-use coffee cups and cutleries) for staff use or wherever possible.

Track and reduce paper use in internal communications and digitize management activities.

Require employees to sort wastes and dispose of them in proper containers.

### Landlords

Provide dedicated collection spaces in the building for garbage, recyclable materials, compost, hazardous materials (e.g. batteries), that are easily accessible by tenants.

Engage a reputable waste contractor who provides punctual and reliable collection service and ensures proper treatment of materials.

Conduct waste audits to identify and quantity the different types of wastes produced in the premise, as well as the progress in achieving the waste reduction goal.

### Collective objectives

- Minimum annual waste diversion rate
- Annual waste reduction goal
- Shared management

arm, the SDCC, on relevant activities. These can include drafting green lease clauses, developing waste auditing guides, as well as training staff to conduct monitoring and management activities. There is a potential to scale the application of green leases to a larger geographical scope if this pilot proves successful.

## SUPPORT CIRCULAR ECONOMIES

Generally, circular economy initiatives aim to prevent resources and materials from being sent to the landfill and recover their value by extending the usable life or giving them a second life. Promoting community programs and social enterprises that contribute to the circular economy must be considered as an integral component

of the global waste management action plan. We propose that circular economy initiatives like the ones outlined below should be provided priority access to the social-rate commercial spaces on the ground floor of the mixed-use buildings. For example, upcycling cooperatives, such as the Concordia University Centre for Creative Reuse, employ creativity and artistry in refurbishing and repurposing products, which can then be reused or resold on the market. Food recovery and redistribution organizations, such as the Quest Food Exchange in Vancouver, as well as mobile applications, such as Too Good To Go, intercept healthy and edible foods from landfills while helping individuals and families suffering from poverty meet their nutritional needs.

# IMPLEMENTATION

Although the finalization of phasing will require close coordination with the other aspects of the Hippodrome decommodified housing development, we believe that the best outcome for the ecological and environmental interventions presented would be achieved through a clear implementation strategy which considers biodiversity, greenspace, and ecosystem services a chronological priority. Components of the interventions covered in this section can be divided into three phasing categories: those which must be completed before construction begins on built form, those which can be completed while construction is ongoing, and those which can be completed after the first residents begin moving in.

## PRE-CONSTRUCTION PHASE

The pre-construction phase of the project should begin with a controlled burn and flood of the entire infestation of phragmites throughout the site, done before any other equipment is present to reduce fire hazards. This should be followed by topographical engineering changes to ensure proper rainwater runoff towards bioswales and the wetland. The portion of the site with the lowest elevation coincides with the planned location of the site's public plaza alongside some residential development. To enable construction of both these facilities and the southwestern wetlands, the surface relief of the site must be modified by moving soil from one part of the site to another. A second controlled burn and flood can be undertaken if needed. Once desired site topography has been achieved and invasive species have been brought under control, siting and surveying should be done for the Hippodrome Park and the Green Corridors. This should be followed by creating the new wetland ecosystem by adding water and planting native wetland flora species as described above, followed by planting native shade intolerant forest species in the forested area of the biodiversity corridor, installing planters in the pollinator field, and planting flowers and grasses in the pollinator fields.

## MID-CONSTRUCTION PHASE

Before construction on the built form of the site begins, the principles of green leases, solid waste management, and zero waste building design and construction methods should be operationalized by the CLT. Once this has occurred, some of the more built-infrastructure elements of our ecology plan can be installed, including irrigation for the urban agriculture facilities, siting and construction of the District Energy System facility, water management and greywater recycling system installation, bioswale and wetswale installation (simply the planters, not the plants themselves), installing planters for guild planting, planting flora along the green corridors, and paving the green corridors.

## POST-CONSTRUCTION PHASE

Once residents begin to move in to the site, other, less intrusive interventions can be undertaken. This includes planting flora in the bioswales and wetswales, installing rainwater harvesting barrels, and planting street trees. Landscaping and facilities construction in the Hippodrome Park can also happen at this stage, though topographical changes have already been made. Finally, circular economy initiatives can be set in motion and vertical farming and rooftop greenhouses can begin to function. Up to a decade after construction has completed, shadow tolerant species can be planted in the biodiversity corridor.

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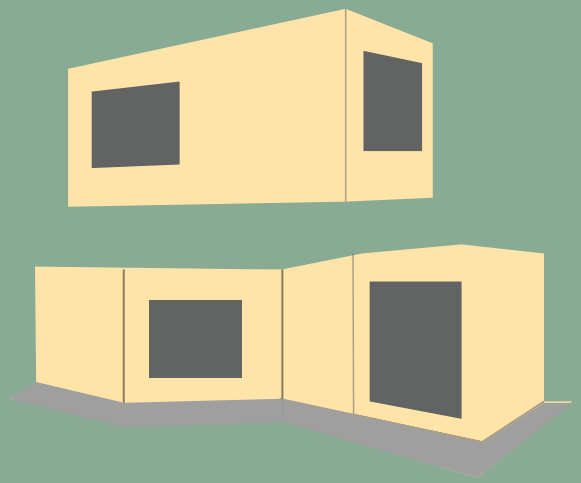
# LEAN CONSTRUCTION



CONSTRUCTION STRATEGIES

- **Lightweight structures & materials**
- **Modular building construction techniques**
- **Structural load values**
- **Simple and straight-forward building designs**

## Strategy 1

Prioritize the use of **lightweight structures** (i.e. timber, aluminum, lightweight steel, and lightweight concrete), as well as **lightweight materials** used for insulation, interior furnishing, and exterior walls wherever possible.

“

For example, research shows that innovative composites make excellent use for lightweight walls and roofs (Khedari et al., 2001). Innovations in bamboo composites overcome the shortcomings of raw bamboo increasing their competitiveness as exterior wall panelling, flooring, and roofing (Vancouver Builders[1] 2019). Other promising building materials include GFRG panels, Bubble Deck Slab, and Porotherm hollow bricks (Vancouver Builders 2019).

Organic materials should be favoured because they are lightweight and recyclable at the end of their life. ”

### Measurement

- A target weight per square foot of development for different uses (residential, mixed-use, instutitional, etc.)
- A target percentage (%) of building materials of natural origins

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria

## Strategy 2

Prioritize **modular building construction** that involves assembling standard prefabricated building modules on the development site

“

To ensure full transparency, licensed modular builders should be asked to explain what practices they have adopted at the factory to maximize material efficiency and reduce the production of offcuts. ”

### Measurement

- A target % of modular building components

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria

## Strategy 3

Require builders to strictly adhere the structural designs to corresponding **minimum load values** for different structures provided in current provincial and national building codes to prevent overdesign and material wastes (reference: National Building Code of Canada, 2015, ss. 4.1.5.3.)

### Measurement

- Minimum load values for different building uses

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria

## Strategy 4

Prioritize **simple and straightforward building design** that minimizes structural and construction complexity and types of materials.

> "Conditions should be applied to limit the complexities of structural frames and building components. For instance, the composition of steel beams of different strengths should be limited to a minimum that ensures structural safety."

### Measurement

- Maximum types of materials used in building designs
- Maximum layers in building components

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria

# RECOVER & USE RECOVERED

- Material Takeback Agreement
- Reusing recycled materials

## Strategy 1

Set a target for building projects to **incorporate used or recycled building** materials that meet the industry standards and regulatory conditions for different functionalities (structure, interior furnishing, building skin etc.)

### Measurement

% of reused or recyclable building materials

### Enforcement Mechanism

Project selection criteria

Expedited permitting criteria

Formal condition attached to permit application

## Strategy 2

Mandate builders to submit **an agreement with a specialized recycle operator** (eg. a reseller, wholesaler or a waste management firm) who will be able to commercialize a high percentage of usable surplus materials and offcuts.

### Measurement

A material takeback agreement or contract

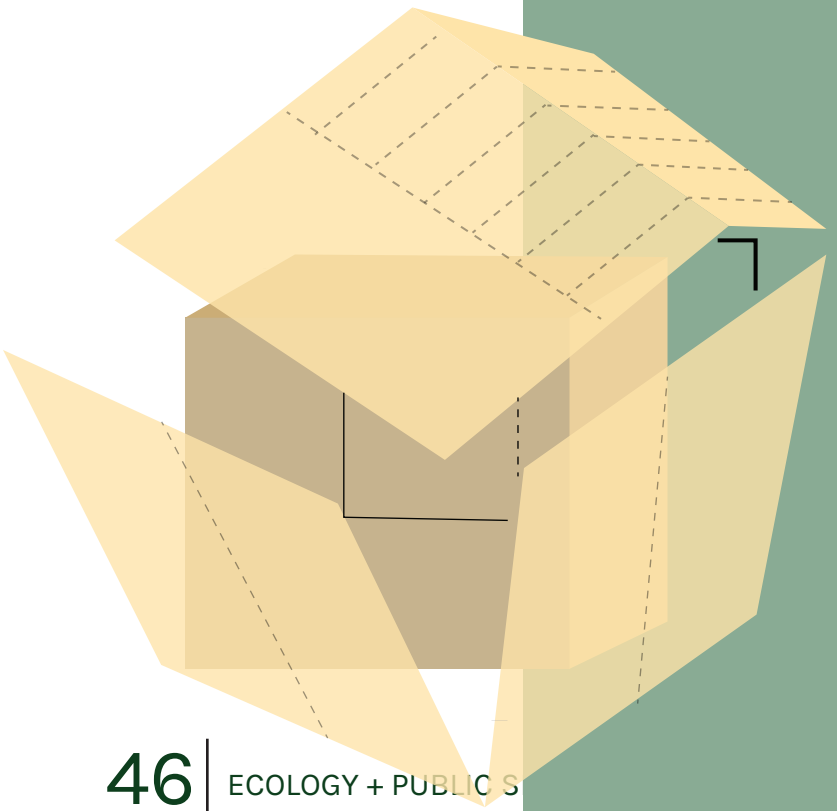
### Enforcement Mechanism

Project selection criteria

Expedited permitting criteria

Formal condition attached to permit application

# DESIGN FOR DISASSEMBLY



- “Layering” Design
- Flexibility & Adaptability of Layout
- Removable and Reusable Connectors
- Deconstruction Manual

## Strategy 1

Mandate builders to **adopt the layering design**, which conceives buildings as composed of different layers according to the anticipated lifespan and position the layers so that the layer of more frequent replacement cycles can be easily accessed without damaging the other more permanent layers

### Measurement

- The replacement cycle of different building layers

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria
- Formal condition attached to permit application

## Strategy 2

Prioritize building designs and components that allow **maximum adaptability and flexibility** of spatial configuration within a given structure.

### Measurement

- Easeness of reconfigurating structure spatial layout

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria

## Strategy 3

Prioritize building designs that incorporate **easily removable and reusable connectors and fasteners** that allow different building components to come apart easily and avoid nails and adhesives

“

For example, demountable bolted shear connectors are excellent for concrete slabs (Jung et al., 2022). Clamping connectors, which use friction, should be preferred for most structures because they do not require cutting into connected members and take less effort to dismount. Bolts ae easier to be taken out than nails in wood structures, hence, reducing damages to the wood (Webster et al. 2005).

Builders should also minimize the number and types of connections when possible and use standardized connectors patterns.

”

### Measurement

- Types of fasteners used in building design

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria
- Formal condition attached to permit application

## Strategy 4

Require builders to provide **a detailed deconstruction manual** that includes necessary informationrelating to the design and construction of a structure for the purpose of guiding deconstruction activities. For example, the document should include construction drawings and details, identification of materials and building components, and structural properties.
tApproaches

### Measurement

- Deconstruction guidelines manual

### Enforcement Mechanism

- Project selection criteria
- Expedited permitting criteria
- Formal condition attached to permit application