FINAL REPORT

Naturalization Project – Environment Canada
4905 Dufferin Street
Toronto, Ontario, Canada

Prepared for:
Environment Canada

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Report of a Major Project submitted to the Faculty of Environmental Studies in partial fulfillment of the requirements for the degree of Master in Environmental Studies,
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Abstract

Fall 2013, Environment Canada and representatives of the “Green team” an organization of environmentally conscious employees, approached the Faculty of Environmental Studies to recruit a student to draft a restoration and re-naturalization plan for a portion of its property at 4905 Dufferin Street in Toronto, Ontario. This report is prepared as guiding document describing the process and methods used to draft a naturalization plan on behalf of Environment Canada. The restoration strategy incorporates four main steps a portion of the property by removing turf and re-naturalizing the site with native species. (1) Determining project goals, as well as local and regional context, (2) inventory and site condition evaluation, (3) restoration design and naturalization plan, (4) implementation, management, and monitoring. The design for this project incorporates several objectives: removal of non-native turf, pathway construction between main building and G. Ross Lord Park, including seating. Establish ecological function through native planting and seeding. Demonstrate Environment Canada’s commitment to nature through signage and storyboards that communicate ecological design alternatives to turf and species initiatives. To select species for planting, native species common to prairie and oak-savannah ecosystems are considered and characterized with soil components and element exposure of each plot, fulfilling the unique requirements for each plot design within the site plan.

1.0 Introduction

Fall 2013, Environment Canada and representatives of the “Green team” (project steering committee), an organization of environmentally conscious employees, approached the Faculty of Environmental Studies to recruit a student to draft a restoration and re-naturalization plan for a portion of its property at 4905 Dufferin Street in Toronto, Ontario. As described by the Green team, the goal of the project is to naturalize a portion of the property by removing turf and re-naturalizing the site with native species. The site is located along the western portion of the property aligning with Dufferin Street. Environment Canada’s Green Team and project steering committee envisions the creation of naturalized space that exhibits a commitment to the natural environment by providing ecological service through aesthetically appealing native plantings.

Many of Environment Canada’s project goals align harmoniously with other urban naturalists, seeking to find the balance between nature and development within an urban setting. Environment Canada hopes to achieve this by replacing the front lawns of the property with native flora as a service to both the ecosystem, and experientially to the human observers of the site, together as dual restoration goals. This research topic allows for an understanding of how to achieve a balance between environmental service and demonstrations of nature as perceived by public observers of Environment Canada’s property in Toronto.

This project involves creating a site plan that includes:

primary research and site evaluation,

development of a naturalization plan and environmental design,

development of a long-term management plan.

The project directly incorporates the process of assessment and planning through to implementation and monitoring of an ecological restoration plan that balances the human experiential appreciation of nature and ecological service to the environment. This naturalization project serves as a demonstration site that communicates the values and standards of Environment Canada. Furthermore, the site demonstrates future possibilities for ecological conversion urban lands that challenges the dominant aesthetics of turf.

In his book: *Lawn People: How Grasses, Weeds and Chemicals Make Us Who We Are*, Paul Robbins (2007) discusses how manicured turf is an ecological construct of American culture (p.22). Manicured turf as a landscape choice has always been about conformity and maintenance and not about turf as providing ecosystem function. Lawn turf derives from countless applications of manipulative chemical compounds used to enhance grass species that should not be successful withstanding biophysical and climatic conditions that differ from Scottish golf ranges (Robbins, 2007). Naturalized grasses and wildflowers in a southern Ontario ecosystem provide great benefit to localized fauna, and human observers, where non-native turf does not. This project serves to analyze and challenge the perception of nature and environmental aesthetics in order to advance awareness that, while manicured non-native lawns have long been a symbolic representation of tidiness, a work ethic and community care, their ecological service is minimal (Nassauer, 1997).

1.1 Role of the Major Project in the Plan of Study

The topic of this research project is directly linked to the area of concentration and main components of my Plan of Study. Environmental planning and resource management are core concepts of my area of concentration. The process of conducting an environmental assessment, and drafting an environmental restoration plan to restore and manage the site, correlates directly with the description of the components of my Plan of Study. Environmental planning can involve planning of any environment containing natural features or ecological processes. Looking directly to resource and environmental management, this can include conservation, or restoration of natural components within an environment. This project helps to accomplish the following learning objectives of my plan:

Learning Objective 1.1 To understand the management practices of biological conservation pertaining to specific ecosystems, in order to analyze specific species and the effects resource consumption has on their survival.
Learning Objective 1.3 To understand protected area management planning in Canada, and the process of developing plans in order to draft and develop current park management plans.
Learning Objective 1.4 To study ecological integrity and restoration by form of case study in areas of significant environmental degradation in order to perform land assessments and ecological restoration projects in particular habitats and environments.
Learning Objective 2.1 To understand popular themes and processes of environmental planning and particular sections of the Ontario Planning Act, which focus on environmental conservation, in order to interpret, draft, and assess environmental planning.
Learning Objective 2.3 To have an understanding of general themes of restoration ecology and how it is portrayed through modern planning in order to reflect such themes in current environmental planning.

Because it results in a formal professional ecological restoration plan, this project also helps build a foundation for a career beyond MES focused on environmental planning; ecological regeneration, and conserving or re-creating nature in urban and rural environments.

1.2 Project Objective

The objective of this research is to develop a restoration ecology plan for the site at 4905 Dufferin Street, Toronto that improves the ecological service of the site by introducing native species to replace the monoculture non-native turf that currently dominates and outcompetes other species. The goal is to remove and suppress invasive species and turf and modify the environment before re-introducing native species that fulfill ecological service while providing the aesthetic and experientially significant elements to demonstrate environmental cognizance that is desired by Environment Canada. The desired output is a formal plan for the restoration site, including drawings and mapping of the area being restored. This includes detail of the replacement species and the rationale for their choice, as well as a long-term management and maintenance plan. Furthermore, a detailed budget is included. The specific question guiding this research aims to understand the synchrony which may be established in harmonizing ecological service and the aesthetic appreciation of nature within an urbanized environment.

This report is prepared as guiding document describing the process and methods used to draft a naturalization plan on behalf of Environment Canada's property at 4905 Dufferin Street. The restoration strategy incorporates four main steps, building on restoration strategies identified by The Waterfront Regeneration Trust (1995):

(1) Determining project goals, as well as local and regional context,

(2) inventory and site condition evaluation,

(3) restoration design and naturalization plan,

(4) implementation, management, and monitoring

1.3 Research Context

The theme of this research project is restoration and re-naturalization. The working definition for this research is purposefully vague. According to Sauer (1999), “At a literal level, the term implies that we are returning the landscape to some former state” (p. 89). The reason for use of the language “former state” is because it is impossible to return a site to its original state. We must recognize that historic conditions cannot necessarily be recreated; we must recognize that true forest restoration is not possible (*ibid,* p. 90).

If we aim to restore to a time of less human occupancy, we must also acknowledge that active ecological management has occurred for centuries. Areas we consider to be wilderness are likely spaces once actively managed by indigenous peoples. As Sauer (1999) explains, “In fact, most plants tribal people value are shade-intolerant and depend on burning or other forms of disturbance to maintain the early successional communities they inhabit” and therefore seemingly require second source maintenance (p.90). Active management has always occurred and is still required today. This is true not only to humans but other species that modify the natural environment for various purposes. As Higgs (2003) makes clear “The pace and extent of human change, whether indirect effects such as suppressed wildfire, to increased trail use, demands some redress. The simple act of packing up our managerial responsibilities and letting nature take its course, the old natural regulation model, will result in a freakish landscape far outside the known historical conditions” (p. 288).

Restoration is incremental. It happens in phases. A typical scenario might be to stabilize all bare soil areas and to initiate exotics removal while starting planting, and then to evaluate the success of plantings and natural regeneration before developing a more detailed planting plan (Sauer, 1999 p. 91). The naturalization site for this project is a space drastically altered from its pre-development state. It is important to develop a strategy that incorporates multiple phases to help ensure environmental success and long-term ecological service.

There is an obligation of current generations to preserve natural resources for the future. However, as societies and their paradigms of current thought shift, so too do the practices of conservation. And so, “we restore by gesturing to the past, but our interest is really in setting the drift pattern for the future” (Higgs, 2003, p. 270).

With decentralized planning creating more power for local groups, Opdam and Steingröver (2008) address the lack of environmental knowledge used when designing metropolitan landscapes for biodiversity. They blame this failure on the wide diversity of species traits, the variety of spatial scales of ecological practices, and the complexity of metapopulation ecology (p.70). The authors apply a knowledge system to create a better understanding of this complexity, which they conceptualize simply as being ecosystem networks. They include ten design guidelines to achieve spatial cohesion amongst species variety and therefore achieve a network between the ecosystems. While they focus mostly on fauna that includes larger mammals, much of their rationale is applicable to this research project. Useful guidelines include the use of ecosystem patches, designed specifically to cater to specific species within a particular area of a broader ecosystem. They discuss the importance of patch quality; ensuring patches are effective as habitat for a species, calculated by vegetation, soil and water conditions in relation to the requirements of a species. It is important to also understand the maximum and minimum network carrying capacity.

The idea of a “stepping-stone” is described as a small patch of an ecosystem that contributes mainly to the network’s connectivity rather than to the network’s carrying capacity. Because the general site area of restoration for this Environment Canada site is seemingly small in the context of the greater ecological network surrounding the area, perhaps this notion of a stepping-stone as a general contribution to the overall network is useful in terms of imagining the site as providing this type of ecological service. The example used by Opdam and Steingröver is that of a stepping-stone being used for a pair of bird species existing within the smaller ecosystem patch but is still used to facilitate the movement of birds within the network (Opdam and Steingröver, 2008). A goal of this project is to fulfil a similar ecosystem function of contributing to network connectedness.

Jianguo Wu (2008) regards humans as "ecosystem engineers" and believes that we are critically important for developing urban sustainability. He focuses on the idea of a human-landscape scale that is large enough to include key ecological function and socioeconomic processes. He emphasizes the interrelationship between urban landscape patterns and ecological or socioeconomic processes on different scales, and encourages place-based research. As mentioned, this project aims at understanding the harmony that can be achieved between ecological function and human experience of an ecosystem. Wu touches on this idea and encourages this balance of function for nature and human occupancy.

1.4 Site Context

In 1998, Environment Canada employed an ecological consultant group to develop a naturalization plan in areas surrounding the current project site. Only the first phase was completed, some of which is still evident today. Attached, as **Appendix – I** is a copy of the 1998 naturalization plan, used as a reference for this project. Work that was completed towards fulfillment of this plan included the creation of 10 subplots divided between woodland, shrub thicket and prairie ecosystem types. Hardwood trees, potted conifers, and prairie seeding made up most of the subplot plantings.

4905 Dufferin Street lies within a subwatershed of the Don River, referred to as the Lower West Don River subwatershed. Within this subwatershed, natural cover amounts to 14% of the open space (Beyond 40 Steps, 2009, p. 3-37). The site plotted for this naturalization project is dominated by non-native turf containing different types of fescue, as well as some naturalized features within the boundaries of property. Nearby, at G. Lord Ross Park (directly south of Environment Canada) is 137 hectares of city parkland. The park contains several natural elements. To regulate flow of the nearby Don River, the G. Ross Lord reservoir provides important wetland habitat to the grey tree frog (*Hyla versicolor*) and spring peeper (*Pseudacris crucifer*) There is also woodland-prairie ecosystem elements found within areas of limited recreation within the park. To the east, the property is bordered by a University of Toronto science facility that contains some open space covered by turf. A part of the Peel plain, 4905 Dufferin and the surrounding area fall within the Lake Erie Lowland eco-district, and mixed-wood plains ecozone (National Soil Database, 2014).

After Hurricane Hazel destroyed much of the Greater Toronto Area's development along the floodplains of the Don and Humber Rivers, the Toronto and Region Conservation Authority (TRCA) was established to deter development along vulnerable flood plains and protect naturally significant areas within the region. Today, the TRCA manages the Don, Humber and Etobicoke-Mimico watersheds through unique plans meant protect and regenerate the natural heritage. As aforementioned, the Lower West Don River is a subwatershed of the Don River, in which 4905 Dufferin resides. While private landowners abide more specifically to city by-laws, the overriding plan of the TRCA does impose regulation and guidance regarding use and protection of naturalized areas.

Beyond 40 Steps, The Don Watershed Plan (2009)*,* is the most current edition of the TRCA's management plan for the Lower West Don River subwatershed. Within this plan TRCA aims to achieve its objective to "protect and sustain what is healthy, and regenerate what is degraded" through several tactics (TRCA, 2009, p. v). Focusing on terrestrial features of the subwatershed, TRCA aims to restore ecosystem function by: reducing intensive development, removing invasive plants that threaten native ecosystems, reduce flooding through stormwater control systems and diverting erosion, as well as improving water quality (*ibid,* 3-36). Important to this project, *Beyond 40 Steps* provides useful information regarding management strategies to regenerate and protect naturalization within the subwatershed. This information is incorporated into the direction and overall objectives of this naturalization project. A contextual map below (**Figure 1**) shows the property boundaries and surrounding area, including: G. Lord Ross Park, University of Toronto Aerospace facility, and Don River.

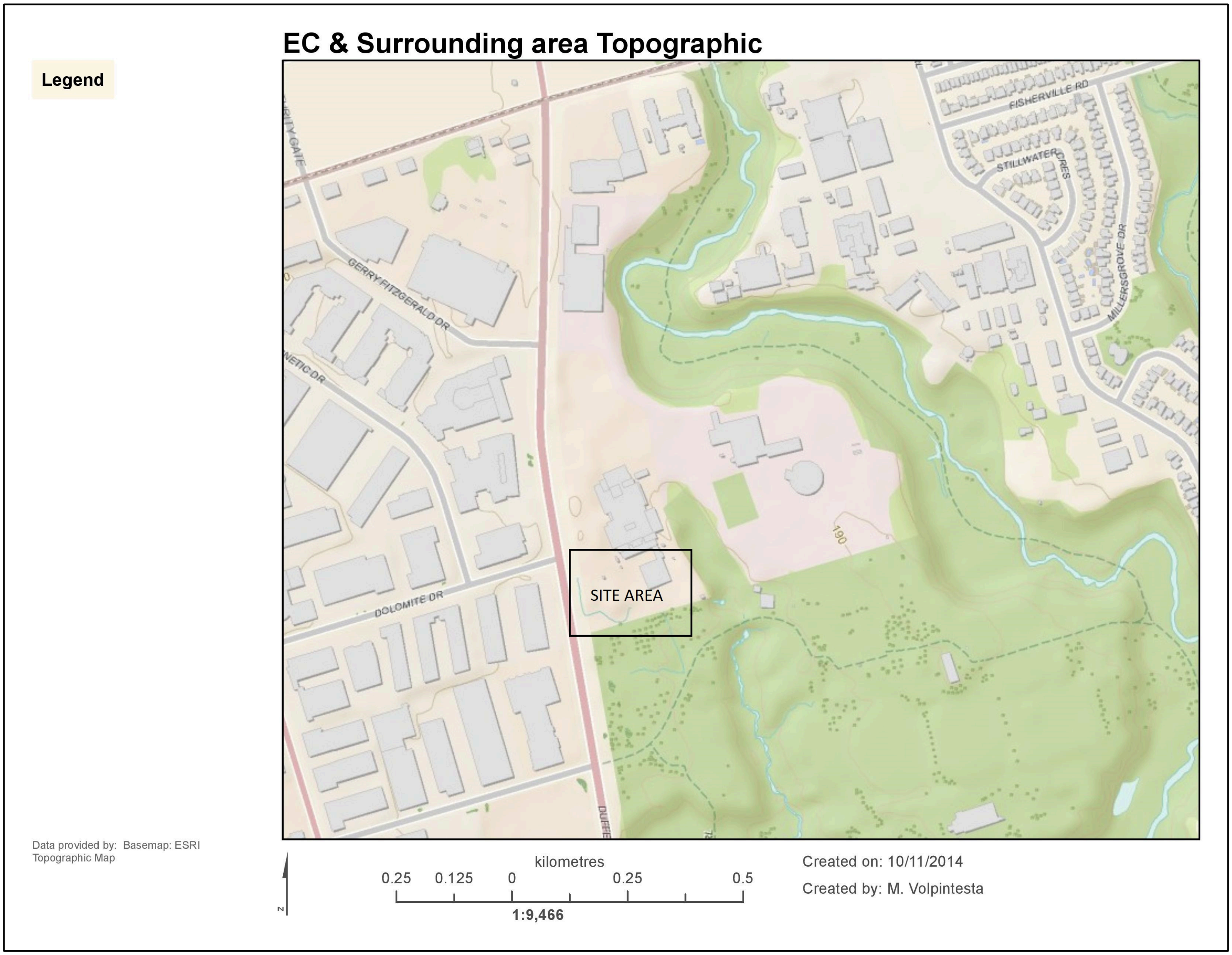

Figure 1 – Context Map of Site

This figure shows Environment Canada at 4905 Dufferin Street and the localized naturalization site in context with G. Lord Ross Park and surrounding area.

2.0 Comprehensive Site Profile

This portion of the report provides a comprehensive profile of the conditions and ecology of the site and surrounding area, as well as details of the site re-naturalization plots. This includes reading the landscape and its function; the surrounding landscape types, adjacent habitats, on-site physical conditions (topography, soil types, drainage characteristics), habitat types and condition.

2.1 Surrounding landscapes and ecology

As described within *Beyond 40 Steps* (2009), 4905 Dufferin lies within a subwatershed of the Don River, the Lower West Don subwatershed. This is relevant because it means an active naturalization plan exists for the site and surrounding area. Not only does the TRCA have a multitude of research and data on the ecosystem health of the watershed, but also it provides detail of regeneration strategies used to restore naturalized sites within the watershed. G. Ross Lord Park, adjacent to 4905 Dufferin Street, is an example of an area for which TRCA activity is prominent in applying naturalization strategies. The largest component of TRCA activity is the G. Ross Lord reservoir, a large dam regulating the flow of the Don, found inside the park. Other activities practiced within the park across the watershed include planting of native species, removal of invasive species and general ecosystem monitoring.

Within the Lower West Don subwatershed, about 14% of land is classified as natural cover, 10% forest, 3% meadow and less than 1% wetland. Impervious cover amounts to 36% cumulatively (TRCA, 2009, p. 6-18). More specifically, measured in hectares, the Lower West Don subwatershed is comprised of 661 ha woodland, 9 ha wetland, and 222 ha of meadowland (*ibid,* p.6-18). TRCA has a "Lower West Don River subwatershed Regeneration Plan", for which a section of the Don River directly east of Environment Canada is a prime focus (*ibid,* p.6-14). TRCA identifies this area as a target towards its terrestrial natural heritage system recovery objective. There are specific initiatives listed focusing on water, nature, and community ecosystem health, some of which are of particular to this project. With regard to nature, TRCA hopes to create and enhance natural cover in the target Terrestrial Natural Heritage (TNH) System of the subwatershed to 12%, specifically relevant to natural heritage enhancement. As aforementioned, the section of the Don River immediately east of Environment Canada is identified by TRCA as a target for TNH expansion. Furthermore, TRCA looks to designate and restrict public access to protected areas for shoreline bird habitat at G. Ross Lord dam (*ibid,* p. 6-15). Within the watershed, TRCA identifies the vulnerability of seven native species that include: grey tree frog (*Hyla versicolor)*, spring peeper (*Pseudacris crucifer*), porcupine (*Hystricomorph hystricidae*), wood frog (*Rana sylvatica*), hooded merganser (*Lophodytes cucullatus*) and veery (*Catharus fuscescens*) (*ibid,* p. 3-36). TRCA targets aim to enhance native habitat for these vulnerable species to maintain viable populations, and so, this project has an opportunity to contribute to this regeneration strategy.

Looking again to the adjacent G. Ross Lord Park, comprised of 127 ha, an inventory of trees and shrubs was recorded along the northern section of the park closest to the area of re-naturalization at Environment Canada (within 200 meters) see **Figure 1**. Within this inventory, several predominant species of tree and shrub were recorded and include; red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), mountain maple (*Acer spicatum*), black oak (*Quercus velutina*), Chinese oak (*Quercus qeriablis)*, American mountain ash (*Sorbus americana*), European buckthorn (*Rhamnus cathartica*), and Norway spruce (*Picea abies*). Kentucky bluegrass (*Poa pratensis*) and mixed fescue types dominate ground cover in this area. While there are elements of naturalization here that certainly are enhanced by G. Ross Lord Park and the large conglomerate of green space, still Environment Canada's property is very much encroached on by urban development resulting in diminished natural space that is ecologically defined by turf.

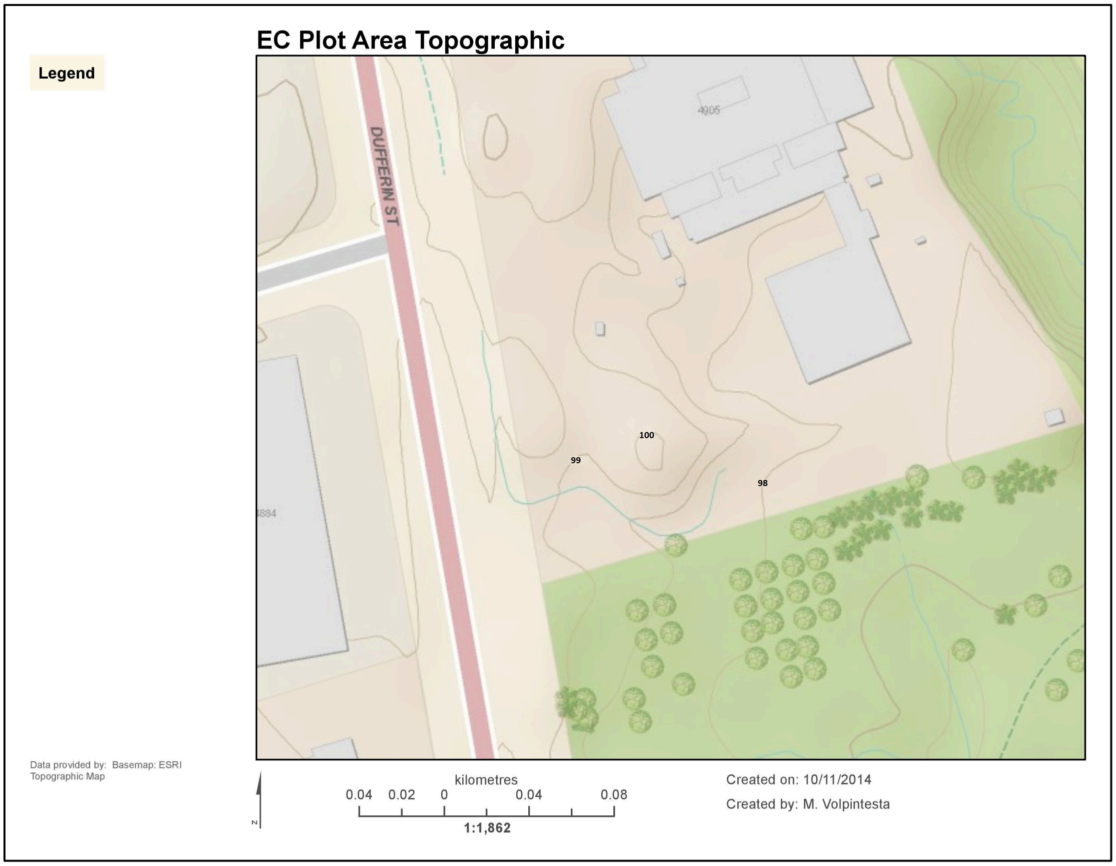

Figure 2 – **Topographic map of the site,** demonstrates the elevation contours of the site peaking at 100 meters.

2.2 On-site details and physical conditions

Since 1998, when the initial phase of the primary naturalization project was completed, groundskeepers of the site have mowed the savannah grasses that had been planted, and none of these remain today. Some shrubs and trees are still evident from the initial project and others exist by means of original development landscaping. The property in its entirety is mostly dominated by turf, mainly Kentucky bluegrass (*Poa pratensis*) and a small variety of fescue species. Focusing particularly on the southwestern portion of the site, closest to Dufferin Street, an inventory of shrubs and trees was recorded. The following species of shrub and tree were found: red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), mountain maple (*Acer spicatum*), black oak (*Quercus velutina*), Chinese oak (*Quercus qeriablis*), American mountain ash *(Sorbus americana*), European buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), balsam fir (*Abies balsamea*) and Norway spruce (*Picea abies*). As buckthorn species are invasive, removal at project commencement is highly recommended.

Figure 5 and 6 demonstrated on page 11 show the canopy using GIS imagery.

2.2.1 Soils

The soil type for the project site is classified as Chinguacousy clay-loam as mapped and identified by the Ontario Department of Agriculture and Food, 1966. The Chinguacousy soils are considered “imperfectly drained” and have developed from clay and silty clay glacial till deposits. These tills were derived principally from locally occurring brown shales, sandstones, and fossiliferous limestone (*ibid)*. According to the Ontario Department of Agriculture (1956), the coarser textures appear to be limited to the surface horizons and may result from postglacial modification by wind and water. This is further indicated by the occurrence of sand spots in some areas. The series is classified as a Gray-Brown Podzolic (Ontario Department of Agriculture and Food, 1966). The surface-cultivated layer is dark grayish brown in color and is generally friable and easily worked.

Using a consumer grade soil test kit, the site was tested for nutrient levels of nitrogen, phosphorus, and potash. Additionally, pH was tested to determine acidity/alkalinity. Using Luster Leaf’s “rapitest” soil test kit No.1601, five samples were taken from five particular locations on-site **(Figure 3**). Under partially cloudy conditions on July 16, 2014, not within 12 hours of rain, a soil sample was taken from the highest and lowest point of each plot, and one sample was collected from the small woodland shrubbery area between plot A and plot B. The sample was collected 6-8 inches below the turf. Each sample was tested for all four classifications mentioned above. The results are shown on the following page **(Table 1).** Nitrogen is synonymous with plant growth and therefore it is important to know the amount of nitrogen available. Both potash and phosphorus strengthen and contribute to the overall growth of many plants. pH level is useful to test because it helps determine which species are most appropriate and will respond to the acidity or alkalinity, which controls a plants ability to utilize other nutrients.

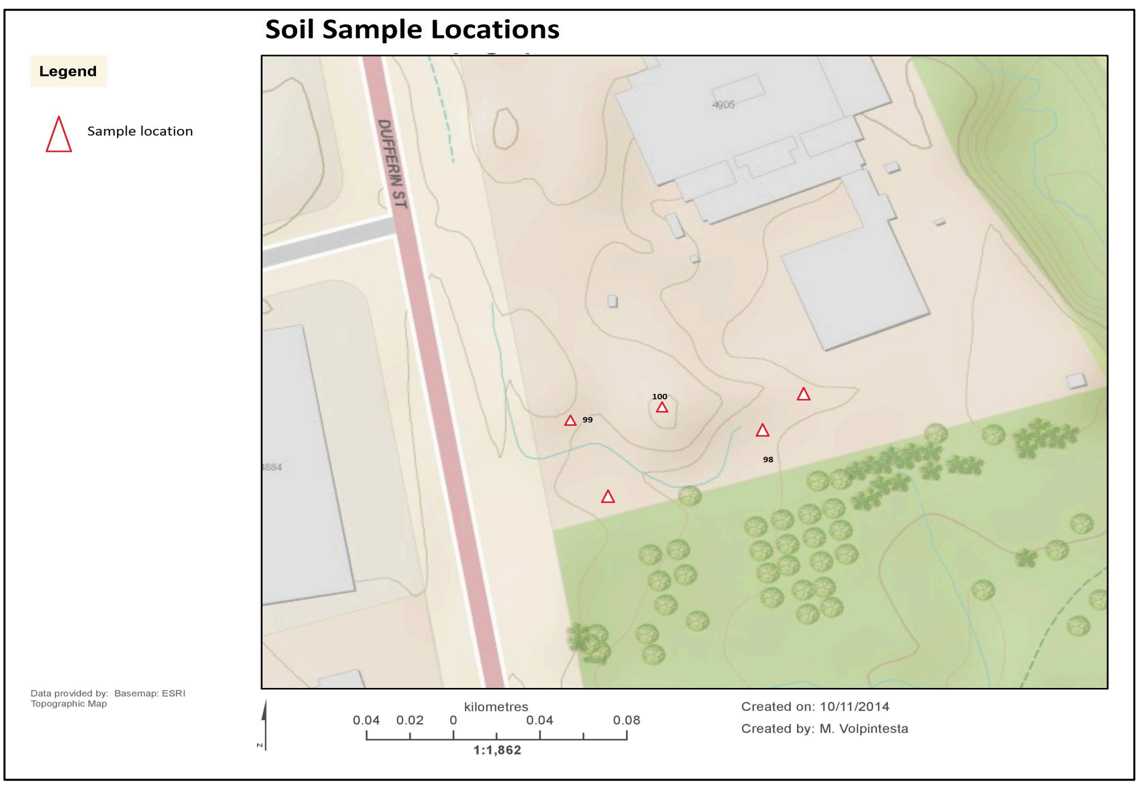

Figure 3 – Soil sample locations

Shown by Figure 3, sample locations were taken from the highest and lowest points from Plots A and B, as well as Plot H as a single measurement. For example "Plot A – H" describes the highest point in Plot A, whereas "Plot B – L" would indicate the result for the lowest point in Plot B. These sampling locations remain the same for Table 1 and Table 2.

Table 1 – "Rapitest" soil test results

	Nitrogen	pH	Potash	Phosphorus
Plot A - H	Deficient	7.25	Adequate	Deficient
Plot A - L	Surplus	7	Adequate	Adequate
Plot B - H	Deficient	7	Adequate	Surplus
Plot B - L	Deficient	7.5	Adequate	Deficient
Plot H	Adequate	6.75	Surplus	Deficient

Table 1 demonstrates the results of the "Rapitest" soil test. The classifications labelled as deficient, adequate, or surplus are determined by the descriptions included within the testing parameters. The test also included a classification labelled "depleted" however none of the tests resulted in this. The predetermined classifications by LusterLeaf are set by measuring the amount of compound within a particular amount of soil and classifying it as being healthy for plant growth or overall success. To simplify understanding test results for users, the kit includes a numerical value for pH and a similar categorical classification for the nitrogen, phosphorous and potash.

Table 2 – Soil moisture

	Moisture %
Plot A - H	19.7
Plot A - L	20.9
Plot B - H	19.5
Plot B - L	18.4
Plot H	18.6

Table 2 demonstrates soil moisture percentage taken at the same locations of soil sampling. The measure was recorded using a Delta-T ThetaProbe SM300 Soil Moisture sensor. The measurements were taken not within 12 hours of precipitation on September 24, 2014. The device probe was inserted 6-8 inches below the turf surface, collecting a digital reading. Moisture is incredibly important to the ability of a plant to grow and thrive within a particular environment (Kline, 1997). Knowledge of moisture content within the soil at the project site is extremely useful in determining the moist appropriate species for planting.

2.2.2 Element exposure

The two plots have identical element exposure and similar drainage patterns. **Figure 4** shows observed drainage patterns. Both plot A and B, are open spaces with high sun exposure. Both plots have trees with larger canopies positioned directly northeast, casting shadows on the outer north-east corners towards late afternoon sun position. As recorded by Natural Resources Canada, the site is susceptible to 801-1200mm of precipitation (calculated using mean average). Furthermore, the mean average annual wind speed is recorded as 4.67 m/s. This peaks in the winter months (DJF) at 5.59 m/s and is the most minimal between the summer and fall months. Winter and spring sees wind direction spread between south and north-westerly gusts, with some eastern breezes as well throughout the two seasons (*ibid).*

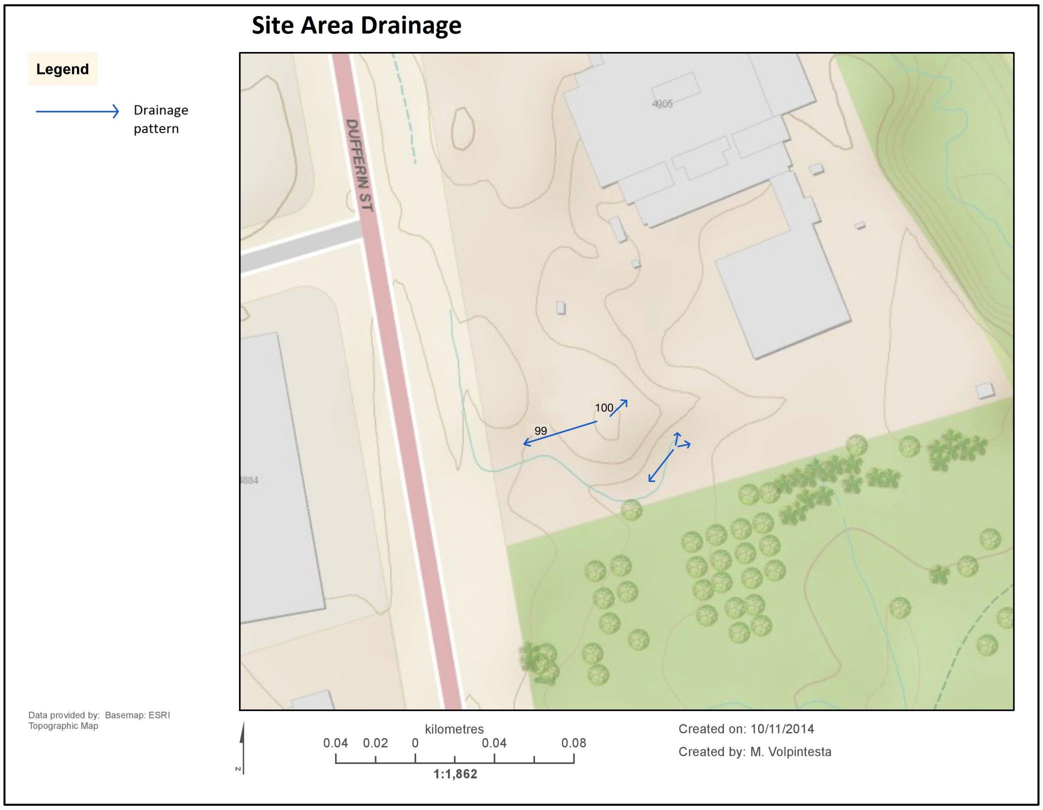

Figure 4 – Natural drainage patterns
Demonstrated by blue arrows, the point demonstrates the direction to which water is flowing, downslope. The tip of the arrow represents the highpoint and orient of flow.

2.3 Plot details

Figure 5 and 6 found below, show the location and size of Plot A and Plot B. The total area of plot A is 14,330 ft^2 and is located closest to Dufferin, directly south of the main driveway entrance to the property. The total area of Plot B is 10,498 ft^2 and is located just opposite the existing tree and shrub plantings, bordering G. Ross Lord Park to the immediate south. Referring back to **Figure 2**, the site topographic map demonstrates a rise in elevation existing in both Plot A and B. Observation demonstrates precipitation and natural drainage flowing southwest toward Dufferin in Plot A with residual flow directly east towards the existing canopy. In Plot B, natural drainage is observed flowing southwest toward the lower laying shrub and tree plantings, while residual flow deposits northeast toward the non-permeable asphalt round-about demonstrated in **Figure 6** below. Plot B is quite raised compared with the surrounding elevation. Soil moisture measurements ascertain this with lower moisture recordings in Plot B and the highest moisture in the drainage pattern of Plot A.

Both Figures 5 & 6 show the specific shape and measurement of each plot in feet with angles. Total area is indicated in squared feet in the highlighted box.

Figure 5 – Plot A aerial satellite

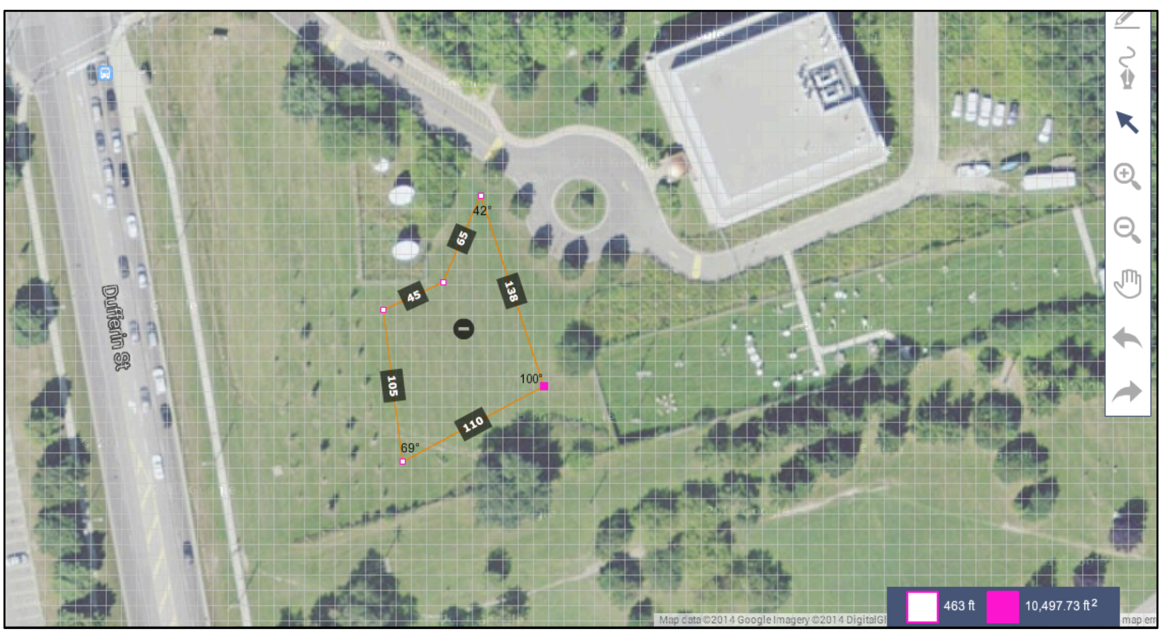

Figure 6 – Plot B aerial satellite

3.0 Naturalization plan and design

The design for this project incorporates several objectives:

removal of non-native turf,

pathway construction between main building and G. Ross Lord Park, including seating,

establish ecological function through native planting and seeding,

demonstrate Environment Canada's commitment to nature through signage and storyboards that communicate ecological design alternatives to turf and species initiatives.

In order to fulfill the first objective, the dominant non-native turf in both plots first requires removal, resulting in a bare surface for planting and landscape design. This section demonstrates the methods of turf removal, as well as plot design and planting sites, including specie selection and plan alternatives. As discussed, one of Environment Canada's goals in this project is to re-establish its commitment to the environment and to the public. The project steering committee and Environment Canada green team desire a plan that demonstrates this goal by having the main focal piece of the plan alongside Dufferin Street towards the building entrance and main driveway (plot A). Plot B is separated from plot A by a small section of existing shrub and tree plantings, existing as a sort of ecosystem patch between the two new planting plots. Both plots should have elements of connectivity between each other and to the surrounding landscapes and ecosystem. Specific site design will include a pathway and seating connected between the main building and nearby park. Signage and storyboards will be positioned along the pathway discussing the benefit of design alternatives to turf and ecological function.

3.1 Turf removal

As demonstrated in **Figures 5 and 6**, each plot is completely covered in turf. There are several methods of turf removal with varying costs and levels of effectiveness. The first and most effective yet costly option would be to dig up the turf completely, exposing the soil beneath. This is done using a turf removal tilling mechanism that removes 6 inches of the top ground. The second most effective and costly option, the zero tillage method, is established by covering the entire surface with 3.3mm PVC black pond liner, slowly killing the turf below through solar blocking. The third option (direct seeding or inter-planting) is likely the most cost efficient but can lead to less seeding success and requires the most time to be effective. Direct seeding requires mowing turf to 0.5cm using a weed mower, and covering the remaining turf with seed or pots combined with triple mix (manure, compost and topsoil) at approximately 1:3 ratio (Foster, 2004).

3.2 Plot design

Each plot, unique in area, shape and topography, begins as open surface soil. Due to the positioning of fixed scientific weather instruments and various satellites found on site, both plots have been positioned specifically to avoid any interference. One of two instrument compounds is shown in **Figure 5** outside the plot a area. Described by Environment Canada's project steering committee, there are specific requirements that must be met by the design. An important objective of the project is to demonstrate the naturalization of the site to the public. Plot A, positioned directly alongside Dufferin Street will incorporate aesthetically pleasing plantings that provide ecosystem function. The plantings should not impede the purpose of scientific equipment on site and ideally should still showcase some of the building façade. Short grasses and wild flowers derived from a prairie savannah ecosystem are ideal. Plot B is positioned away from the frontal sidewalk view, and therefore may require less aesthetic motive behind planting and can include species more consistent with a prairie/tallgrass ecosystem. Plot B will be comprised of more of a true oak-savannah ecosystem with black and red oak as well as other tallgrass features present. The concept of two plots is most desired because it incorporates existing plantings, and creates two smaller ecosystems that can interact but also be site specific, referred to by Kline as a patchwork ecosystem, connecting the greater landscape (Kline, 1997, p.32).

A pathway will be incorporated into the design to connect the two plots. A pathway will divide both plots, connecting G. Ross Lord Park and to the main entrance of the building along Dufferin Street. This creates an opportunity for public by-passers and Environment Canada employees to experience the naturalization project. Mentioned by the project steering committee, employees often use informal pathways to enter the park for recreational purposes during work breaks and off time. To further public knowledge of the project, seating and signage will be posted along the pathway informing users of the specific components of the naturalization project. The pathway must have a permeable surface. Options in materials vary between wood decking, and shale gravel.

Each plot is divided and organized into sub plots with specific planting suggestions to optimize opportunities for fulfillment of the project objectives. **Figure 7** demonstrates the shape and make up of sub plots within plot A and B. Specific plot composition is described further below.

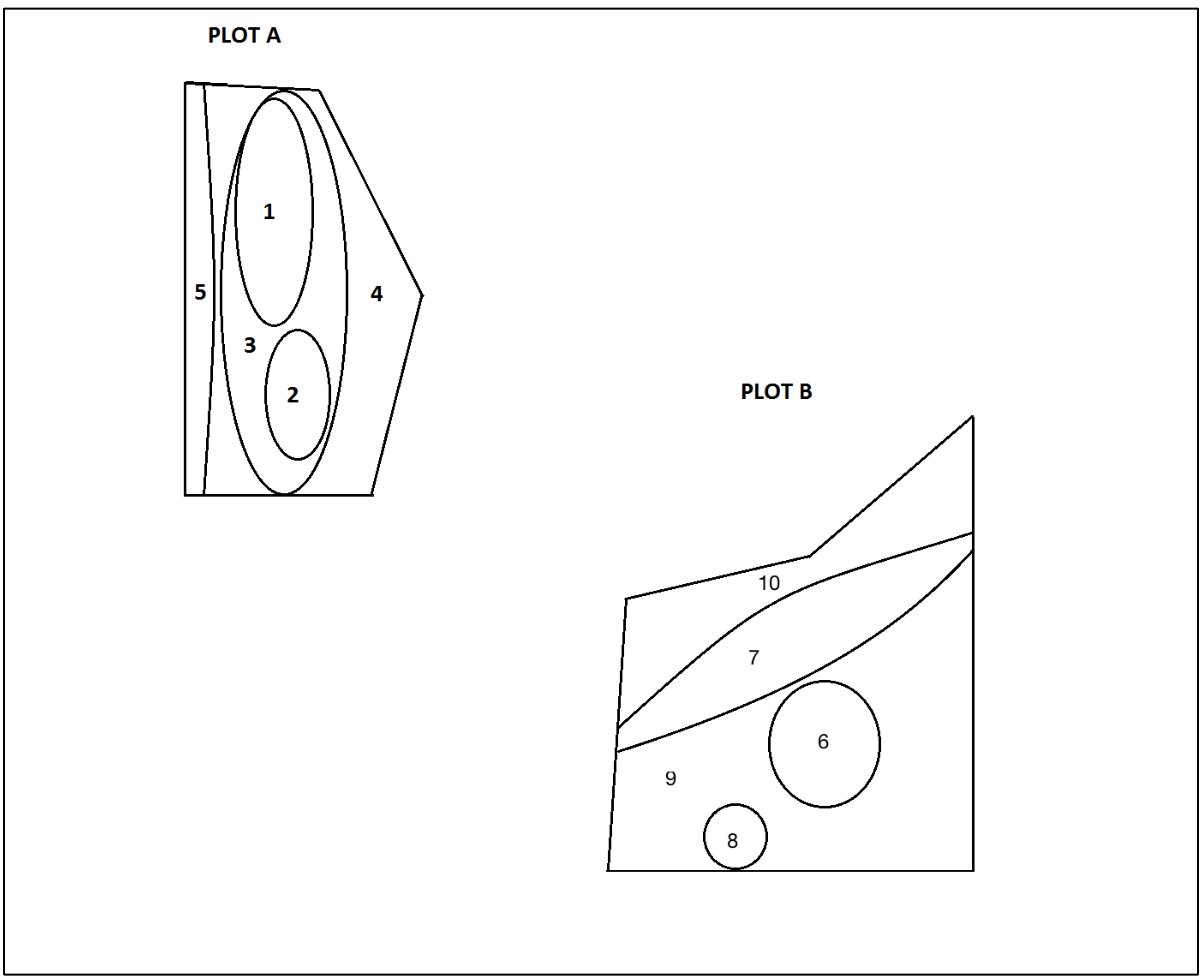

Figure 7 – Subplot makeup of Plot A & B

Table 3 and Figure 7 correspond to one another. The number corresponds to the plant list within each plot. For example, 1 – Canadian wild Rye, and Indian Grass is located within the circled area of "1" shown by Figure 7.

Table 3 – Plot planting lists

Plant List – Plot A	
1	Canadian Wild Rye, Indian Grass
2	Butterfly Milkweed
3	Little Bluestem, Indian Grass, Blue Vervain, Lance Leaved Coreopsis
4	Little Bluestem, Blue Vervain, Sweet Oxeye, Green Headed Coneflower
5	Switch Grass, Little Bluestem, Green Headed Coneflower

Plant List – Plot B	
6	Black Oak
7	Blue Vervain, Sweet Oxeye. Greenheaded Coneflower
8	New Jersey Tea
9	Big Bluestem, Little Bluestem, Lance Leaved Coreopsis, Blue Vervain
10	Big Bluestem, Switch Grass, Canadian Wild Rye

3.3 Species selection

Before European colonization began, forest cover was occasionally "interrupted" by two principal types of tallgrass ecosystems, both prairie and savannah (High Park Nature, 2014). Prairies are commonly open and treeless areas dominated by grasses and wildflowers. In contrast, savannahs are open space woodland that combines prairie and some forest features (*ibid*). A savannah is a tallgrass community with 25-35 percent tree cover, according to the Ecological Land Classification System for Southern Ontario (*ibid).*

As is aforementioned, Plot A will be comprised of shorter native savannah grasses and wildflowers to not impede the façade of the building and Environment Canada's weather instruments. Switch grass (*Panicum virgatum),* a salt tolerant prairie grass will be planted along the edge of the plot A to avoid destruction by harmful salt deposits during winter months from nearby Dufferin Street. Plot B incorporates a more complete catalogue of oak-savannah species with the ability to include taller grasses, woody shrubs and oak trees.

To select species for planting, native species common to prairie and oak-savannah ecosystems are considered and characterized with soil components and element exposure of each plot, fulfilling the unique requirements for plots A and B. Due to fairly neutral soil characteristics with average acidity, moisture and nutrient composition, the species selected have a good opportunity for full succession. While the species chosen are meant to thrive in recovering ecosystems in sun or shade, there are still ideal conditions for succession on-site. The clay-loam soil type has fairly good drainage, and element exposure is also ideal for the species selected. Consideration is also given to targeted vulnerable species identified by both TRCA and Ontario's MNR, including those listed above and including the declining monarch butterfly. Pollinator species like New Jersey Tea have also been chosen and will be organized together within subplots to attract the important and declining bee populations. An aspect of the plan incorporates pollinator plantings. The use of Butterfly Milkweed and New Jersey tea can be effective in harbouring the Monarch butterfly and one of the five bee families that are native to the Toronto area (David Suzuki Organization, 2014). The table below as **Table 4** lists each grass, wildflower, shrub and tree, its characteristics, and the plot to which it can be found.

Table 4 – Planting List and characteristics

Common Name	Botanical Name	Characteristics and Size	Community	Soil Texture	Moisture	Sun Exposure	Plot	Notes
Big Bluestem	*Andropogon gerardii*	Tallgrass, large	Prairie, savannah, meadow	Silt/ clay-loam	Int. / dry	Full sun	B	Common to Oak-Savannah
Little Bluestem	*Andropogon scoparious*	Shortgrass, medium	Prairie, meadow, savannah	Silt/ clay-loam	Int. / dry	Full sun	A, B	Common around Great Lakes, SW Ontario
Blue Vervain	*Verbena hastata*	Forb, Wild flower, medium	Meadow	Silt/ clay-loam	Wet/ moist	Full sun	A, B	
Switch Grass	*Panicum virgatum*	Tallgrass, large	Prairie, meadow, savannah	Sand/ silt/ clay-loam	Moist/ int.	Full sun	A, B	Highly salt tolerant
Canadian Wild Rye	*Elymus Canadensis*	Tallgrass, large	Prairie, meadow, savannah	Sand/ clay-loam	Int.	Full sun	A, B	
Butterfly Milkweed	*Asclepias tuberosa*	Wildflower, medium	Prairie, meadow, savannah	Sand/ clay-loam	Dry	Full sun	B	Attractant to Monarch butterfly, bright orange flowers bloom in July
Greenheaded Coneflower	*Rudbeckia laciniata*	Wildflower, large	Prairie, meadow, savannah	Silt/ clay-loam	Moist/ int.	Full sun/ partial shade	A, B	Up to 3m tall
Lance Leaved Coreopsis	*Coreopsis lanceolata*	Wildflower, large	Savannah	Sand/ clay-loam	Int.	Full Sun	A, B	
Sweet Oxeye	*Heliopsis helianthoides*	Wildflower, large	Prairie, meadow, savannah	Sand/ clay-loam	Int./ dry	Full sun/ partial shade	A	Similar to sunflower
Indian Grass	*Sorghastrum nutans*	Grass, medium/large	Prairie, savannah	Sand/ loam	Int./ dry	Full	A, B	
New Jersey Tea	*Ceanothus americanus*	Shrub, small	Prairie, meadow, savannah	Sand/ loam	Int./ dry	Full sun/ partial shade	B	
Black Oak	*Quercus velutina*	Tree, medium	Prairie, meadow, savannah	Sand/ loam	Int./ dry	Full Sun	B	Up to 20m height, 90cm diameter
LEGEND	Size: groundcover / tree height / shrub height S = <20cm / 6 – 10m / <1.5m M = / 11 – 18m / 1.6 – 3m L = / 19 – 30m+ / 3.1-6m+			Soil Texture: Sand, Silt or Loam, Clay Soil Moisture: Wet, Moist, Int. = Intermediate/mesic, Dry				

3.4 Project phases and implementation

Figure 8 illustrates a completed site plan of plot A and B drawn using AutoCAD architectural software (also attached in larger format as **Appendix – II).** The plan will be implemented in two main phases and will require continuous maintenance and monitoring. Phase one entails the process of turf removal and pathway construction and possible soil modification. Phase two involves the seeding and planting process. The timeline of this project varies depending on the preferred method of turf removal and plan alternatives as selected by Environment Canada's project steering committee.

To begin phase one, turf is removed or destroyed completely from both plots. At this time any soil modification can occur. This is followed by pathway construction beginning at plot A, near the entrance driveway, and through to the south end of plot B entering G. Ross Lord Park. Phase two can only begin once turf removal and path construction is complete. Seeding and planting will occur according to species characterization. Once all planting and seeding are complete, educational signage and bench seating can be installed throughout the naturalization site.

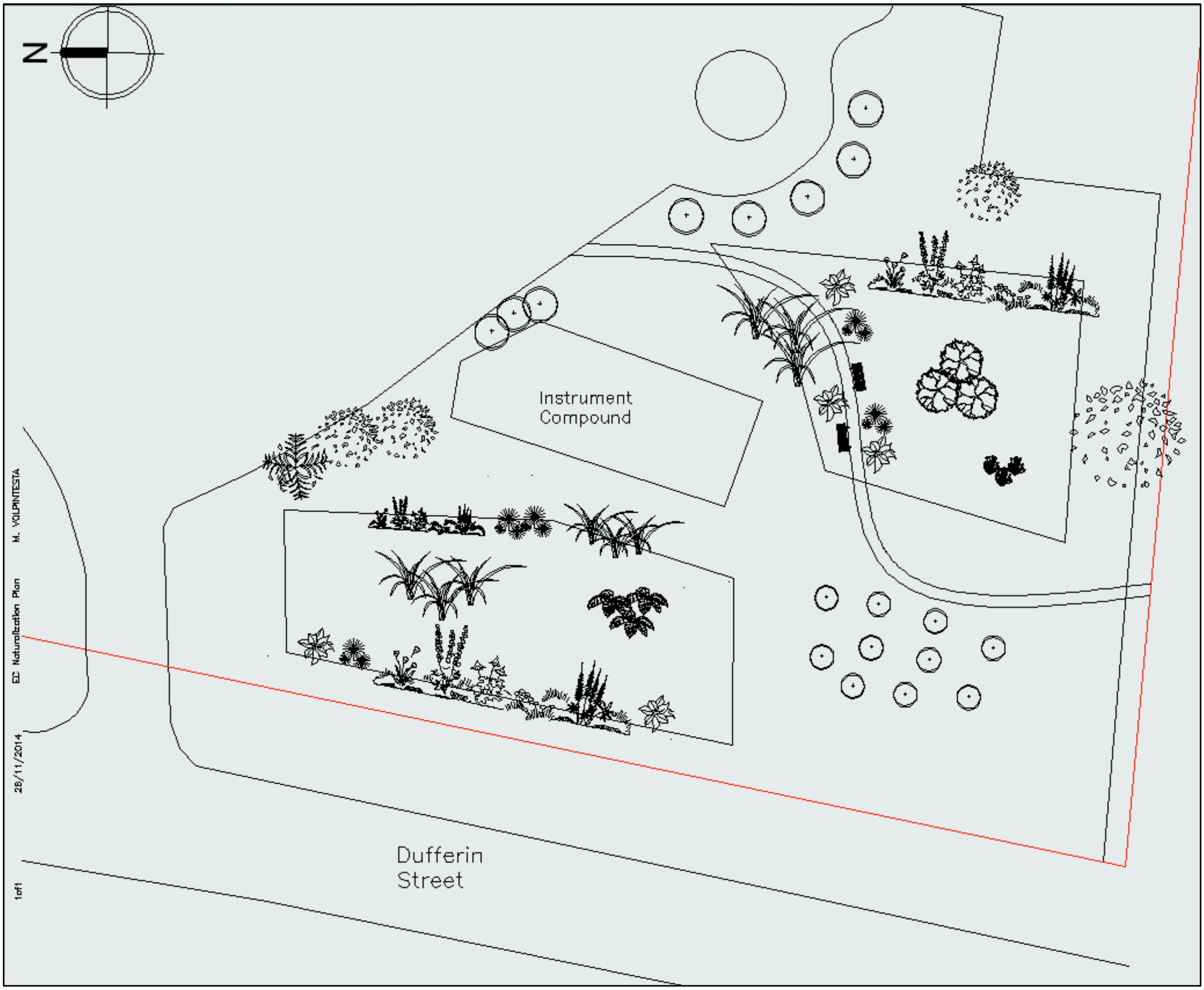

Figure 8 – Naturalization plan CAD drawing

This image of a digital AutoCAD drawing represents the architectural measurements of each plot and pathway and specific location of planting sites. The drawing also demonstrates the property boundary, building exterior and existing City of Toronto infrastructure.

4.0 Alternatives to plan and budget

See **Table 5 on page 18** for budget and plan alternatives

During the initial phases of consultation, the project steering committee requested that the plan incorporate a range of restoration strategies, due to potential budget and implementation constraints. In adherence of this request, some aspects of the plan are interchangeable.

The first option of turf removal is the most expensive, which would be to remove turf mechanically. This would require the least amount of time, and could be very effective removing the surface turf, but can cause damage to soil and alter composition, potentially requiring soil modification. Turf removal by covering with black 3mm pond liner is the next most effective option. This option is more affordable than removal, but takes much longer to complete. The most affordable option would be short mowing inter-planting amongst the existing turf. This option is not recommended due to competition with non-native grass species, and full succession is not likely.

Soil modification is not necessary for this project. While it can enhance probability for ecosystem function and overall succession, it is costly and resources could be invested in other parts of the project to yield positive outcomes. The results of the soil testing demonstrate average acidity and some evidence of plant strengthening nutrients. If desired by Environment Canada, minor modification may see the addition of a topsoil mix, including nitrogen, phosphorus, and potash. Machined turf removal is necessary for soil modification eradicating other alternatives.

To achieve a true ecological restoration, an integrated pathway must not be constructed of an impermeable surface. Often in meadow ecosystems where human interaction is allocated, boardwalks are constructed to lie above but not in contact with delicate plantings. This also creates an experience of being immersed into the ecosystem, and eliminates disconnectedness felt by users, and by physically separating the landscape. It would be the most costly to construct a wooden deck through both plots. Another option would be to construct a layered permeable pH-neutral gravel surface using natural gravel. Accessibility may be restrictive in this instance.

Plantings are the most affordable by seed. This however, is accompanied with the highest risk of non-succession. There is a relatively lower rate of seed success, and plants are easily outcompeted by invasive species like returning turf and other species commonly represented in the seedbed like varieties of thistle (Waterfront Regeneration Trust, 1995). While it is appropriate for grasses to be planted by seed, plugs offer a higher rate of success and more immediate visual results. The larger shrubs and tree plantings should be acquired in sapling form. Specifically focusing on the larger oak species, externally nursed medium sized trees can be ordered and have a greater chance of full succession. High consideration must be given in acquiring plantings that carry the highest success rate, without doing so may result in a failed naturalization (*ibid)*.

As one of Environment Canada's objectives is to demonstrate its commitment to the environment publically, signage and educational briefing materials are recommended alongside some environmental features. This will allow for pathway users to become educated on particular plantings and Environment Canada initiatives.

Lastly, proper plant sourcing is vital in successful establishment. The Ontario Society for Ecological Restoration or SER Ontario (SERO) is part of an international organization committed to the ecologically sensitive repair and management of ecosystems. Each year SERO produces a list of buyers' guidelines and grower lists that incorporate recent education on native species, successful and unsuccessful plantings and invasive species. It is recommended the SERO growers list be consulted for final selection of plant materials.

Table 5 – Alternatives and budget

Feature	Install Date	Platinum Plan	Install Date	Silver	Install Date	Bronze
Turf removal & soil preparation	March 2015 April 2015	Machined turf removal using sod cutter machine. Tilling of soil. Soil modification, adding of bone meal and blood meal to increase levels of potash, nitrogen, and phosphorus. Sand additives. Budget: Sod cutter weekly rental $300.00 + labour $100.00 per day. Tiller rental $80.00 per day (2 – 3 day use). Sand $174.75 (5 cubic yards). Nutrient application of bone meal, blood meal approx. $1750.00 per 25,000 ft.	March 2015 March 2016	Turf removal by ground cover using PVC black pond liner, approx. 25,000ft. Sand additives for planting. Budget: $4000.00 3mm PVC black pond liner. Sand $174.75 (5 cubic yards).	March 2015	Turf removal by mowing to 0.5mm using hand mower. Sand additives for planting. Budget: Manual labour $100.00 per day (5 days) (may require multiple mows) Sand $174.75 (5 cubic yards).
Pathway construction	April 2015	Wood decking, approximately 160 ft. by 5ft. wide. Budget: 800 ft^2 Wood decking (supplies, $3500.00. Labour (80 hours) and construction supplies, $3100.00	March 2016	Gravel pathway, using 7/8" clear limestone screening 160 ft. by 5 ft. wide. Budget: 800 ft^2 by 2" thickness limestone screening (6 cubic yards) $374.00 not including delivery fees.	March 2015	Woodchip, mulch pathway, 160 ft. by 5ft. wide. Budget: 800 ft^2 by 2" thickness woodchip mulch (6 cubic yards +1 for upkeep) $255.00 not including delivery fees.
Planting & Seeding	April 2015	Ornamental grasses gallon pots approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft^2 coverage. Five 50mm diameter Black Oak saplings. Budget: Grasses with approx. 100cm spacing, 1176 (1 gallon) pots at approx. $12.99 each, total $15,288.00. Wildflower pots, approx. 60cm spacing, 2000 4" plugs, total $2,620.00. Black Oak saplings, 50mm diameter $399.99 each, total $1,999.95	April 2016	Ornamental grasses gallon pots approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft. coverage. Five 250cm Black Oak saplings. Budget: Grasses with approx. 100cm spacing, 1176 (1 gallon) pots at approx. $12.99 each, total $15,288.00. Wildflower pots, approx. 60cm spacing, 2000 4" plugs, total $2,620.00. Black Oak saplings, 250cm $199.99 each, total $999.95	April 2015	Ornamental grass seeding approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft. coverage. Five 250cm Black Oak saplings. Budget: Grass seeding Approx. 20 kg seeding covering $9.99 – $12.99 per kg, $199.80 – $259.80. Wildflower pots, approx. 60cm spacing, 2000 4" plugs, total $2,620.00. Black Oak saplings, 250cm $199.99 each, total $999.95
Signage & Seating	Sept. 2015	Outdoor 1/8" PVC vinyl signage, 48" x 120" $620.00 each. Two Outdoor Jayhawk standard park benches, $629.00 each. Budget: Signage x 3, $1,860.00 Benching x 2, $1258.00	Sept. 2015	Outdoor 1/8" PVC vinyl signage, 48" x 120" $620.00 each. Two Outdoor Jayhawk standard park benches, $629.00 each. Budget: Signage x 3, $1,860.00 Benching x 2, $1258.00	Sept. 2015	Outdoor 1/8" PVC vinyl signage, 48" x 120" $620.00 each. Budget: Signage x 3, $1,860.00
	TOTAL	$32,310.70	TOTAL	$26,574.75	TOTAL	$6,609.55

*** Budget estimates courtesy of Greely Sand and Gravel Ottawa, Humber Nurseries Toronto, and The Home Depot.

5.0 Management and long-term maintenance

Maintenance and monitoring should include the following actions; controlled burns (prescribed fire), control of invasive brush and trees, control of herbaceous weeds, seed collecting and introducing further understory species (Oak-Savannah Management, 2014). Monitoring and maintenance requirements in naturalized areas should remain minimal, however because the restoration objective is to retain a meadow at a certain stage of succession, then monitoring of grass and woody growth is required.

A main factor in managing meadows mainly involves removing woody vegetation, depending on the successional stage required (Waterfront Regeneration Trust, 1995). In old fields, characteristically a mixture of introduced and native species, control of introduced species is seldom necessary. In urban areas, highly manicured parkland is coming under increasing public criticism as a sterile environment in which differences in sites are ignored, and where only a few exotic bird species thrive (*ibid,* p.98*)*. It is also becoming increasingly costly to maintain, and is often hazardous to maintenance operators.

Mowing near natural areas can damage their ecological diversity and habitat. A buffer of 5 m to 10 m should be left un-mown and allowed to naturalize. For areas of widely spaced trees in turf, considerable handwork by small mowers is required. Such areas can be filled with other plant materials to create patches and wildlife habitat with a new mowing line around them. In areas of dense tree groupings, mowing under trees should be discontinued to permit a natural groundcover and under storey to develop, either through naturalization or with restoration procedures.

As described within *The Waterfront Regeneration Trust* (1995), landscapes appear neglected where the edges between one kind and another have not been adequately considered, particularly between manicured and rough turf and meadow. Edges should be laid out in sweeping lines, as an obviously designed edge looks purposeful. Well laid out and carefully considered, it creates an attractive landscape of contrasting elements, with the meadow habitat enhancing the mown turf.

Annual prescribed burning, as demonstrated within Toronto's High Park is an effective way to regenerate growth and maintain an oak-savannah ecosystem. Research has shown that the health of an oak-savannah is best maintained if the site is burned every year. If resources do not permit annual burns, then the site should be burned as often as possible, but under no conditions should the burn frequency be less than three years.

Attached, as Appendix – III is a reformatted copy of the deliverable plan to Environment Canada excluding some appendixes already included in this report.

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Appendixes

Appendix - I

Final Report

Naturalization - Phase I
Environment Canada
4905 Dufferin Street
Downsview, Ontario

Prepared for:

Environment Canada

January 6, 2000

Aboud & Associates Inc.
Consulting Ecologists & Arborists

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1.0 PROJECT SUMMARY

Naturalization Phase I of the Environment Canada facility at 4905 Dufferin Street, Downsview began in September 1998 and ended December 1999. During this time a site analysis and site design plan were developed with respect to naturalization, and site preparation and plantings of trees, shrubs and prairie species occurred at selected locations. Aboud & Associates (Contractor) was retained by the Naturalization Steering Committee (Committee) to carry out all works related to site design, implementation (site preparation and planting), and activities related to communications, meetings and presentations. A chronological list of major tasks and project milestones is summarized in Table 1.

Table 1. Summary of Completed Tasks (see Drawing No. 1)

Item	Date	Major Tasks & Milestones
1	Sept. to Dec. 1998	1. A presentation was made to the Committee and staff of Environment Canada about naturalization in general and specific details of the proposed site plans. 2. Information signs of naturalization were designed and installed at key locations. 3. Existing trees were pruned (20) or removed (20) to provide additional light and space for new trees, and remove weedy species/unhealthy trees. 4. Planting plans were prepared for three shrub thicket areas and approximately 60 shrubs of nine species were planted with assistance from Environment Canada volunteers in Shrub Area 3. 5. A site design workshop was prepared and presented to the Committee. 6. Control of unwanted vegetation in the three prairie areas began using an application of Roundup®. These areas were plowed and tilled in preparation for planting the following spring.
2	Jan. to May 1999	1. The site design plan was completed and submitted in April 1999. It presents a summary of background materials, a schedule for implementation, design criteria, and plans both written and graphically, on how and where to install hard landscape features, e.g., trails, seating, and signage. 2. Shrubs (260) were planted with assistance from Environment Canada volunteers in Shrub Areas 1 and 2. Trees (275) were planted in Woodland Areas 1, 2 and 3, and the Parking Lot Islands. 3. Control of unwanted vegetation in planted areas of three woodlands and two shrub thickets and the parking lot islands was carried out using Roundup®. Approximately 200 cubic yards of wood chips were supplied and installed in all areas of tree and shrub plantings. 4. Final preparation of the prairie areas included tilling and spot spraying using Roundup®. 5. Plugs (10,000) of prairie species (5 grasses, 20 forbs) were hand-planted by the contractor, and volunteers from Environment Canada and the University of Guelph. Seeds of Canada anemone, gray coneflower and northern blazing star were broadcast at the edges of the prairie areas.
3	June to Sept. 1999	1. Maintenance of the planted areas was ongoing throughout this period. Tasks included thorough weeding (hand pulling and herbicide) of Prairie Area 3, and spot spraying of invasive weeds in Prairie Areas 1 and 2. Volunteers from Environment Canada hand-weeded most of Prairie Areas 1 and 2. All areas of woodland, shrub thicket and open-grown trees in the parking lot islands were spot sprayed. 2. Seeds (two kilograms) of Canada wild rye were broadcast throughout all three prairie areas to provide additional control of unwanted vegetation.
4	Oct. to Dec. 1999	1. Plantings of 24 trees were added to Woodland Area 2 to replace trees that were injured by wood borers (insects) and to the Parking Lot Islands. Shrubs (10) were added to Shrub Area 4. 2. A final presentation was made to the Committee and staff of EC

A detailed description of ecosystem types, ecosystem sizes and planted stock is presented in Table 2.

Table 2. Summary of Planted Ecosystem Types
(see Drawing No. 1 for locations of ecosystem types)

Ecosystem Type	Subplot No.	Area sq. metres	Quantity of Plants	Comments
Woodland	1	850	140	Planting dominated by bareroot, hardwood trees, with some potted conifers and bareroot shrubs.
	2	400	60	
	3	300	40	
		Total 1,550	240	
Shrub Thicket	1	630	140	Planting dominated by bareroot, hardwood shrubs, with some potted conifers and bareroot trees.
	2	400	120	
	3	200	50	
	4	100	10	
		Total 1,330	320	
Prairie	1	600	2,000	Planting dominated by plugs, with some potted plants in Area 3. Seeds (2.5kg) were broadcast throughout all 3 prairie areas.
	2	2,020	7,700	
	3	120	350	
		Total 2,740	10,050	
Parking Lot Islands (linear metres)	N/a	270	35	Planting solely of bareroot, hardwood trees.

1.1 Establishment Success

Plants were installed at several different times and at selected locations throughout the site. As well, different stock types of seedling plugs, bareroot, potted, and balled and burlapped, were incorporated into the plantings. Establishment success of ecosystem types is here defined by at least 80% of the plantings having survived transplanting into their new location, and showing signs of growth (stem elongation) and/or development of specific structures, e.g., flowers, fruit. Ecosystem establishment success for all areas was over 90%. Shrubs planted in October 1998 (Shrub Area 3) are well established. Stem elongation of most shrubs has surpassed 10 cm, and some species (e.g., elderberry, hazelnut) have grown over 60 cm and produced fruit. Based on area covered, about 90% of the planted stock in all prairie areas has survived transplanting and grown. As well, at least half of the plugs have produced flowers and developed fruit. It is expected that many of these fruits have developed viable seeds that will germinate in the next growing season. Many plants of tall species such as big bluestem, gray coneflower and giant sunflower grew to heights over two metres during their first growing season. Seeds of Canada wild rye, Canada anemone, gray coneflower and northern blazing star were broadcast in all prairie areas. Germination and growth of these seeds is expected in the upcoming growing season.

Plant losses of two to six percent were identified in all areas planted to shrubs and trees. Woodland Area 2 experienced losses of 15% due to attack from wood boring insects. Affected trees were removed and replaced with healthy stock in October 199

1.2 Financial Summary

Detailed bookkeeping and maintenance of expenses and fees have been ongoing throughout the project. This information has been forwarded to Environment Canada as part of the invoicing process. As well, detailed costing has been ongoing through discussions and meetings during the project. A financial summary of the costs to prepare, supply and install major project items should be useful in assessing the budget of Phase I and also for future project expansion. Table 3 presents a cost summary of Phase I.

The initial upset limit of the budget to complete Phase I was $40,000.00 (excluding GST). However, cost overruns, setbacks and project additions (e.g., additional plantings) increased the project costs to surpass the initial upset limit. Although cost overruns were shared between Environment Canada and the Contractor, the total amounts are listed below to provide a reasonable measure of what was spent.

Table 3. Cost Summary of Phase I

Task/Product	Description	Subtotal	Total
Site Design Plan	Prepare for and conduct 1 meeting, hold site design workshop with Committee, prepare and supply 20 copies of final site design plan	$8,500	
			$8,500
Site Preparation	Prairie (spray, plow, till)	$5,500	
	Woodland (spray, stake)	$1,600	
	Shrub Thicket (spray, stake)	$1,200	
	Parking Lot Islands (spray, stake)	$800	
			9,100
Planting	Prairie (supply, install, maintain)	$9,300	
	Woodland (supply, install, mulch, maintain)	$6,500	
	Shrub Thicket (supply, install, mulch, maintain)	$4,600	
	Parking Lot Islands (supply, install, mulch, maintain)	$2,000	
			$22,400
Meetings, Signage and Presentations	Includes 5 meetings, and preparation and delivery of 2 presentations. Design, supply and installation of 6 outdoor signs.	$4,500	
			$4,500
Administration	office, telephone, fax. correspondence	$1,500	
			$1,500
		Total	**$46,000**

NOTE: The costs listed are estimates.

Although communications (email, telephone, facsimile) with Committee members throughout the contract were extensive, costs for this task were not billed and are not included in the above cost summary.

2.0 LESSONS LEARNED "WEAKNESSES IDENTIFIED"

2.1 Use of Pesticides

The application of Roundup®, a glyphosate-based herbicide to control vegetation was identified in the project proposal as a vital step to site preparation. As well, this systemic (moves throughout the plant), non-specific (targets all green vegetation) herbicide is well known for its effectiveness at eliminating persistent perennial weeds for the establishment of prairie plantings. However opposition to the use of pesticides at Environment Canada's Downsview facility was expressed by staff following the announcement of plans of the first application in September 1998. This reaction caused the temporary cancellation of spraying while information was gathered and discussions were held. Although spraying did resume on the project as originally planned, it became clear that the use of pesticides at the facility is a contentious issue. There are three scenarios described in Table 4 that would provide vegetation control as part of the current and continued naturalization of prairie sites. Other methods exist such as solarization and smothering. However they are not practical on projects of this large size.

Table 4. Types of Vegetation Control

Type of Control	Description	Advantages	Disadvantages
Cultivation	Repeatedly (every 3 to 5 weeks) turn under existing vegetation using a plow, disc or rototiller until sufficient weed control has been reached. Cost: Expensive relative to use of herbicide. May cost up to 3 to 5 times more.	Very effective at eliminating annual weeds and loosens the soil to facilitate planting	May take up to three years to control some perennial weeds. Repeated use of heavy equipment can harm soil structure. Prolonged cultivation delays planting activity and loss of wildlife habitat. Cultivation machines consume fossil fuels and release emissions.
Topsoil Removal	Topsoil is removed with heavy equipment. This removes roots and seeds of weeds. Cost: Very expensive relative to use of herbicide. Massive volumes of soil are excavated, transported and dumped. May cost 10 to 20 times greater or more.	Very effective at eliminating all weeds. Prairie plants have a competitive edge over weeds at growing in the impoverished subsoil.	Soil structure is destroyed along with most soil micro-organisms. May leave depressions on site once 15 to 20 cm of topsoil has been removed. Excavation equipment consumes fossil fuels and releases emissions.
Pesticide	Glyphosate-based herbicide is sprayed on green tissue of plants. Vegetation is killed in 1 to 2 weeks. Cost: Least expensive method of control. Often used in conjuction with cultivation.	Very effective at eliminating perennial weeds. Does not disrupt soil structure or soil micro-organisms. Chemical binds to soil particles and is broken down by bacteria.	Must be applied at specific periods of plants' development and under specific weather conditions. All pesticides are controlled substances and must be properly applied to protect humans and the environment.

Cultivation and topsoil removal methods are further disadvantaged at the Downsview site because of its complex layout. Curbs, roads, sidewalks, existing trees, parking areas, and satellite and instrument compounds are constraints to repeated cultivation or use of large excavation equipment. Maneuvering around these objects would be slow and there is the possibility of causing damage.

Given the above comparison of vegetation control techniques, an integrated approach using cultivation and herbicide would be the most practical, least expensive and most effective. Roundup® applications were restricted to weekends only at a time when staff attendance at the facility was low. However, these explanations may not satisfy individuals opposed to using herbicide. There is a mass of information that supports and condemns the use of pesticides, including Roundup®. Some of this information is based on science and facts, and some is misleading due to misused information and issues and beliefs held by individuals. This report does not try to prove the human and environmental safety of Roundup®. This information must come from trained and recognized specialists. It is important that the success of the naturalization project and future project expansion not be jeapardized or again setback by losing site of the project's goals. As well, it is important that managers at Environment Canada's Downsview site make a decision on whether or not to permit the use of pesticides as part of the naturalization process.

Herbicide use dropped significantly over the course of Phase I. Ten litres of concentrated Roundup® were applied during each application in October '98 and April '99. In July '99 this was reduced to 5 litres and in September '99 to 1.2 litres. This trend is expected to continue as minor infestations of perennial weeds are brought under control.

The following brief discussion is intended to put the issue of pesticide use into context by comparing Roundup® (used here for naturalization) with another commonly used herbicide, Killex® (active ingredients: 2-4-D, megaprob, dicamba). Ontario's Pesticides Act and Regulation 914, administered by the Ministry of the Environment, requires that pesticide products be registered under the federal Pest Control Products Act, and classified into one of the six schedules of the Ontario Regulation before they may be sold and used in Ontario. Pesticide products are classified according to their toxicity, persistence, method of handling or ways in which they may be sold. The order of pesticide toxicity from most toxic to least toxic is schedule 1, 5, 2, 3, 4, 6. Roundup®, a schedule 6 herbicide is slightly toxic and slightly persistent. Killex® a schedule 3 herbicide is moderately toxic and moderately persistent. It is used to control broad-leaved weeds and typically used in areas where monocultures of turfgrasses are found, e.g., golf courses. With this in mind, the limited and diminishing use of a schedule 6 herbicide (Roundup®) for the purposes of naturalization, provides benefits, including healthier systems for humans and the environment than the regular and ongoing inputs of energy and chemicals (e.g., mowing and pesticides) on traditional landscapes.

2.2 Economies of Scale

Phase I of site naturalization saw the installation of woodland, shrub thicket, prairie and parking islands in 11 different areas throughout the site. This variety of ecosystem types and locations reduces the efficiency of managing and implementing tasks, causes operational obstacles for the facility, and adds costs to the project, (e.g., cleanup of multiple areas). Efficiencies would be gained if plantings of trees and shrubs were consolidated, i.e., complete all woodland and shrub thicket plantings at the same time. Alternatively, installing the remaining prairie and savanna areas at the same time would increase the efficiency of site preparation and planting. For example the cost to plow and till one hectare may only be 50% greater than that for 0.5 ha. In reviewing the options for future site naturalization it is recommended that similar tasks and outcomes be amalgamated.

2.3 Aesthetics - Weeds & Mulch

Building occupants and some members of the Committee have raised concerns about the appearance of the site. Annual weeds are highly visible in Prairie Areas 1 and 2, and they will continue to be present in the upcoming season. Over time they will disappear through competition from the perennial prairie plants. In the meantime and while the aesthetics of weeds is a concern, steps can be taken such as cutting to reduce their visibility.

Wood chip mulch was used extensively throughout all areas of trees and shrubs. Do to the small size of the trees and the lack of groundcovers, the mulch will continue to be a dominant visible factor for several years. Understanding the value of the mulch for the growth and development of these areas may be the best way to see them in a different capacity. For future mulching needs, other types of wood chips could be acquired that are more natural in appearance. Due to the extensive volume (200 cubic yards) of wood chips used, those being the least costly were used in Phase I.

Naturalization is a dynamic process with changes occurring as plantings mature. This is much unlike a contemporary design and also the generally held images of an “attractive” landscape. Until ecosystems and their evolution are better understood, some people will continue to view these projects as unattractive and unkept.

2.4 Prescribed Burn

It is well known and practiced that the most effective method of prairie maintenance is the intermittent use of fire. It controls unwanted vegetation such as cool season weeds (dandelions, mustards, thistles) and woody plants, and provides conditions favourable (e.g., blackened earth to absorb solar heat, reduced nitrogen) for prairie species. There are firms that specialize in burning prairies, called a prescribe burn. These companies provide all requirements to carry out prescribed burns including permits, insurance, timing and communications. The prairie ecosystems at Environment Canada will be a candidate for a prescribed burn as early as the spring 2001. For this reason, the Committee should commence discussions about prescribed burns within the department soon. Just as pesticide use generated controversy, it is likely that prescribed burns will too. It is incumbent upon Environment Canada to make a decision on the use of prescribed burns at their facility. Should prescribed burns be approved as a maintenance tool, up to a full year of preparations are required to make all of the appropriate preparations due to the extensive communications process and required permits.

3.0 NEXT STEPS

3.1 Maintaining Existing Plantings

The plantings of Phase I are expected to perform well (see Section 1.1 Establishment Success). However, they require maintenance to ensure continued growth and development. Prairie Areas 1, 2 and 3 should be monitored for invasive weed species such as Canada thistle and quack grass, with appropriate action, such as spot spraying, taken to eliminate them. Although large numbers of annual weeds are again expected in pockets throughout the prairie areas, they will not be a long-term problem. The extent of annual weeds may warrant some action such as mowing. As well, prescribed burning should be given serious consideration. Hand pulling of weeds is not recommended because it disrupts the prairie plants and encourages the germination of weed seeds. With each disturbance to the prairie site, habitat will be created that favours the germination and growth of weeds. The recently installed driveway to the instrument compound will likely be another area supporting unwanted vegetation.

Weed control will be a minor task in the tree and shrub plantings. These areas should be monitored and action taken to deal with identified weed problems. The addition of wood chip mulch will be required in some areas to reduce weeds and provide beneficial growing conditions to the trees and shrubs.

3.2 Expanding Site Naturalization

The area naturalized in Phase I is 0.6 ha. This represents about 1/4 of the undeveloped open space that is potentially available for naturalization. Steps can be taken by the Committee in preparation to naturalize new areas. It is recommended that property owners be contacted if naturalization plans approach the following areas.

i. Dufferin Street right-of-way (City of Toronto, Public Works Dept.),
ii. Property boundaries at the north and northeast (University of Toronto),
iii. Property boundaries at the south and southeast (G. Ross Lord Park, TRCA, City of Toronto Recreation & Parks).

These property owners will be interested in what is being planned on the neighbouring lands. The Contractor met with personnel at the University of Toronto Aerospace in 1998 to explore their interest in naturalization. Their reaction to naturalization was concern about human safety and property aesthetics. In order to satisfy these concerns and gain their moral and possibly financial support, further discussions and information about naturalization are needed. In the case of the Dufferin Street right-of-way, City approval is mandatory before plantings or site changes can occur.

It is recommended that awarding of the next planting contract should occur at a time so that adequate planning, site preparation and planting can occur. This usually means awarding the contract in the fall or winter so that the contractor has sufficient time to effectively plan project steps. For example, if a contract is awarded in the spring or summer, it may limit planting until the next year. This is very likely the case when planning to install a prairie planting that requires extensive site preparation.

Plantings should be avoided around the wetland pond area along Dufferin Street until a decision to develop the pond and associated trails and the observation deck has been made. The Site Design Plan, April 1999 displays the location of the proposed ecosystem types including the wetland pond, as well as the hard landscape features. Areas for trails and outdoor amenities should be identified on the grounds and plans developed so that disturbances to future plantings are minimized.

Prior to Phase I, the site's 25-year history has been a contemporary landscape of turfgrass and open grown ornamental trees. Some of these existing trees in Woodland Area 1 and Shrub Areas 1 and 2 were pruned and others were removed because of disease, structural defects or incompatibility with the naturalization project. Tree monitoring should continue throughout the site as part of regular site maintenance. Necessary treatments/action should be taken that include pruning, thinning and mulching. The sugar maple trees located in the front (west of the visitor parking area) should be afforded considerable protection. These trees are in moderate to high health and moderate structural condition. They are also included as part of the future savanna ecosystem as outlined in the Naturalization Master Plan.

4.0 DISCUSSION & SUMMARY

The following are key points and recommendations that reflect the foregoing discussion.

1. The financial summary (Section 1.2) and Economies of Scale (Section 2.2) will provide guidelines on expected costs and enhanced efficiency for future work, respectively.

2. The installed ecosystems of Phase I will require ongoing maintenance, with a particular focus on the prairie.

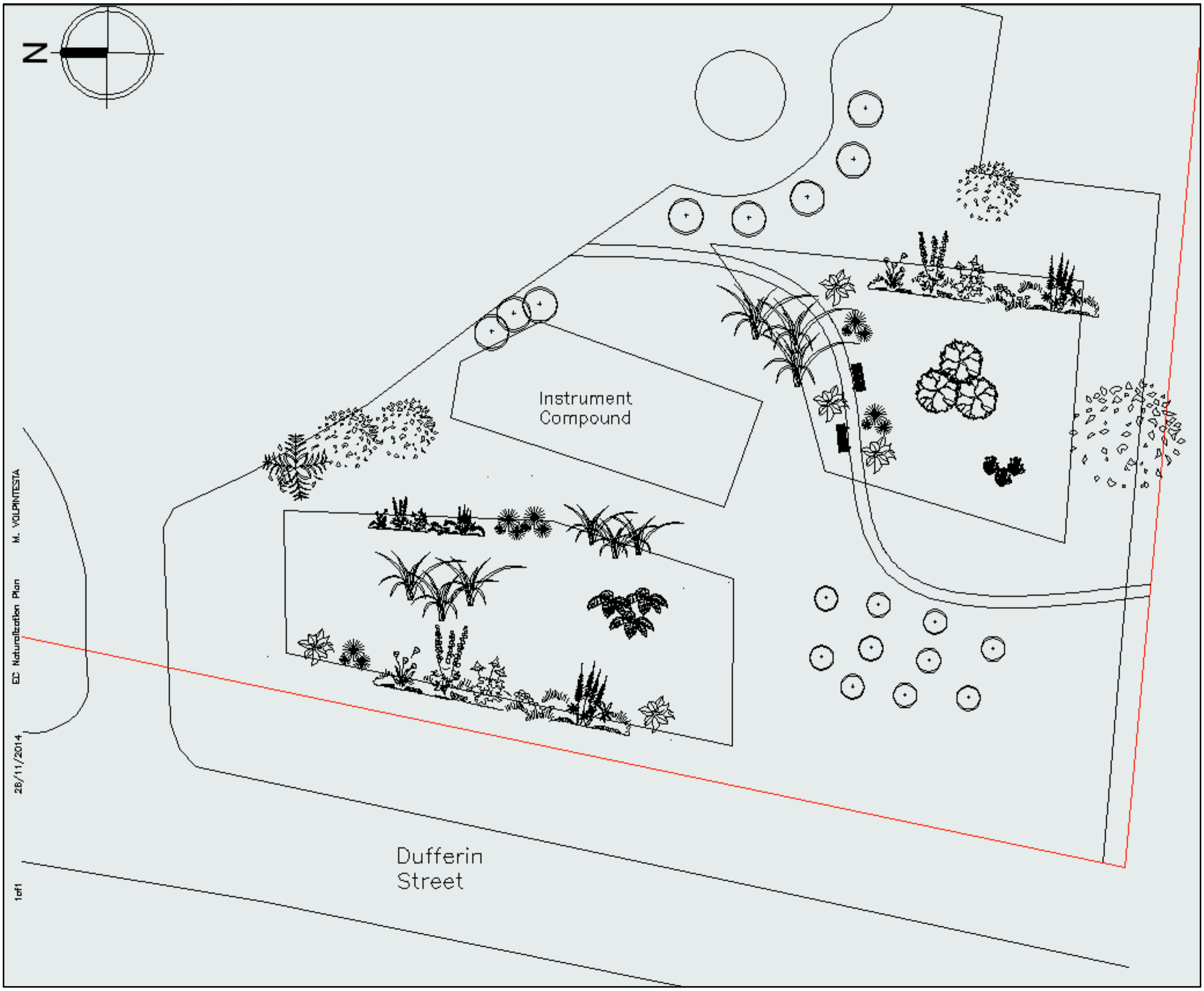
3. Attempts should be made to gain project support from adjacent property owners, and Municipal requirements should be well understood as part of future expansion preparations.

4. Environment Canada should resolve the controversy of pesticide use as a tool that is used to naturalize the site.

5. A decision of conducting prescribed burns in the prairie should be made soon to allow adequate planning and preparation time.

With the completion of Phase I, Environment Canada - Downsview has implemented a unique, environmentally responsive landscape. With this bold step taken, the facility now has a naturalization model that is the foundation for future expansion on the site.

Appendix II – Naturalization Plan Architectural CAD drawing



Appendix III – Deliverable copy of Naturalization Plan to Environment Canada

FINAL REPORT

Naturalization Project – Environment Canada
4905 Dufferin Street
Toronto, Ontario, Canada

Prepared for

Environment Canada

November 28th, 2014

Drafted by
M. Volpintesta
York University

Table of Contents

1.0 Introduction

Fall 2013, Environment Canada and representatives of the “Green team” (project steering committee), an organization of environmentally conscious employees, approached the Faculty of Environmental Studies to recruit a student to draft a restoration and re-naturalization plan for a portion of its property at 4905 Dufferin Street in Toronto, Ontario. As described by the Green team, the goal of the project is to naturalize a portion of the property by removing turf and re-naturalizing the site with native species. The site is located along the western portion of the property aligning with Dufferin Street. Environment Canada’s Green Team and project steering committee envisions the creation of naturalized space that exhibits a commitment to the natural environment by providing ecological service through aesthetically appealing native plantings.

Many of Environment Canada’s project goals align harmoniously with other urban naturalists, seeking to find the balance between nature and development within an urban setting. Environment Canada hopes to achieve this by replacing the front lawns of the property with native flora as a service to both the ecosystem, and experientially to the human observers of the site, together as dual restoration goals. This research topic allows for an understanding of how to achieve a balance between environmental service and demonstrations of nature as perceived by public observers of Environment Canada’s property in Toronto.

This project involves creating a site plan that includes:

primary research and site evaluation,

development of a naturalization plan and environmental design,

development of a long-term management plan.

The project directly incorporates the process of assessment and planning through to implementation and monitoring of an ecological restoration plan that balances the human experiential appreciation of nature and ecological service to the environment. This naturalization project serves as a demonstration site that communicates the values and standards of Environment Canada. Furthermore, the site demonstrates future possibilities for ecological conversion urban lands that challenges the dominant aesthetics of turf.

In his book: *Lawn People: How Grasses, Weeds and Chemicals Make Us Who We Are*, Paul Robbins (2007) discusses how manicured turf is an ecological construct of American culture (p.22). Manicured turf as a landscape choice has always been about conformity and maintenance and not about turf as providing ecosystem function. Lawn turf derives from countless applications of manipulative chemical compounds used to enhance grass species that should not be successful withstanding biophysical and climatic conditions that differ from Scottish golf ranges (Robbins, 2007). Naturalized grasses and wildflowers in a southern Ontario ecosystem provide great benefit to localized fauna, and human observers, where non-native turf does not. This project serves to analyze and challenge the perception of nature and environmental aesthetics in order to advance awareness that, while manicured non-native lawns have long been a symbolic representation of tidiness, a work ethic and community care, their ecological service is minimal (Nassauer, 1997).

1.1 Project Objective

The objective of this research is to develop a restoration ecology plan for the site at 4905 Dufferin Street, Toronto that improves the ecological service of the site by introducing native species to replace the monoculture non-native turf that currently dominates and outcompetes other species. The goal is to remove and suppress invasive species and turf and modify the environment before re-introducing native species that fulfill ecological service while providing the aesthetic and experientially significant elements to demonstrate environmental cognizance that is desired by Environment Canada. The desired output is a formal plan for the restoration site, including drawings and mapping of the area being restored. This includes detail of the replacement species and the rationale for their choice, as well as a long-term management and maintenance plan. Furthermore, a detailed budget is included. The specific question guiding this research aims to understand the synchrony which may be established in harmonizing ecological service and the aesthetic appreciation of nature within an urbanized environment.

This report is prepared as guiding document describing the process and methods used to draft a naturalization plan on behalf of Environment Canada's property at 4905 Dufferin Street. The restoration strategy incorporates four main steps, building on restoration strategies identified by The Waterfront Regeneration Trust (1995):

(1) Determining project goals, as well as local and regional context,

(2) inventory and site condition evaluation,

(3) restoration design and naturalization plan,

(4) implementation, management, and monitoring

1.2 Research Context

The theme of this research project is restoration and re-naturalization. The working definition for this research is purposefully vague. According to Sauer (1999), "At a literal level, the term implies that we are returning the landscape to some former state" (p. 89). The reason for use of the language "former state" is because it is impossible to return a site to its original state. We must recognize that historic conditions cannot necessarily be recreated; we must recognize that true forest restoration is not possible (*ibid,* p. 90).

If we aim to restore to a time of less human occupancy, we must also acknowledge that active ecological management has occurred for centuries. Areas we consider to be wilderness are likely spaces once actively managed by indigenous peoples. As Sauer (1999) explains, "In fact, most plants tribal people value are shade-intolerant and depend on burning or other forms of disturbance to maintain the early successional communities they inhabit" and therefore seemingly require second source maintenance (p.90). Active management has always occurred and is still required today. This is true not only to humans but other species that modify the natural environment for various purposes. As Higgs (2003) makes clear "The pace and extent of human change, whether indirect effects such as suppressed wildfire, to increased trail use, demands some redress. The simple act of packing up our managerial responsibilities and letting nature take its course, the old natural regulation model, will result in a freakish landscape far outside the known historical conditions" (p. 288).

Restoration is incremental. It happens in phases. A typical scenario might be to stabilize all bare soil areas and to initiate exotics removal while starting planting, and then to evaluate the success of plantings and natural regeneration before developing a more detailed planting plan (Sauer, 1999 p. 91).

The naturalization site for this project is a space drastically altered from its pre-development state. It is important to develop a strategy that incorporates multiple phases to help ensure environmental success and long-term ecological service.

There is an obligation of current generations to preserve natural resources for the future. However, as societies and their paradigms of current thought shift, so too do the practices of conservation. And so, “we restore by gesturing to the past, but our interest is really in setting the drift pattern for the future” (Higgs, 2003, p. 270).

With decentralized planning creating more power for local groups, Opdam and Steingröver (2008) address the lack of environmental knowledge used when designing metropolitan landscapes for biodiversity. They blame this failure on the wide diversity of species traits, the variety of spatial scales of ecological practices, and the complexity of metapopulation ecology (p.70). The authors apply a knowledge system to create a better understanding of this complexity, which they conceptualize simply as being ecosystem networks. They include ten design guidelines to achieve spatial cohesion amongst species variety and therefore achieve a network between the ecosystems. While they focus mostly on fauna that includes larger mammals, much of their rationale is applicable to this research project. Useful guidelines include the use of ecosystem patches, designed specifically to cater to specific species within a particular area of a broader ecosystem. They discuss the importance of patch quality; ensuring patches are effective as habitat for a species, calculated by vegetation, soil and water conditions in relation to the requirements of a species. It is important to also understand the maximum and minimum network carrying capacity.

The idea of a “stepping-stone” is described as a small patch of an ecosystem that contributes mainly to the network’s connectivity rather than to the network’s carrying capacity. Because the general site area of restoration for this Environment Canada site is seemingly small in the context of the greater ecological network surrounding the area, perhaps this notion of a stepping-stone as a general contribution to the overall network is useful in terms of imagining the site as providing this type of ecological service. The example used by Opdam and Steingröver is that of a stepping-stone being used for a pair of bird species existing within the smaller ecosystem patch but is still used to facilitate the movement of birds within the network (Opdam and Steingröver, 2008). A goal of this project is to fulfil a similar ecosystem function of contributing to network connectedness.

Jianguo Wu (2008) regards humans as “ecosystem engineers” and believes that we are critically important for developing urban sustainability. He focuses on the idea of a human-landscape scale that is large enough to include key ecological function and socioeconomic processes. He emphasizes the interrelationship between urban landscape patterns and ecological or socioeconomic processes on different scales, and encourages place-based research. As mentioned, this project aims at understanding the harmony that can be achieved between ecological function and human experience of an ecosystem. Wu touches on this idea and encourages this balance of function for nature and human occupancy.

1.3 Site Context

In 1998, Environment Canada employed an ecological consultant group to develop a naturalization plan in areas surrounding the current project site. Only the first phase was completed, some of which is still evident today. Attached, as **Appendix – I** is a copy of the 1998 naturalization plan, used as a reference for this project. Work that was completed towards fulfillment of this plan included the creation of 10 subplots divided between woodland, shrub thicket and prairie ecosystem types. Hardwood trees, potted conifers, and prairie seeding made up most of the subplot plantings.

4905 Dufferin Street lies within a subwatershed of the Don River, referred to as the Lower West Don River subwatershed. Within this subwatershed, natural cover amounts to 14% of the open space (Beyond 40 Steps, 2009, p. 3-37). The site plotted for this naturalization project is dominated by non-native turf containing different types of fescue, as well as some naturalized features within the boundaries of property. Nearby, at G. Lord Ross Park (directly south of Environment Canada) is 137 hectares of city parkland. The park contains several natural elements. To regulate flow of the nearby Don River, the G. Ross Lord reservoir provides important wetland habitat to the grey tree frog (*Hyla versicolor*) and spring peeper (*Pseudacris crucifer*) There is also woodland-prairie ecosystem elements found within areas of limited recreation within the park. To the east, the property is bordered by a University of Toronto science facility that contains some open space covered by turf. A part of the Peel plain, 4905 Dufferin and the surrounding area fall within the Lake Erie Lowland eco-district, and mixed-wood plains ecozone (National Soil Database, 2014).

After Hurricane Hazel destroyed much of the Greater Toronto Area's development along the floodplains of the Don and Humber Rivers, the Toronto and Region Conservation Authority (TRCA) was established to deter development along vulnerable flood plains and protect naturally significant areas within the region. Today, the TRCA manages the Don, Humber and Etobicoke-Mimico watersheds through unique plans meant protect and regenerate the natural heritage. As aforementioned, the Lower West Don River is a subwatershed of the Don River, in which 4905 Dufferin resides. While private landowners abide more specifically to city by-laws, the overriding plan of the TRCA does impose regulation and guidance regarding use and protection of naturalized areas.

Beyond 40 Steps, The Don Watershed Plan (2009)*,* is the most current edition of the TRCA's management plan for the Lower West Don River subwatershed. Within this plan TRCA aims to achieve its objective to "protect and sustain what is healthy, and regenerate what is degraded" through several tactics (TRCA, 2009, p. v). Focusing on terrestrial features of the subwatershed, TRCA aims to restore ecosystem function by: reducing intensive development, removing invasive plants that threaten native ecosystems, reduce flooding through stormwater control systems and diverting erosion, as well as improving water quality (*ibid,* 3-36). Important to this project, *Beyond 40 Steps* provides useful information regarding management strategies to regenerate and protect naturalization within the subwatershed. This information is incorporated into the direction and overall objectives of this naturalization project. A contextual map below (**Figure 1**) shows the property boundaries and surrounding area, including: G. Lord Ross Park, University of Toronto Aerospace facility, and Don River.

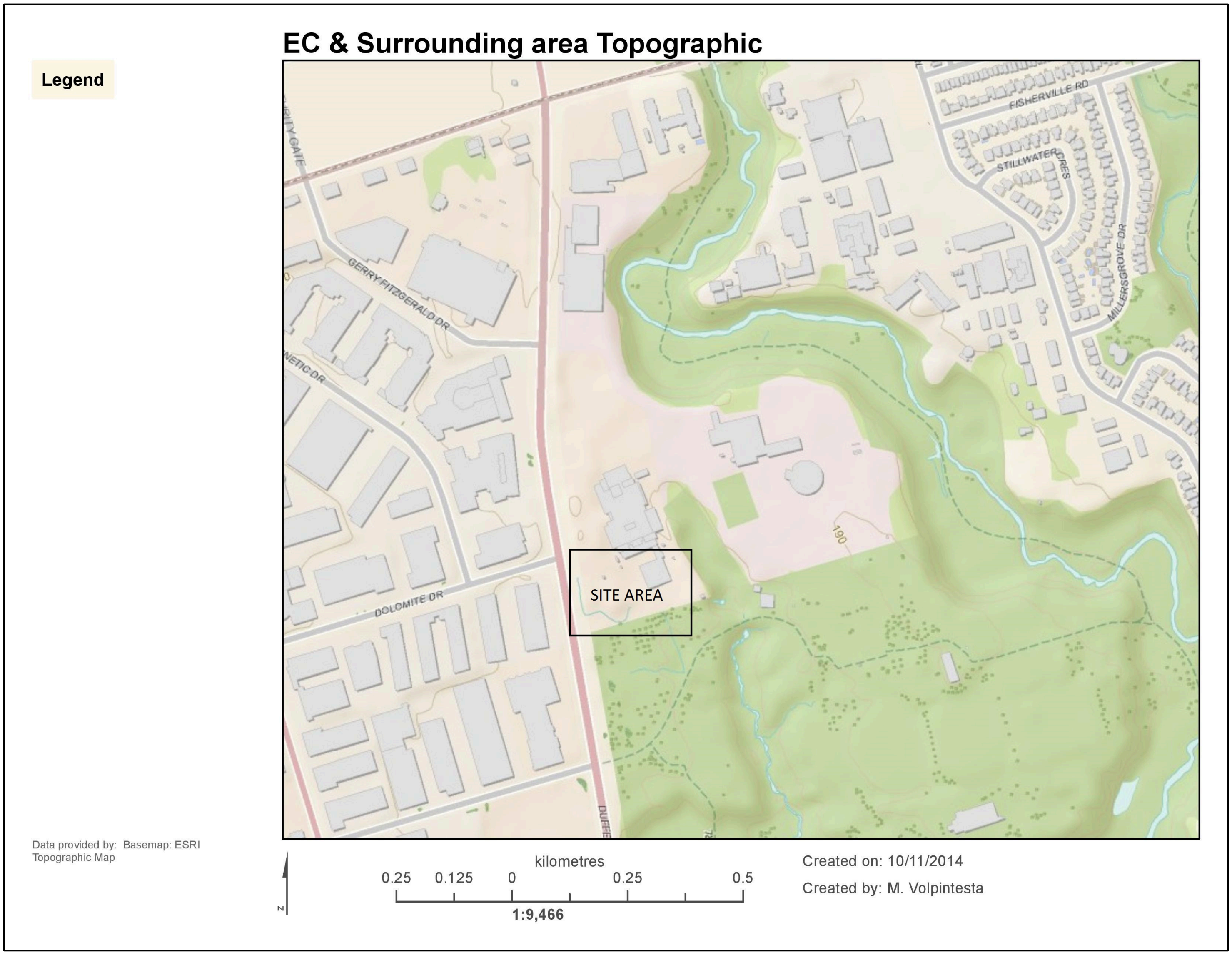


Figure 1 – Context Map of Site

This figure shows Environment Canada at 4905 Dufferin Street and the localized naturalization site in context with G. Lord Ross Park and surrounding area.

2.0 Comprehensive Site Profile

This portion of the report provides a comprehensive profile of the conditions and ecology of the site and surrounding area, as well as details of the site re-naturalization plots. This includes reading the landscape and its function; the surrounding landscape types, adjacent habitats, on-site physical conditions (topography, soil types, drainage characteristics), habitat types and condition.

2.1 Surrounding landscapes and ecology

As described within *Beyond 40 Steps* (2009), 4905 Dufferin lies within a subwatershed of the Don River, the Lower West Don subwatershed. This is relevant because it means an active naturalization plan exists for the site and surrounding area. Not only does the TRCA have a multitude of research and data on the ecosystem health of the watershed, but also it provides detail of regeneration strategies used to restore naturalized sites within the watershed. G. Ross Lord Park, adjacent to 4905 Dufferin Street, is an example of an area for which TRCA activity is prominent in applying naturalization strategies. The largest component of TRCA activity is the G. Ross Lord reservoir, a large dam regulating the flow of the Don, found inside the park. Other activities practiced within the park across the watershed include planting of native species, removal of invasive species and general ecosystem monitoring.

Within the Lower West Don subwatershed, about 14% of land is classified as natural cover, 10% forest, 3% meadow and less than 1% wetland. Impervious cover amounts to 36% cumulatively (TRCA, 2009, p. 6-18). More specifically, measured in hectares, the Lower West Don subwatershed is comprised of 661 ha woodland, 9 ha wetland, and 222 ha of meadowland (*ibid,* p.6-18). TRCA has a "Lower West Don River subwatershed Regeneration Plan", for which a section of the Don River directly east of Environment Canada is a prime focus (*ibid,* p.6-14). TRCA identifies this area as a target towards its terrestrial natural heritage system recovery objective. There are specific initiatives listed focusing on water, nature, and community ecosystem health, some of which are of particular to this project. With regard to nature, TRCA hopes to create and enhance natural cover in the target Terrestrial Natural Heritage (TNH) System of the subwatershed to 12%, specifically relevant to natural heritage enhancement. As aforementioned, the section of the Don River immediately east of Environment Canada is identified by TRCA as a target for TNH expansion. Furthermore, TRCA looks to designate and restrict public access to protected areas for shoreline bird habitat at G. Ross Lord dam (*ibid,* p. 6-15). Within the watershed, TRCA identifies the vulnerability of seven native species that include: grey tree frog (*Hyla versicolor)*, spring peeper (*Pseudacris crucifer*), porcupine (*Hystricomorph hystricidae*), wood frog (*Rana sylvatica*), hooded merganser (*Lophodytes cucullatus*) and veery (*Catharus fuscescens*) (*ibid,* p. 3-36). TRCA targets aim to enhance native habitat for these vulnerable species to maintain viable populations, and so, this project has an opportunity to contribute to this regeneration strategy.

Looking again to the adjacent G. Ross Lord Park, comprised of 127 ha, an inventory of trees and shrubs was recorded along the northern section of the park closest to the area of re-naturalization at Environment Canada (within 200 meters) see **Figure 1**. Within this inventory, several predominant species of tree and shrub were recorded and include; red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), mountain maple (*Acer spicatum*), black oak (*Quercus velutina*), Chinese oak (*Quercus qeriablis)*, American mountain ash (*Sorbus americana*), European buckthorn (*Rhamnus cathartica*), and Norway spruce (*Picea abies*). Kentucky bluegrass (*Poa pratensis*) and mixed fescue types dominate ground cover in this area. While there are elements of naturalization here that certainly are enhanced by G. Ross Lord Park and the large conglomerate of green space, still Environment Canada's property is very much encroached on by urban development resulting in diminished natural space that is ecologically defined by turf.

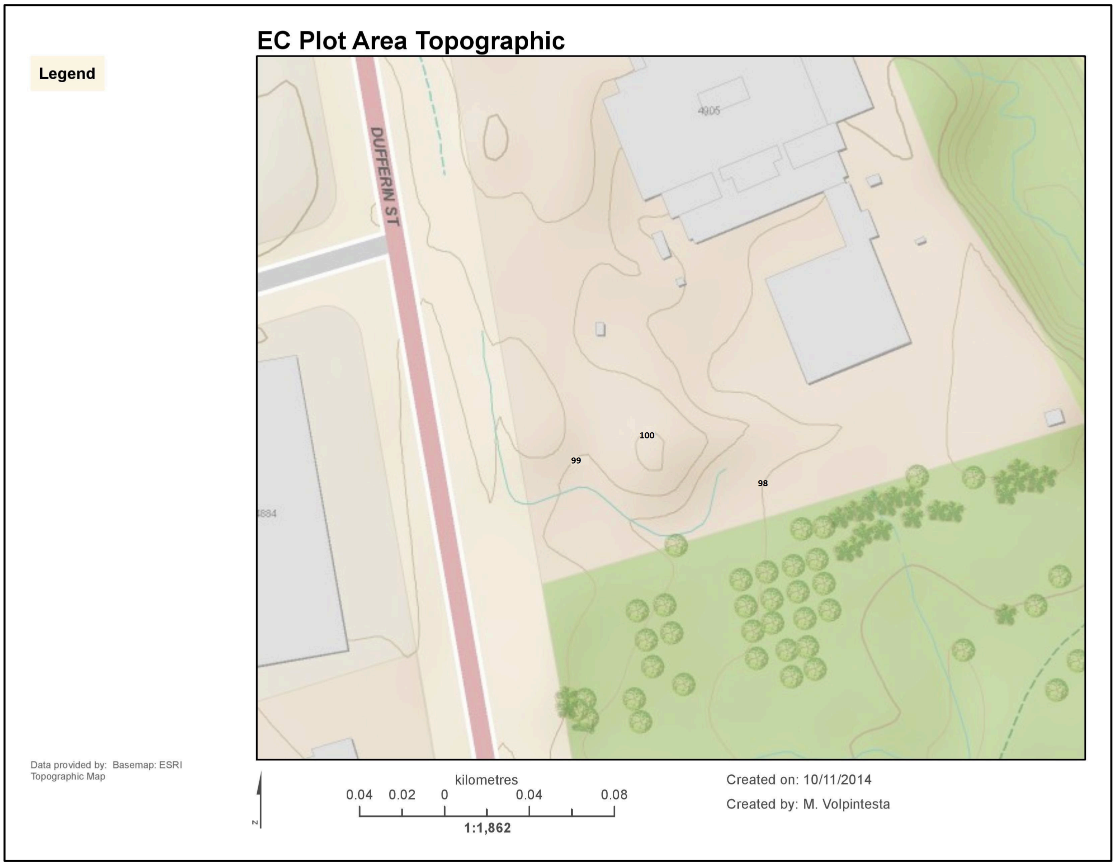


Figure 2 – **Topographic map of the site,** demonstrates the elevation contours of the site peaking at 100 meters.

2.2 On-site details and physical conditions

Since 1998, when the initial phase of the primary naturalization project was completed, groundskeepers of the site have mowed the savannah grasses that had been planted, and none of these remain today. Some shrubs and trees are still evident from the initial project and others exist by means of original development landscaping. The property in its entirety is mostly dominated by turf, mainly Kentucky bluegrass (*Poa pratensis*) and a small variety of fescue species. Focusing particularly on the southwestern portion of the site, closest to Dufferin Street, an inventory of shrubs and trees was recorded. The following species of shrub and tree were found: red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), mountain maple (*Acer spicatum*), black oak (*Quercus velutina*), Chinese oak (*Quercus qeriablis*), American mountain ash *(Sorbus americana*), European buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), balsam fir (*Abies balsamea*) and Norway spruce (*Picea abies*). As buckthorn species are invasive, removal at project commencement is highly recommended.

Figure 5 and 6 shown on page 12 show the canopy using GIS imagery.

2.2.1 Soils

The soil type for the project site is classified as Chinguacousy clay-loam as mapped and identified by the Ontario Department of Agriculture and Food, 1966. The Chinguacousy soils are considered "imperfectly drained" and have developed from clay and silty clay glacial till deposits. These tills were derived principally from locally occurring brown shales, sandstones, and fossiliferous limestone (*ibid)*. According to the Ontario Department of Agriculture (1956), the coarser textures appear to be limited to the surface horizons and may result from postglacial modification by wind and water. This is further indicated by the occurrence of sand spots in some areas. The series is classified as a Gray-Brown Podzolic (Ontario Department of Agriculture and Food, 1966). The surface-cultivated layer is dark grayish brown in color and is generally friable and easily worked.

Using a consumer grade soil test kit, the site was tested for nutrient levels of nitrogen, phosphorus, and potash. Additionally, pH was tested to determine acidity/alkalinity. Using Luster Leaf's "rapitest" soil test kit No.1601, five samples were taken from five particular locations on-site **(Figure 3)**. Under partially cloudy conditions on July 16, 2014, not within 12 hours of rain, a soil sample was taken from the highest and lowest point of each plot, and one sample was collected from the small woodland shrubbery area between plot A and plot B. The sample was collected 6-8 inches below the turf. Each sample was tested for all four classifications mentioned above. The results are shown on the following page **(Table 1).** Nitrogen is synonymous with plant growth and therefore it is important to know the amount of nitrogen available. Both potash and phosphorus strengthen and contribute to the overall growth of many plants. pH level is useful to test because it helps determine which species are most appropriate and will respond to the acidity or alkalinity, which controls a plants ability to utilize other nutrients.

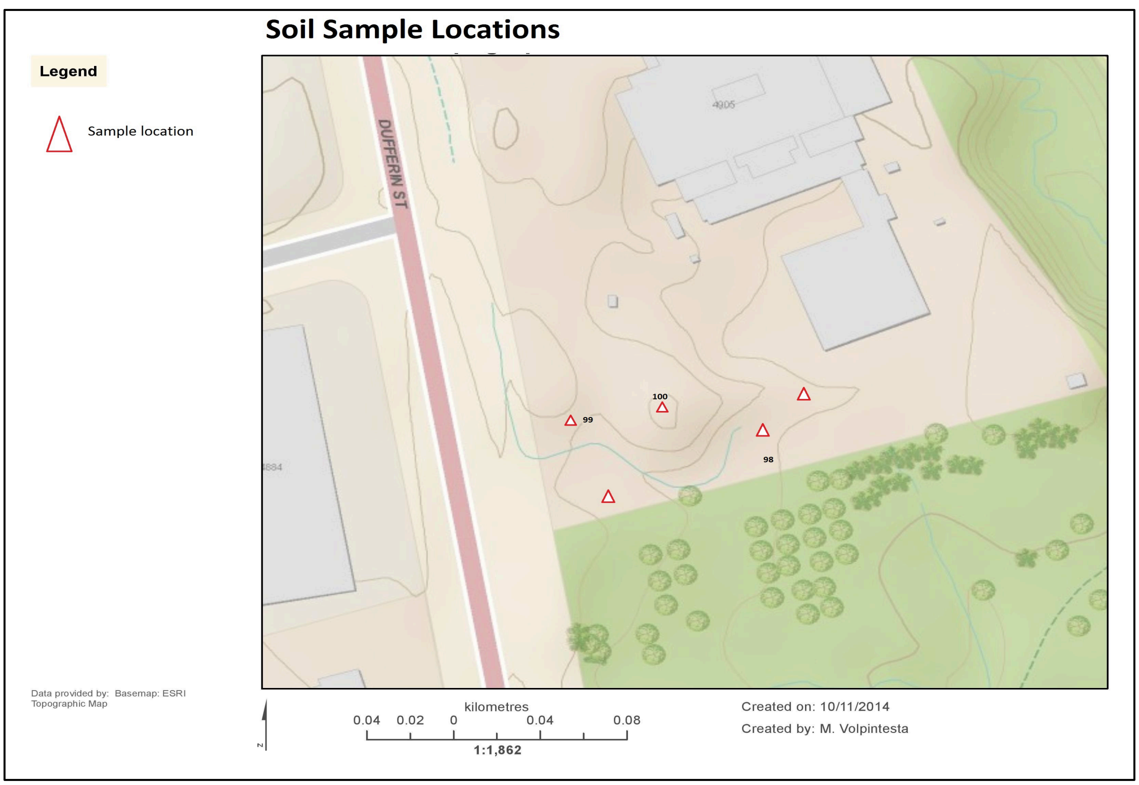


Figure 3 – Soil sample locations

Shown by Figure 3, sample locations were taken from the highest and lowest points from Plots A and B, as well as Plot H as a single measurement. For example "Plot A – H" describes the highest point in Plot A, whereas "Plot B – L" would indicate the result for the lowest point in Plot B. These sampling locations remain the same for Table 1 and Table 2.

Table 1 – "Rapitest" soil test results

	Nitrogen	pH	Potash	Phosphorus
Plot A - H	Deficient	7.25	Adequate	Deficient
Plot A - L	Surplus	7	Adequate	Adequate
Plot B - H	Deficient	7	Adequate	Surplus
Plot B - L	Deficient	7.5	Adequate	Deficient
Plot H	Adequate	6.75	Surplus	Deficient

Table 1 demonstrates the results of the "Rapitest" soil test. The classifications labelled as deficient, adequate, or surplus are determined by the descriptions included within the testing parameters. The test also included a classification labelled "depleted" however none of the tests resulted in this. The predetermined classifications by LusterLeaf are set by measuring the amount of compound within a particular amount of soil and classifying it as being healthy for plant growth or overall success. To simplify understanding test results for users, the kit includes a numerical value for pH and a similar categorical classification for the nitrogen, phosphorous and potash.

Table 2 – Soil moisture

	Moisture %
Plot A - H	19.7
Plot A - L	20.9
Plot B - H	19.5
Plot B - L	18.4
Plot H	18.6

Table 2 demonstrates soil moisture percentage taken at the same locations of soil sampling. The measure was recorded using a Delta-T ThetaProbe SM300 Soil Moisture sensor. The measurements were taken not within 12 hours of precipitation on September 24, 2014. The device probe was inserted 6-8 inches below the turf surface, collecting a digital reading. Moisture is incredibly important to the ability of a plant to grow and thrive within a particular environment (Kline, 1997). Knowledge of moisture content within the soil at the project site is extremely useful in determining the moist appropriate species for planting.

2.2.2 Element exposure

The two plots have identical element exposure and similar drainage patterns. **Figure 4** shows observed drainage patterns. Both plot A and B, are open spaces with high sun exposure. Both plots have trees with larger canopies positioned directly northeast, casting shadows on the outer north-east corners towards late afternoon sun position. As recorded by Natural Resources Canada, the site is susceptible to

801-1200mm of precipitation (calculated using mean average). Furthermore, the mean average annual wind speed is recorded as 4.67 m/s. This peaks in the winter months (DJF) at 5.59 m/s and is the most minimal between the summer and fall months. Winter and spring sees wind direction spread between south and north-westerly gusts, with some eastern breezes as well throughout the two seasons (*ibid).*

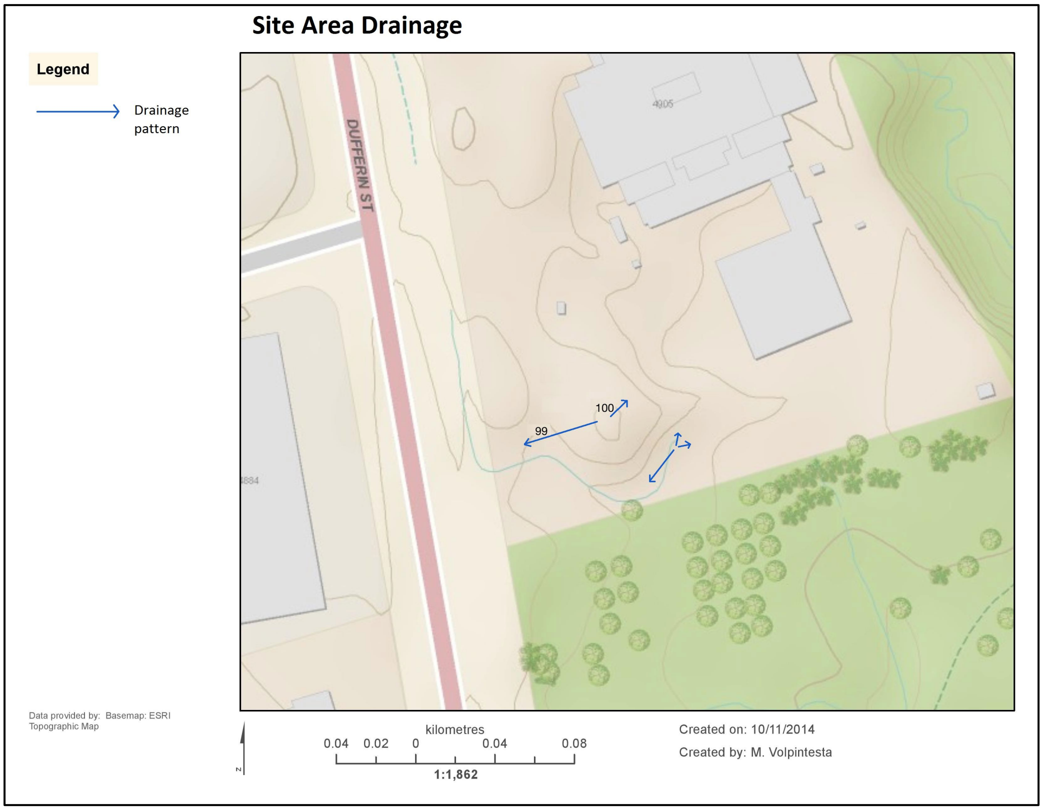


Figure 4 – Natural drainage patterns
Demonstrated by blue arrows, the point demonstrates the direction to which water is flowing, downslope. The tip of the arrow represents the highpoint and orient of flow.

2.3 Plot details

Figure 5 and 6 found below, show the location and size of Plot A and Plot B. The total area of plot A is 14,330 ft^2 and is located closest to Dufferin, directly south of the main driveway entrance to the property. The total area of Plot B is 10,498 ft^2 and is located just opposite the existing tree and shrub plantings, bordering G. Ross Lord Park to the immediate south. Referring back to **Figure 2**, the site topographic map demonstrates a rise in elevation existing in both Plot A and B. Observation demonstrates precipitation and natural drainage flowing southwest toward Dufferin in Plot A with residual flow directly east towards the existing canopy. In Plot B, natural drainage is observed flowing southwest toward the lower laying shrub and tree plantings, while residual flow deposits northeast toward the non-permeable asphalt round-about demonstrated in **Figure 6** below. Plot B is quite raised compared with the surrounding elevation. Soil moisture measurements ascertain this with lower moisture recordings in Plot B and the highest moisture in the drainage pattern of Plot A.

Both Figures 5 & 6 show the specific shape and measurement of each plot in feet with angles. Total area is indicated in squared feet in the highlighted box.

Figure 5 – Plot A aerial satellite

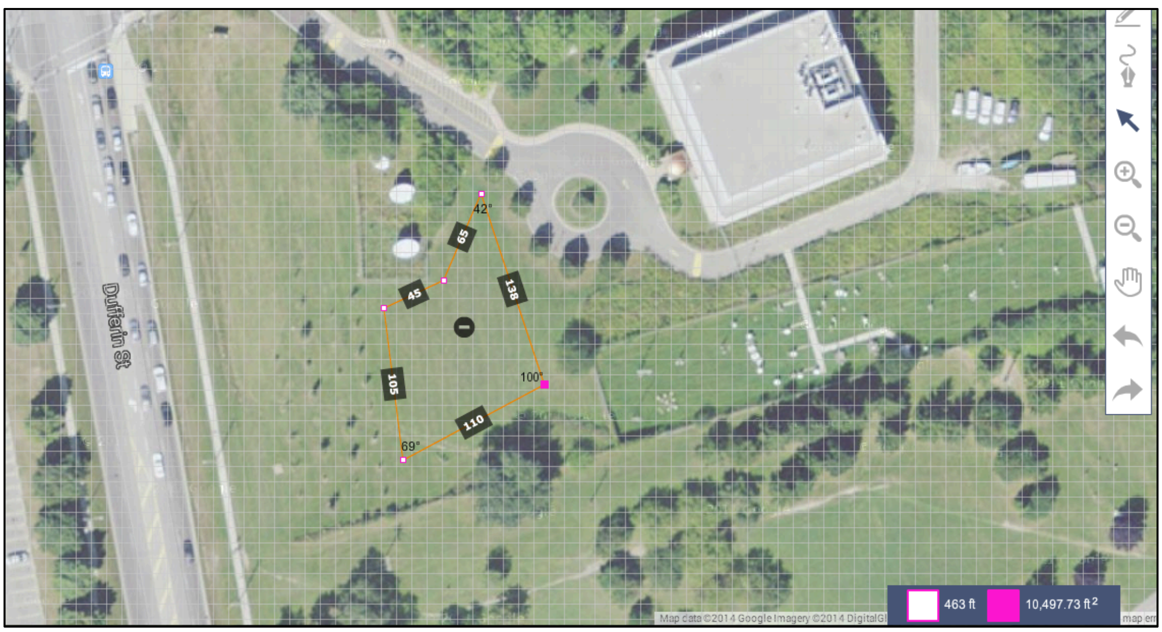


Figure 6 – Plot B aerial satellite

3.0 Naturalization plan and design

The design for this project incorporates several objectives:

removal of non native turf,

pathway construction between main building and G. Ross Lord Park, including seating,

establish ecological function through native planting and seeding,

demonstrate Environment Canada's commitment to nature through signage and story boards that communicate ecological design alternatives to turf and species initiatives

In order to fulfill the first objective, the dominant non-native turf in both plots first requires removal, resulting in a bare surface for planting and landscape design. This section demonstrates the methods of turf removal, as well as plot design and planting sites, including specie selection and plan alternatives. As discussed, one of Environment Canada's goals in this project is to re-establish its commitment to the environment and to the public. The project steering committee and Environment Canada green team desire a plan that demonstrates this goal by having the main focal piece of the plan alongside Dufferin Street towards the building entrance and main driveway (plot A). Plot B is separated from plot A by a small section of existing shrub and tree plantings, existing as a sort of ecosystem patch between the two new planting plots. Both plots should have elements of connectivity between each other and to the surrounding landscapes and ecosystem. Specific site design will include a pathway and seating connected between the main building and nearby park. Signage and storyboards will be positioned along the pathway discussing the benefit of design alternatives to turf and ecological function.

3.1 Turf removal

As demonstrated in **Figures 5 and 6**, each plot is completely covered in turf. There are several methods of turf removal with varying costs and levels of effectiveness. The first and most effective yet costly option would be to dig up the turf completely, exposing the soil beneath. This is done using a turf removal tilling mechanism that removes 6 inches of the top ground. The second most effective and costly option, the zero tillage method, is established by covering the entire surface with 3.3mm PVC black pond liner, slowly killing the turf below through solar blocking. The third option (direct seeding or inter-planting) is likely the most cost efficient but can lead to less seeding success and requires the most time to be effective. Direct seeding requires mowing turf to 0.5cm using a weed mower, and covering the remaining turf with seed or pots combined with triple mix (manure, compost and topsoil) at approximately 1:3 ratio (Foster, 2004).

3.2 Plot design

Each plot, unique in area, shape and topography, begins as open surface soil. Due to the positioning of fixed scientific weather instruments and various satellites found on site, both plots have been positioned specifically to avoid any interference. One of two instrument compounds is shown in **Figure 5** outside the plot A area. Described by Environment Canada's project steering committee, there are specific requirements that must be met by the design. An important objective of the project is to demonstrate the naturalization of the site to the public. Plot A, positioned directly alongside Dufferin Street will incorporate aesthetically pleasing plantings that provide ecosystem function. The plantings should not impede the purpose of scientific equipment on site and ideally should still showcase some of the building façade. Short grasses and wild flowers derived from a prairie savannah ecosystem are ideal. Plot B is positioned away from the frontal sidewalk view, and therefore may require less aesthetic motive behind planting and can include species more consistent with a prairie/tallgrass ecosystem. Plot B will be comprised of more of a true oak-savannah ecosystem with black and red oak as well as other tallgrass features present. The concept of two plots is most desired because it incorporates existing plantings, and creates two smaller ecosystems that can interact but also be site specific, referred to by Kline as a patchwork ecosystem, connecting the greater landscape (Kline, 1997, p.32).

A pathway will be incorporated into the design to connect the two plots. A pathway will divide both plots, connecting G. Ross Lord Park and to the main entrance of the building along Dufferin Street. This creates an opportunity for public by-passers and Environment Canada employees to experience the naturalization project. Mentioned by the project steering committee, employees often use informal pathways to enter the park for recreational purposes during work breaks and off time. To further public knowledge of the project, seating and signage will be posted along the pathway informing users of the specific components of the naturalization project. The pathway must have a permeable surface. Options in materials vary between wood decking, and shale gravel.

Each plot is divided and organized into sub plots with specific planting suggestions to optimize opportunities for fulfillment of the project objectives. **Figure 7** demonstrates the shape and make up of sub plots within plot A and B. Specific plot composition is described further below.

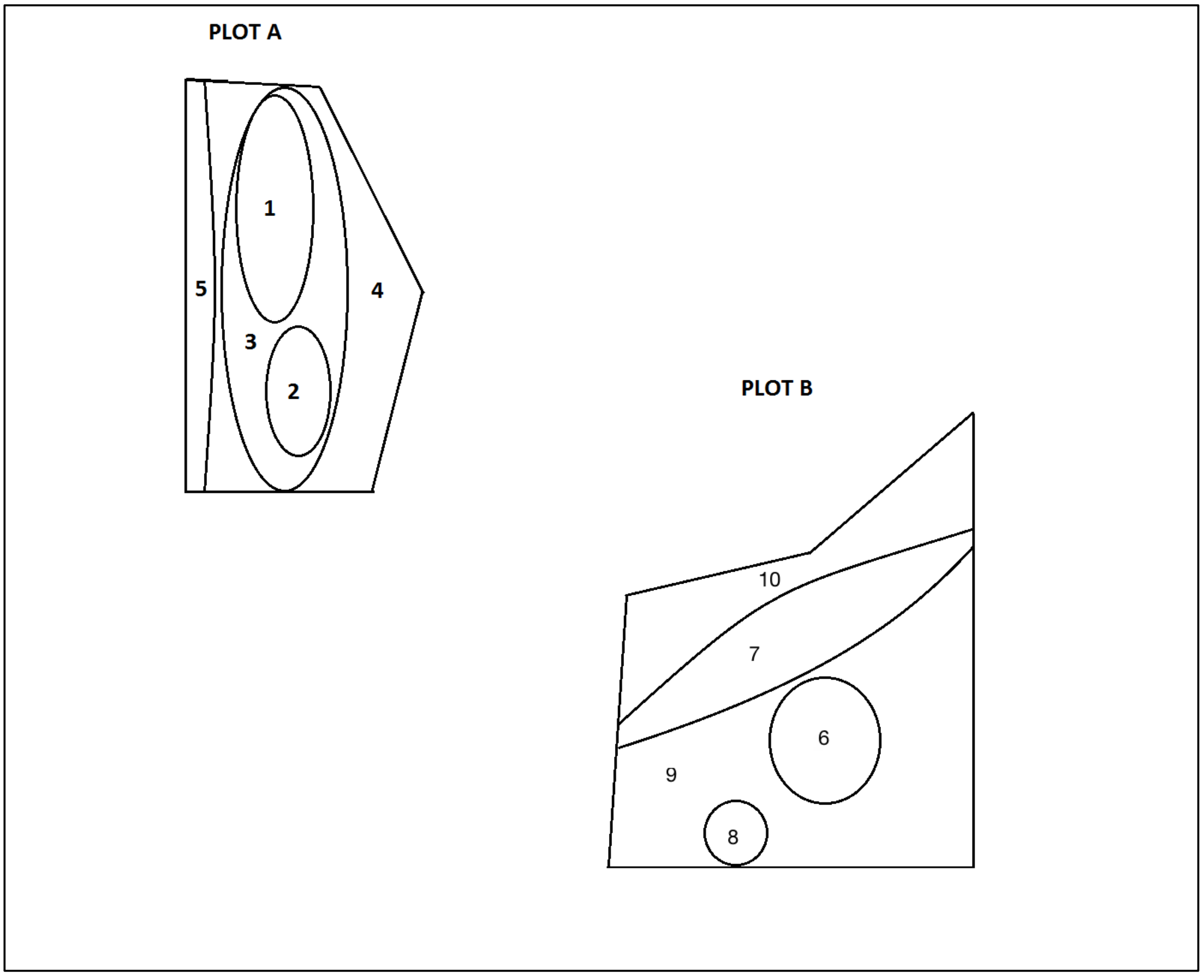


Figure 7 – Subplot makeup of Plot A & B

Table 3 and Figure 7 correspond to one another. The number corresponds to the plant list within each plot. For example, 1 – Canadian wild Rye, and Indian Grass is located within the circled area of "1" shown by Figure 7.

Table 3 – Plot planting lists

Plant List – Plot A	
1	Canadian Wild Rye, Indian Grass
2	Butterfly Milkweed
3	Little Bluestem, Indian Grass, Blue Vervain, Lance Leaved Coreopsis
4	Little Bluestem, Blue Vervain, Sweet Oxeye, Green Headed Coneflower
5	Switch Grass, Little Bluestem, Green Headed Coneflower

Plant List – Plot B	
6	Black Oak
7	Blue Vervain, Sweet Oxeye. Greenheaded Coneflower
8	New Jersey Tea
9	Big Bluestem, Little Bluestem, Lance Leaved Coreopsis, Blue Vervain
10	Big Bluestem, Switch Grass, Canadian Wild Rye

3.3 Species selection

Before European colonization began, forest cover was occasionally “interrupted” by two principal types of tallgrass ecosystems, both prairie and savannah (High Park Nature, 2014). Prairies are commonly open and treeless areas dominated by grasses and wildflowers. In contrast, savannahs are open space woodland that combines prairie and some forest features (*ibid*). A savannah is a tallgrass community with 25-35 percent tree cover, according to the Ecological Land Classification System for Southern Ontario (*ibid).*

As is aforementioned, Plot A will be comprised of shorter native savannah grasses and wildflowers to not impede the façade of the building and Environment Canada’s weather instruments. Switch grass (*Panicum virgatum),* a salt tolerant prairie grass will be planted along the edge of the plot A to avoid destruction by harmful salt deposits during winter months from nearby Dufferin Street. Plot B incorporates a more complete catalogue of oak-savannah species with the ability to include taller grasses, woody shrubs and oak trees.

To select species for planting, native species common to prairie and oak-savannah ecosystems are considered and characterized with soil components and element exposure of each plot, fulfilling the unique requirements for plots A and B. Due to fairly neutral soil characteristics with average acidity, moisture and nutrient composition, the species selected have a good opportunity for full succession. While the species chosen are meant to thrive in recovering ecosystems in sun or shade, there are still ideal conditions for succession on-site. The clay-loam soil type has fairly good drainage, and element exposure is also ideal for the species selected. Consideration is also given to targeted vulnerable species identified by both TRCA and Ontario’s MNR, including those listed above and including the declining monarch butterfly. Pollinator species like New Jersey Tea have also been chosen and will be organized together within subplots to attract the important and declining bee populations. An aspect of the plan incorporates pollinator plantings. The use of Butterfly Milkweed and New Jersey tea can be effective in harbouring the Monarch butterfly and one of the five bee families that are native to the Toronto area (David Suzuki Organization, 2014). The table below as **Table 4** lists each grass, wildflower, shrub and tree, its characteristics, and the plot to which it can be found.

Table 4 – Planting List and characteristics

Common Name	Botanical Name	Characteristics and Size	Community	Soil Texture	Moisture	Sun Exposure	Plot	Notes
Big Bluestem	*Andropogon gerardii*	Tallgrass, large	Prairie, savannah, meadow	Silt/ clay-loam	Int. / dry	Full sun	B	Common to Oak-Savannah
Little Bluestem	*Andropogon scoparious*	Shortgrass, medium	Prairie, meadow, savannah	Silt/ clay-loam	Int. / dry	Full sun	A, B	Common around Great Lakes, SW Ontario
Blue Vervain	*Verbena hastata*	Forb, Wild flower, medium	Meadow	Silt/ clay-loam	Wet/ moist	Full sun	A, B	
Switch Grass	*Panicum virgatum*	Tallgrass, large	Prairie, meadow, savannah	Sand/ silt/ clay-loam	Moist/ int.	Full sun	A, B	Highly salt tolerant
Canadian Wild Rye	*Elymus Canadensis*	Tallgrass, large	Prairie, meadow, savannah	Sand/ clay-loam	Int.	Full sun	A, B	
Butterfly Milkweed	*Asclepias tuberosa*	Wildflower, medium	Prairie, meadow, savannah	Sand/ clay-loam	Dry	Full sun	B	Attractant to Monarch butterfly, bright orange flowers bloom in July
Greenheaded Coneflower	*Rudbeckia laciniata*	Wildflower, large	Prairie, meadow, savannah	Silt/ clay-loam	Moist/ int.	Full sun/ partial shade	A, B	Up to 3m tall
Lance Leaved Coreopsis	*Coreopsis lanceolata*	Wildflower, large	Savannah	Sand/ clay-loam	Int.	Full Sun	A, B	
Sweet Oxeye	*Helioopsis helianthoides*	Wildflower, large	Prairie, meadow, savannah	Sand/ clay-loam	Int./ dry	Full sun/ partial shade	A	Similar to sunflower
Indian Grass	*Sorghastrum nutans*	Grass, medium/large	Prairie, savannah	Sand/ loam	Int./ dry	Full	A, B	
New Jersey Tea	*Ceanothus americanus*	Shrub, small	Prairie, meadow, savannah	Sand/ loam	Int./ dry	Full sun/ partial shade	B	
Black Oak	*Quercus velutina*	Tree, medium	Prairie, meadow, savannah	Sand/ loam	Int./ dry	Full Sun	B	Up to 20m height, 90cm diameter
LEGEND	Size: groundcover / tree height / shrub height S = <20cm / 6 – 10m / <1.5m M = / 11 – 18m / 1.6 – 3m L = / 19 – 30m+ / 3.1-6m+			Soil Texture: Sand, Silt or Loam, Clay Soil Moisture: Wet, Moist, Int. = Intermediate/mesic, Dry				

3.4 Project phases and implementation

Figure 8 illustrates a completed site plan of plot A and B drawn using AutoCAD architectural software (also attached in larger format as **Appendix – II).** The plan will be implemented in two main phases and will require continuous maintenance and monitoring. Phase one entails the process of turf removal and pathway construction and possible soil modification. Phase two involves the seeding and planting process. The timeline of this project varies depending on the preferred method of turf removal and plan alternatives as selected by Environment Canada's project steering committee.

To begin phase one, turf is removed or destroyed completely from both plots. At this time any soil modification can occur. This is followed by pathway construction beginning at plot A, near the entrance driveway, and through to the south end of plot B entering G. Ross Lord Park. Phase two can only begin once turf removal and path construction is complete. Seeding and planting will occur according to species characterization. Once all planting and seeding are complete, educational signage and bench seating can be installed throughout the naturalization site.

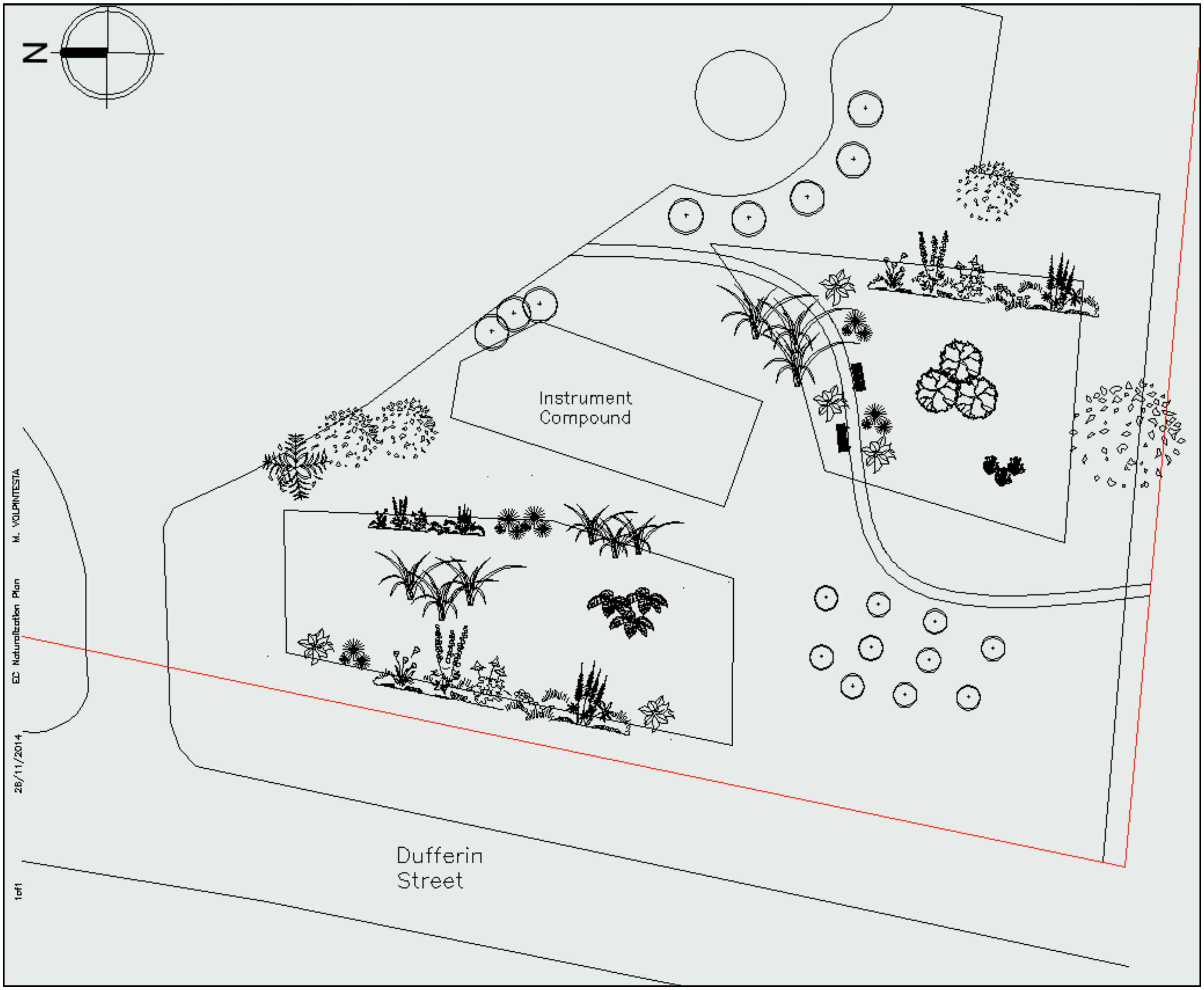


Figure 8 – Naturalization plan CAD drawing

This image of a digital AutoCAD drawing represents the architectural measurements of each plot and pathway and specific location of planting sites. The drawing also demonstrates the property boundary, building exterior and existing City of Toronto infrastructure.

4.0 Alternatives to plan and budget

See **Table 5** for budget and plan alternatives

During the initial phases of consultation, the project steering committee requested that the plan incorporate a range of restoration strategies, due to potential budget and implementation constraints. In adherence of this request, some aspects of the plan are interchangeable.

The first option of turf removal is the most expensive, which would be to remove turf mechanically. This would require the least amount of time, and could be very effective removing the surface turf, but can cause damage to soil and alter composition, potentially requiring soil modification. Turf removal by covering with black 3mm pond liner is the next most effective option. This option is more affordable than removal, but takes much longer to complete. The most affordable option would be short mowing inter-planting amongst the existing turf. This option is not recommended due to competition with non-native grass species, and full succession is not likely.

Soil modification is not necessary for this project. While it can enhance probability for ecosystem function and overall succession, it is costly and resources could be invested in other parts of the project to yield positive outcomes. The results of the soil testing demonstrate average acidity and some evidence of plant strengthening nutrients. If desired by Environment Canada, minor modification may see the addition of a topsoil mix, including nitrogen, phosphorus, and potash. Machined turf removal is necessary for soil modification eradicating other alternatives.

To achieve a true ecological restoration, an integrated pathway must not be constructed of an impermeable surface. Often in meadow ecosystems where human interaction is allocated, boardwalks are constructed to lie above but not in contact with delicate plantings. This also creates an experience of being immersed into the ecosystem, and eliminates disconnectedness felt by users, and by physically separating the landscape. It would be the most costly to construct a wooden deck through both plots. Another option would be to construct a layered permeable pH-neutral gravel surface using natural gravel. Accessibility may be restrictive in this instance.

Plantings are the most affordable by seed. This however, is accompanied with the highest risk of non-succession. There is a relatively lower rate of seed success, and plants are easily outcompeted by invasive species like returning turf and other species commonly represented in the seedbed like varieties of thistle (Waterfront Regeneration Trust, 1995). While it is appropriate for grasses to be planted by seed, plugs offer a higher rate of success and more immediate visual results. The larger shrubs and tree plantings should be acquired in sapling form. Specifically focusing on the larger oak species, externally nursed medium sized trees can be ordered and have a greater chance of full succession. High consideration must be given in acquiring plantings that carry the highest success rate, without doing so may result in a failed naturalization (*ibid)*.

As one of Environment Canada's objectives is to demonstrate its commitment to the environment publically, signage and educational briefing materials are recommended alongside some environmental features. This will allow for pathway users to become educated on particular plantings and Environment Canada initiatives.

Lastly, proper plant sourcing is vital in successful establishment. The Ontario Society for Ecological Restoration or SER Ontario (SERO) is part of an international organization committed to the ecologically sensitive repair and management of ecosystems. Each year SERO produces a list of buyers' guidelines and grower lists that incorporate recent education on native species, successful and unsuccessful plantings and invasive species. It is recommended the SERO growers list be consulted for final selection of plant materials.

Table 5 – Alternatives and budget

Feature	Install Date	**Platinum Plan**	Install Date	**Silver**	Install Date	**Bronze**
Turf removal & soil preparation	March 2015 April 2015	Machined turf removal using sod cutter machine. Tilling of soil. Soil modification, adding of bone meal and blood meal to increase levels of potash, nitrogen, and phosphorus. Sand additives. Budget: Sod cutter weekly rental $300.00 + labour $100.00 per day. Tiller rental $80.00 per day (2 – 3 day use). Sand $174.75 (5 cubic yards). Nutrient application of bone meal, blood meal approx. $1750.00 per 25,000 ft.	March 2015 March 2016	Turf removal by ground cover using PVC black pond liner, approx. 25,000ft. Sand additives for planting. Budget: $4000.00 3mm PVC black pond liner. Sand $174.75 (5 cubic yards).	March 2015	Turf removal by mowing to 0.5mm using hand mower. Sand additives for planting. Budget: Manual labour $100.00 per day (5 days) (may require multiple mows) Sand $174.75 (5 cubic yards).
Pathway construction	April 2015	Wood decking, approximately 160 ft. by 5ft. wide. Budget: 800 ft^2 Wood decking (supplies, $3500.00. Labour (80 hours) and construction supplies, $3100.00	March 2016	Gravel pathway, using 7/8” clear limestone screening 160 ft. by 5 ft. wide. Budget: 800 ft^2 by 2” thickness limestone screening (6 cubic yards) $374.00 not including delivery fees.	March 2015	Woodchip, mulch pathway, 160 ft. by 5ft. wide. Budget: 800 ft^2 by 2” thickness woodchip mulch (6 cubic yards +1 for upkeep) $255.00 not including delivery fees.
Planting & Seeding	April 2015	Ornamental grasses gallon pots approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft^2 coverage. Five 50mm diameter Black Oak saplings. Budget: Grasses with approx. 100cm spacing, 1176 (1 gallon) pots at approx. $12.99 each, total $15,288.00. Wildflower pots, approx. 60cm spacing, 2000 4” plugs, total $2,620.00. Black Oak saplings, 50mm diameter $399.99 each, total $1,999.95	April 2016	Ornamental grasses gallon pots approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft. coverage. Five 250cm Black Oak saplings. Budget: Grasses with approx. 100cm spacing, 1176 (1 gallon) pots at approx. $12.99 each, total $15,288.00. Wildflower pots, approx. 60cm spacing, 2000 4” plugs, total $2,620.00. Black Oak saplings, 250cm $199.99 each, total $999.95	April 2015	Ornamental grass seeding approx. 10,000 ft^2 coverage Wildflower pots approx. 6000 ft. coverage. Five 250cm Black Oak saplings. Budget: Grass seeding Approx. 20 kg seeding covering $9.99 – $12.99 per kg, $199.80 – $259.80. Wildflower pots, approx. 60cm spacing, 2000 4” plugs, total $2,620.00. Black Oak saplings, 250cm $199.99 each, total $999.95
Signage & Seating	Sept. 2015	Outdoor 1/8” PVC vinyl signage, 48” x 120” $620.00 each. Two Outdoor Jayhawk standard park benches, $629.00 each. Budget: Signage x 3, $1,860.00 Benching x 2, $1258.00	Sept. 2015	Outdoor 1/8” PVC vinyl signage, 48” x 120” $620.00 each. Two Outdoor Jayhawk standard park benches, $629.00 each. Budget: Signage x 3, $1,860.00 Benching x 2, $1258.00	Sept. 2015	Outdoor 1/8” PVC vinyl signage, 48” x 120” $620.00 each. Budget: Signage x 3, $1,860.00
	TOTAL	$32,310.70	TOTAL	$26,574.75	TOTAL	$6,609.55

*** Budget estimates courtesy of Greely Sand and Gravel Ottawa, Humber Nurseries Toronto, and The Home Depot.

5.0 Management and long-term maintenance

Maintenance and monitoring should include the following actions; controlled burns (prescribed fire), control of invasive brush and trees, control of herbaceous weeds, seed collecting and introducing further understory species (Oak-Savannah Management, 2014). Monitoring and maintenance requirements in naturalized areas should remain minimal, however because the restoration objective is to retain a meadow at a certain stage of succession, then monitoring of grass and woody growth is required.

A main factor in managing meadows mainly involves removing woody vegetation, depending on the successional stage required (Waterfront Regeneration Trust, 1995). In old fields, characteristically a mixture of introduced and native species, control of introduced species is seldom necessary. In urban areas, highly manicured parkland is coming under increasing public criticism as a sterile environment in which differences in sites are ignored, and where only a few exotic bird species thrive (*ibid,* p.98). It is also becoming increasingly costly to maintain, and is often hazardous to maintenance operators.

Mowing near natural areas can damage their ecological diversity and habitat. A buffer of 5 m to 10 m should be left un-mown and allowed to naturalize. For areas of widely spaced trees in turf, considerable handwork by small mowers is required. Such areas can be filled with other plant materials to create patches and wildlife habitat with a new mowing line around them. In areas of dense tree groupings, mowing under trees should be discontinued to permit a natural groundcover and under storey to develop, either through naturalization or with restoration procedures.

As described within *The Waterfront Regeneration Trust* (1995), landscapes appear neglected where the edges between one kind and another have not been adequately considered, particularly between manicured and rough turf and meadow. Edges should be laid out in sweeping lines, as an obviously designed edge looks purposeful. Well laid out and carefully considered, it creates an attractive landscape of contrasting elements, with the meadow habitat enhancing the mown turf.

Annual prescribed burning, as demonstrated within Toronto's High Park is an effective way to regenerate growth and maintain an oak-savannah ecosystem. Research has shown that the health of an oak-savannah is best maintained if the site is burned every year. If resources do not permit annual burns, then the site should be burned as often as possible, but under no conditions should the burn frequency be less than three years.

Attached, as Appendix – III is a reformatted copy of the deliverable plan to Environment Canada excluding some appendixes already included in this report.

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