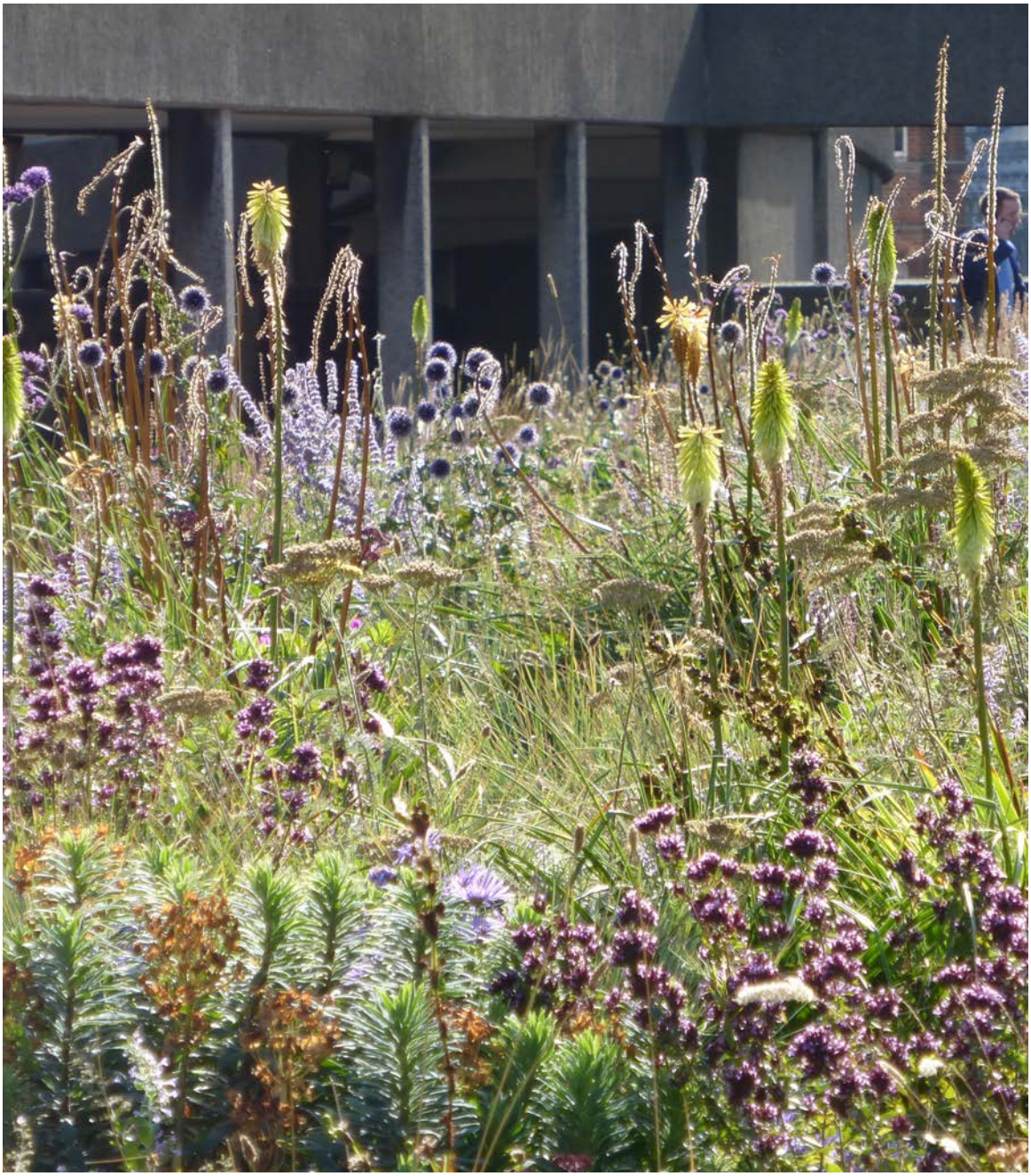
Growing Grit

Low Nutrient Mineral Substrates for Resilient Perennial Planting



The Barbican Centre. London, UK. Design by Nigel Dunnett, University of Sheffield. Author's image.

Ben O'Brien

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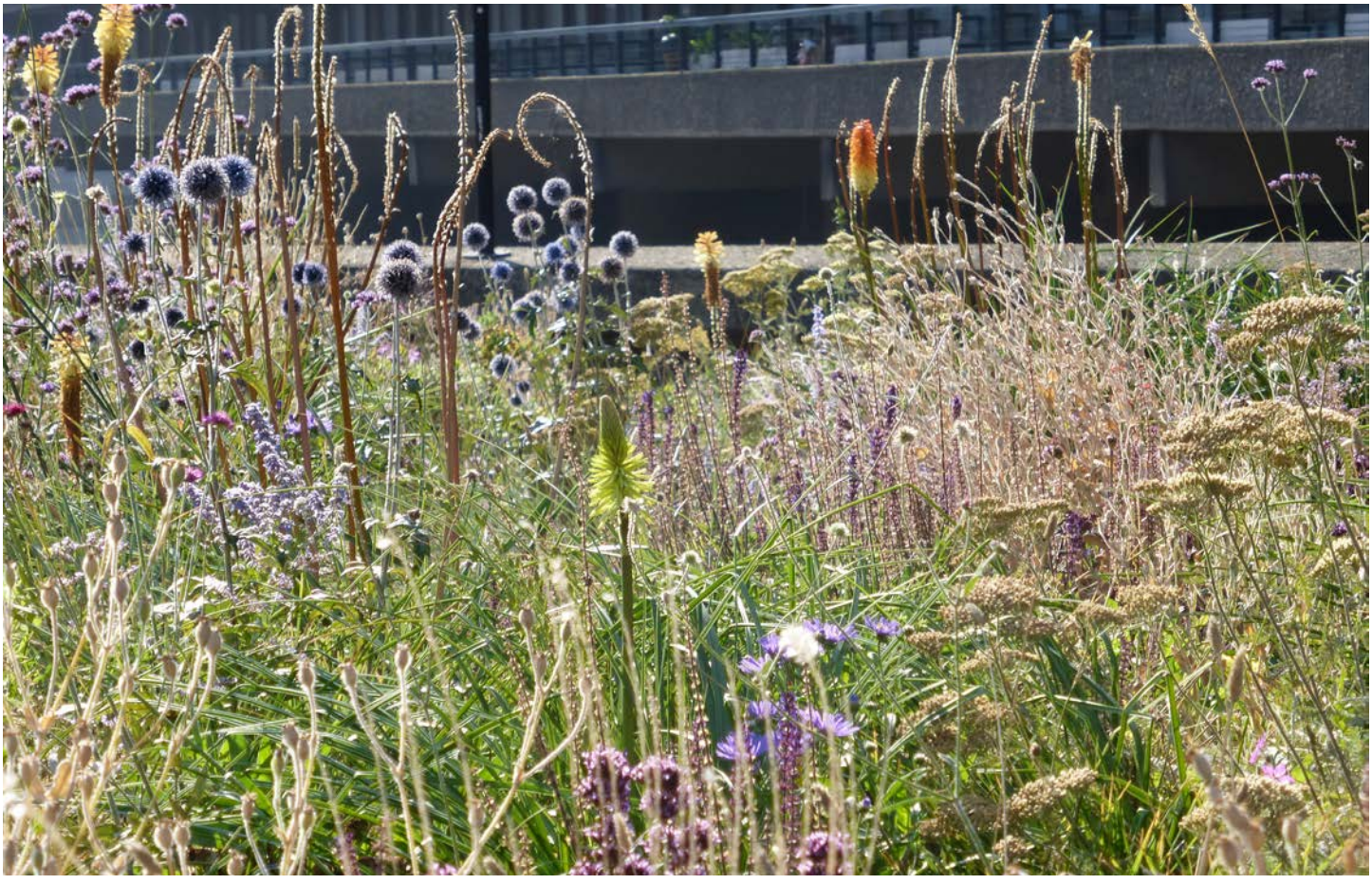
Summary

In current landscape architectural practice we are placing ever-greater demands on the vegetation in our designed environments. 21st century plantings must be dramatically beautiful, sustain local wildlife, capture and filter storm water, green our roofs, clean our air, and preserve biodiversity all while the resources for maintenance are on the decline. The challenge facing landscape architects today is how to create beautiful, biodiverse, and resilient designed vegetation.

A fundamental problem however is that conventional planting soils are incapable of supporting this new planting typology. Consistently moist, high fertility, organic soils favour competitive plant species, weaken a plant's ability to tolerate drought stress, and are highly susceptible to weed invasion. Artificial substrates offer a potentially superior alternative. These proxy soils combine free draining, often recycled mineral materials with very low quantities of organic matter.

This project will investigate the potential of these substrates as an alternative to conventional planting soil. LACF grant funding will go toward the construction, planting, and 2 year monitoring of a trial garden to test the performance of 49 different herbaceous plants and 36 different bulbs on 4 substrates: 2 commercial green roof soils, and 2 different mixtures of recycled concrete aggregate and compost.

Work in 2018 will focus on developing easily replicated methods to ensure successful plant establishment. The second year will yield valuable information about the ongoing and long-term requirements of established plantings on artificial substrates. It is hoped that, if successful, similar substrates and plant communities may become more widely adopted in Canadian landscape practice.



Perennial planting in green roof substrate. The Barbican Centre, London, UK
Design by Nigel Dunnett, University of Sheffield
Image: Ben O'Brien

Project Significance

In recent years, a number of high profile landscape architecture projects have shown both the popularity and ecological value of naturalistic perennial planting. The most notable example is the High Line Park in New York City. Designed by James Corner Field Operations, with planting design by Piet Oudolf, the park is now visited by a staggering 7.5 million people a year from all over the world. While the experience of walking along an elevated former railway line through Manhattan is certainly novel, undoubtedly what has proved the main attractor is the park's naturalistic planting.

Given its long season of flowering interest, adaptability to site conditions, planting density and diversity, naturalistic herbaceous vegetation offers many ecological, sustainability, and human health benefits. The most important point however, is that this type of planting design can deliver these measurable benefits while simultaneously creating environments that people find immensely engaging and pleasurable to be in. People simply love colourful, richly planted landscapes. Indeed James Hitchmough and Nigel Dunnett, professors at the University of Sheffield in the UK, have found that since their storm water planting scheme was installed in a street in downtown Sheffield people have changed their daily walking habits so they can walk through the planting. This supports the fundamental idea behind Hitchmough and Dunnett's landmark book *The Dynamic Landscape*; that nature-like vegetation is good for biodiversity and sustainability but that in cities, in order for it to be effective and engaging, it must be designed to be genuinely attractive to ordinary people who aren't ecologically aware.

A key problem however, is that famous projects like the High Line aren't easily replicated in everyday practice. The High Line is remarkably well funded and the challenge for landscape architects, if this planting is to become more widely adopted in towns and cities on projects without similar financial resources, is creating designed vegetation with the same aesthetic richness as the High Line, but without a similarly luxuriant budget for maintenance.

Pioneering research is being done in the UK, notably by the aforementioned professors Hitchmough and Dunnett in Sheffield as well as in Germany where carefully researched perennial, bulb, and grass mixtures are developed to persist with minimal maintenance over long periods in harsh urban planting environments (see image below). Research in this field is essentially focused on getting the maximum aesthetic impact with the least ongoing maintenance requirements. Researchers in both the UK and Germany have focused on two key areas: testing different artificial planting substrates to determine which can best support durable long term plant growth while minimizing the risks of weed invasion, and trialling of a wide range of plant species to be used in the design of beautiful, biodiverse and resilient plant communities on these substrates.

This project is an attempt to further explore both key ideas, and significantly advance an area of practical landscape research that has so far been little explored in North America.

Perennial planting in gravel substrate. Mannheim, Germany
Image: Cassian Schmidt

Methodology and Timeline

SEE ATTACHED EXPERIMENTAL DESIGN PLAN

To facilitate this project, a trial garden will be constructed in Cherry Valley, Ontario at Athol Central Public School (location to be determined after consultation with school board).

Construction

The trial garden will consist of eight raised beds. Existing vegetation on the site of each bed will be stripped and the underlying soil will be graded level. Posts (4”x4” untreated lumber) will be dug into the ground to secure each corner of the plot and the sides will be built from two 2”x6”x8’ on end to create a planting box 2.44m (8 feet) square, with a depth of approximately 30cm (12 inches). The bottom and sides of the box will be lined with industrial grade landscape fabric to ensure the plants are unable to root into the underlying soil. This will ensure a consistency of results, as the entire root mass of each plant will be positioned exclusively within the substrates.

Planting Installation

Prior to planting, substrates will be compacted to ensure minimal settling of material after plants are installed. Plants will be sourced from reputable wholesale growers to ensure uniformity. The methods of establishment will be simplified to mimic how a larger scale planting would be installed and maintained by a contractor in practice. Plants will be installed in May 2018 (bulbs will be planted in September or October) by hand, on 30cm grid spacing, with the crown of each plant level with the surface of the substrate. The initial watering of the plots will be performed by hand with a hose and watering wand. Four of the beds (see design plan below) will be watered and inoculated with a mycorrhizae solution. The powdered mycorrhizal fungae is mixed with water and applied via a spray attachment, similar to a liquid fertilizer applicator, on the end of the hose. The other four beds will be watered by hand. All plants will receive the same amount of water or water / mycorrhizae solution.

Planting Establishment

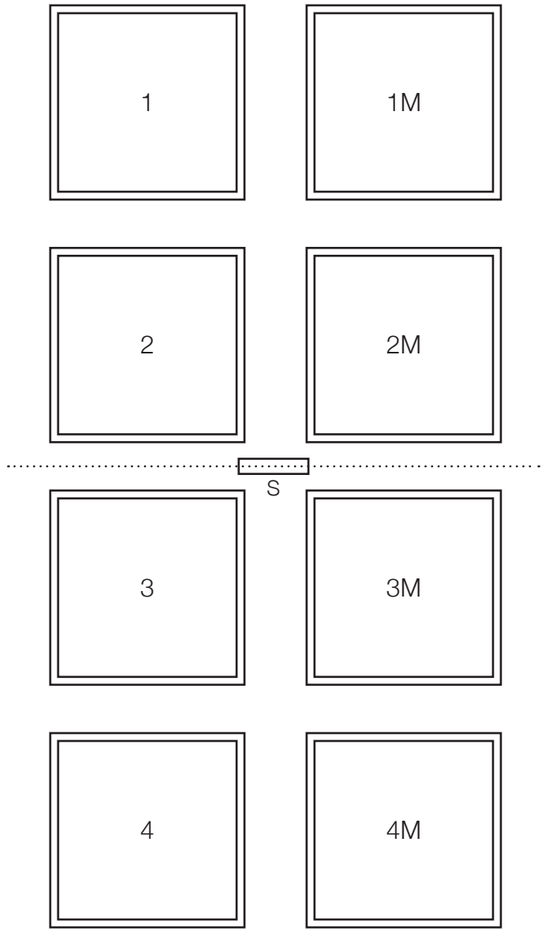
Throughout the remainder of the 2018 growing season the plots will be watered via an oscillating sprinkler system. Watering will ideally take place on days with little to no wind to ensure even water dispersal across the experiment.

To test when the substrate becomes saturated, holes will be cut in the bottom of plastic buckets and the bottoms will be lined with coloured construction paper. Buckets will then be filled with 20cm of each substrate and positioned in four corners of the experiment. The sprinkler system will be turned on and once the construction paper at the bottom of each substrate bucket has turned uniformly dark (indicating the water has reached the bottom of the bucket), the substrate can be considered saturated. Rain gauges will note the amount of water required from the sprinkler system to reach this saturation point, and the time to reach saturation will also be recorded. Thereafter, the sprinkler irrigation will be set to the required time to reach saturation, and only run as long as necessary. Rainfall will be noted throughout the experiment and rainfall events that account for the same amount of water required to reach saturation will be noted and considered the same as an irrigation event.

During the first season, close monitoring will determine when irrigation is required. Irrigation will be applied regularly (exact rate will depend on temperatures, weather, cloud cover etc.), and in accordance with rainfall, until plants begin showing signs of new growth. New growth emerging is a good indicator that plants have begun to root beyond their potting soil and into the substrate. This critical establishment period is typically the first 6 - 8 weeks post-planting. After this point, irrigation can become less frequent but will remain consistent to ensure successful plant establishment.

Any weeds that germinate between the planted species will be removed with a Dutch push hoe, severing the roots below the surface and before the weed flowers and sets seed. Weeds that germinate around the base of plants will be removed carefully by hand.

Plants will be photographed and measured throughout the experiment. Width of basal foliage and height of foliage, stems and flowers will all be recorded through the growing season. The timeline of decline and mortality for plants that prove poorly suited to the substrates will also be noted for reference.

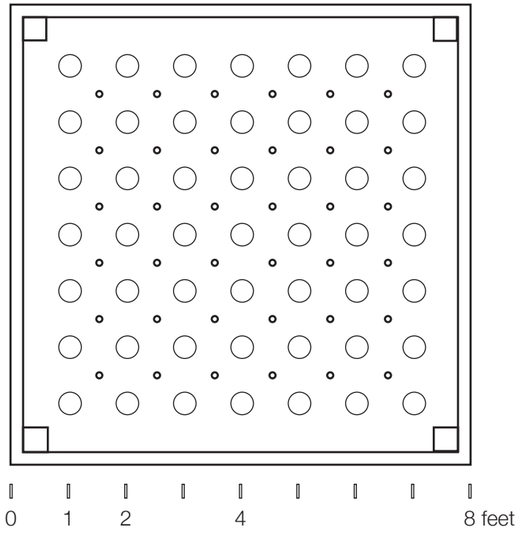


Trial Garden Layout

1. Concrete aggregate / compost (80% / 20%)
2. Concrete aggregate / compost (50% / 50%)
3. Commercial intensive green roof soil
4. Commercial organic green roof soil

M. Mycorrhizal inoculant applied

S. Oscillating sprinkler location



Plot Detail

Lumber edge (untreated 2” x 6” x 8’)

Corner post (untreated 4” x 4” x 4’)

Perennial / grass planting location

Bulb planting location
- 1 large bulb per spot (i.e. Narcissus)
- 4 small bulbs per spot (i.e. Crocus)

Plants to Trial

Note: Species list subject to change due to supplier availability

Herbaceous Perennials

Achillea ‘Coronation Gold’
Allium schoenoprasum
Amsonia ‘Blue Ice’
Artemisia schmidtiana ‘Silver Mound’
Asclepias tuberosa
Aubrieta ‘Royal Blue’
Calamintha nepeta subsp. nepeta
Coreopsis tripteris ‘Gold Standard’
Echinacea pallida
Echinacea paradoxa
Echinacea purpurea
Eryngium planum ‘Blaukappe’
Euphorbia corollata
Gaura lindheimeri ‘Whirling Butterflies’
Geum triflorum
Inula ensifolia
Lavandula x intermedia ‘Phenomenal’
Limonium latifolium
Monarda fistulosa ‘Claire Grace’
Nepeta ‘Purrsian Blue’ / ‘Cat’s Meow’
Oenothera macrocarpa
Oenothera fruticosa ‘Fireworks’
Origanum laevigatum ‘Herrenhausen’
Penstemon digitalis
Phlomis russeliana
Potentilla nepalensis ‘Miss Willmott’
Pulsatilla vulgaris
Ratibida columnifera
Ratibida pinnata
Rudbeckia fulgida var. fulgida
Salvia nemorosa ‘Caradonna’
Scabiosa columbaria ‘Butterfly Blue’
Sisyrinchium striatum
Solidago ptarmicoides
Solidago rigida
Solidago rugosa ‘Fireworks’
Symphyotrichum ericoides
Symphyotrichum laeve ‘Bluebird’
Symphyotrichum oblongifolius ‘Raydon’s Favorite’
Teucrium chamaedrys
Thymus vulgaris

Grasses

Andropogon virginicus
Bouteloua curtipendula
Bouteloua gracilis ‘Blonde Ambition’
Festuca mairei
Muhlenbergia reverchonii ‘Undaunted’
Schizachyrium scoparium ‘Standing Ovation’
Sesleria autumnalis
Sesleria nitida

Bulbs

Allium atropurpureum
Allium christophii
Allium karataviense ‘Ivory Queen’
Allium schubertii
Allium sphaerocephalon
Allium ‘Mt Everest’
Allium ‘Globemaster’
Camassia esculenta ‘Quamash’
Chionodoxa luciliae
Crocus tommasinianus ‘Barr’s Purple’
Crocus ‘Ruby Giant’
Eremurus stenophyllus
Iris hollandica ‘Eye of the Tiger’
Iris reticulata ‘Joyce’
Iris reticulata ‘Katharine Hodgkin’
Muscari armeniacum
Muscari latifolium
Narcissus ‘February Gold’
Narcissus ‘Hawera’
Narcissus ‘Tete a Tete’
Narcissus ‘Thalia’
Nectaroscordum siculum
Ornithogalum umbellatum
Puschkinia libanotica
Scilla peruviana
Scilla sibirica
Tulipa bakeri ‘Lilac Wonder’
Tulipa clusiana chyrsantha ‘Tubergen’s Gem’
Tulipa hageri ‘Splendens’
Tulipa polychroma
Tulipa praestans ‘Fusilier’
Tulipa sylvestris
Tulipa tarda
Tulipa turkestanica
Tulipa ‘Ballerina’
Tulipa ‘Negrita’

Future Research

Documentation will continue in 2019. Plants that successfully establish and overwinter will no longer be irrigated in the second growing season. The following spring will also demonstrate which of the fall-planted bulb species are best adapted to the substrates. 2019 will yield valuable information regarding the long-term maintenance requirements and performance of herbaceous plants on artificial substrates. If resources become available an additional trial could be developed to further refine substrate mixtures and investigate both a wider palette of plants, perhaps including woody tree and shrub species on deeper substrates, and explore the potential effects of fall planting installation.

Once an optimal substrate has been developed, research can begin into creating plant mixtures using perennial, grass and bulb species that prove reliable and robust.

Communication of the Project

Results of the project will be communicated to landscape architects via Ground Magazine, the quarterly publication of the Ontario Association of Landscape Architects. An article for the spring 2018 issue is already planned to give an overview of the relevant European research and practice, and describe the experimental design. If successful, article proposals will also be sent to Landscapes/Paysages magazine as well as the ASLA's Landscape Architecture Magazine. Speaking events at garden clubs, horticultural societies, or at trade shows and conferences will also be pursued to expand this knowledge to a wider public audience.

Project Budget

The proposed project budget is intended to cover the material costs for the construction of the experiment. Local contractors will be approached to donate the labour required to construct the experiment, and all planting, irrigation, and establishment activities will be performed by Ben O'Brien.

Proposed Project Budget

Plant material sourced from wholesale trade suppliers : $2,000
Lumber and materials required for the construction of raised beds : $ 1,200
Lafarge "Aggneo" recycled concrete aggregate : $ 300
Green roof substrates sourced from Gro-Bark Ltd. and Smart Green Technologies Inc. : $ 300
Compost sourced from Astoria Organic Matters LP : $ 200

Total Requested Funds : $ 4,000

If the requested funds are approved, a sign will be constructed to acknowledge the generous support of the Landscape Architecture Canada Foundation, with its logo prominently displayed.

Alternate Funding

As of November 17, 2017 there are currently no other organizations or individuals financially supporting the project. The funds requested in the budget are sufficient to cover the project costs in their entirety. Therefore additional funding from community organizations, individuals, and other sources will only be sought if the application to the LACF is unsuccessful.

Application of Results

From a geographical perspective, Prince Edward County is an ideal location to test these ideas. Situated along the shore of Lake Ontario, the county falls within a transition area between two hardiness zones: 5b and 6a. These climate zones cover Toronto and the rapidly urbanizing cities of southern Ontario, as well as much of the more densely populated areas of eastern Canada including Montreal and Halifax. Additionally, Prince Edward County experiences frequent and prolonged droughts in mid summer. It can be reasonably anticipated then that the trial plots will undergo summer moisture stress similar in effect to the heat and drought of the urban heat island.

While the experiment is hardly as rigorous as a formal scientific investigation, it has been designed to generate consistent results. There is also a strong focus on developing simple installation, establishment and maintenance methods that can be applied and scaled up in practice. Further testing will be required to explore how substrates and their plant communities respond in real world situations, however the results from the trial plots will provide a foundation and allow future experimentation to proceed with a fair degree of confidence.

If the experiment proves successful, artificial substrates have the potential to replace imported topsoil in a range of landscape applications. In newly constructed landscapes where site soil is dramatically altered, or nonexistent the substrates could either be used entirely in place of soil, or as the upper layer overlying structural subsoil underneath. In planting beds installed at grade, in raised planters, above structures where the depth of growing media is severely limited, and potentially also in rain garden or swale plantings, traditional landscape soils could be replaced by artificial substrates. In addition, research at the University of Sheffield has shown that the influence of the weed seed bank in a site's existing native soil can be dramatically reduced when soil is "blanketed" by a deep sterile mulch material. In experiments in Sheffield planting has been installed into 20cm deep mulches of 5-12mm pea gravel or limestone chips as a way of reducing the productivity and weed seed bank of the underlying soil. In certain experiments this method has led to no weed invasion in the planting, years after installation. While the artificial substrates in this project aren't as sterile as pure gravel, due to the addition of organic material, they may still have relevance as blanketing mulches which can be used to aid planting establishment on highly productive or weedy native soils. This would have wide relevance in planting retrofit settings where, for example, existing turf grass is to be converted to perennial planting or other meadow vegetation.

Artificial substrates have the potential to support beautiful, biodiverse and resilient herbaceous plant communities, but research in this field in North America has been limited to date. By researching both different artificial substrate mixtures and a wide range of herbaceous perennials, grasses, and bulbs, this project endeavours to develop methods where these substrates and well-adapted plant communities may be applied on a large scale in Canadian landscape architectural practice.

Perennial planting in green roof substrate. The Barbican Centre, London, UK
Design by Nigel Dunnett, University of Sheffield
Image: Ben O'Brien

UNIVERSITY of GUELPH

ONTARIO AGRICULTURAL COLLEGE
School of Environmental Design and Rural Development
Capacity Development and Extension • Landscape Architecture • Rural Planning and Development

November 13, 2017

Dear Landscape Architecture Canada Foundation

I am pleased to write this letter of support for Ben O'Brien's application. I have known Ben over the last three years of his four years in Bachelor of Landscape Architecture program. I taught Ben throughout those three years and since his graduation we have kept in touch regarding his work and research interests, and his hopes and ambitions for the future.

Ben was a pleasure to have in our student body. In my experience as an instructor, Ben always raised the level of discussion in classes and amongst his classmates. He has a wonderful capacity for conceptual thinking, and in linking theory to practice. He read far beyond the requirements of his coursework and applied what he learned in an intellectually rigorous way. He is not afraid of criticism; in fact, he invites it and knows that constructive critique will help push his learning to a higher level. In his time in our BLA program, Ben gained respect from both faculty and his classmates.

While Ben was in his final year of our program, he and I had conversations about his interest in planting design – one of my own passions - particularly with regard for sustainability and resilience. Upon graduation, independently, Ben developed a list of well-regarded planting designers with whom he wished to meet, and set about doing just that by traveling internationally to conferences and by simply knocking on doors. His obvious passion for the subject, and sincere interest in learning from the best, was rewarded by those same designers taking an interest in meeting with him and discussing their work. I am impressed with Ben's efforts to continue learning after he graduated from our program – not only learning but also striving for a better solution than the standard approach.

Ben is interested in new resilient approaches to planting design, especially in the face of harsh conditions due to urbanization and climate change. I have read his proposal and believe we all stand to learn from this experiment. This approach has been experimented with in different ways in northern Europe but it has not yet brought it to mainstream thinking here in Canada.

If you are able to support Ben's application for this research, I know he will follow through in a timely manner, and the results will be of interest to the profession of Landscape Architecture in particular, and to all those who aim to create resilient landscapes.

If you need more information from me, please do not hesitate to contact me.

Sincerely,

Karen Landman

Karen Landman PhD RPP MCIP
Professor of Landscape Architecture
klandman@uoguelph.ca

Ben O'Brien

Education

Bachelor of Landscape Architecture, With Distinction
University of Guelph
2010 - 2014

University Awards

University Olmsted Scholar (BLA Award)
The Landscape Architecture Foundation's Olmsted Scholars Program recognizes and supports students with exceptional leadership potential who are using ideas, influence, communication, service, and leadership to advance sustainable design and foster human and societal benefits.

Victor Chanasyk Medal for Professionalism
Awarded to a graduating student from the BLA program who is judged by the faculty to have the most promising potential to mature into an outstanding professional practitioner.

ASLA Student Merit Award
The ASLA Student Merit Award recognizes excellence in the study of landscape architecture and the skills related to the art and technology of landscape architecture.

Experience

Founder and Landscape Designer
Wild by Design, July 2014 - Present

Responsibilities
- design, plant sourcing, planting installation, and maintenance of rural landscapes and town gardens
- coordinating and overseeing project implementation
- garden consultation services
- volunteer designer of PEC pilot community garden
- public speaking and workshop presentations

Landscape Designer and Greenhouse Labourer
Lockyer's Country Gardens, April 2011 - July 2014

Responsibilities
- small scale landscape design and construction
- sales of trees, shrubs, and perennial plants
- customer service and consultation
- assisting in day-to-day greenhouse operations

Contact

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Continuing Education

2014 Annual Conference
American Society of Landscape Architects
Denver, Colorado
November 21 - 24, 2014

Native Design: Intricate to the Expansive
New Directions in the American Landscape
New London, Connecticut
January 7 - 8, 2016

Forum 2016 - Restoring Resilience
Carolinian Canada Coalition
Toronto, Ontario
October 25 - 26, 2016

Creating Plant Communities
Ecological Landscape Alliance Symposium
Brooklyn, New York
December 9, 2016

Sustaining the Living Landscape
Ecological Landscape Alliance Conference
Amherst, Massachusetts
March 8 - 9, 2017

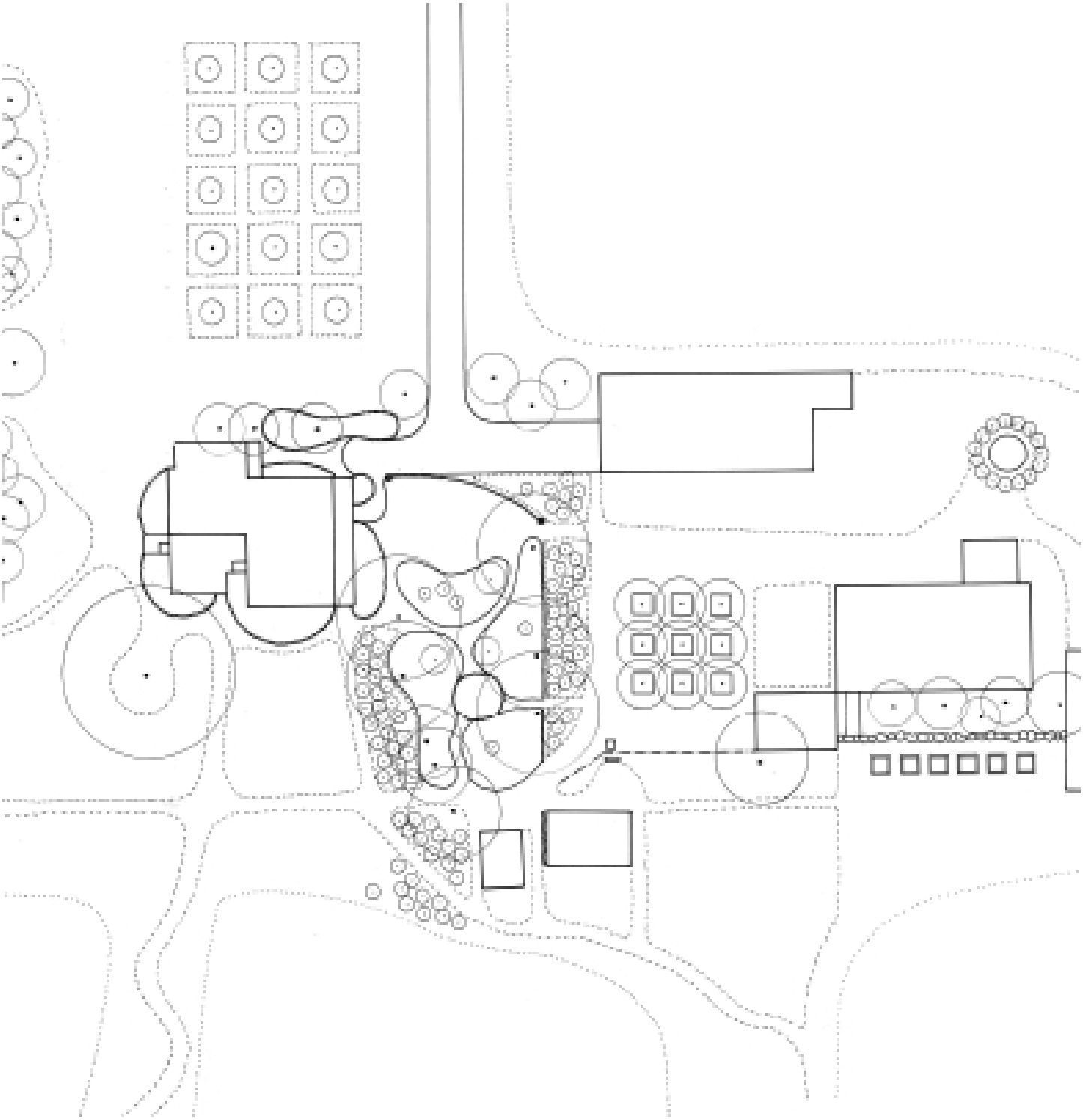
Perennial Plantings Beyond Nature
Urban Growth Conference
Lund, Sweden
September 8 - 10, 2017

wild by design

Farm Garden
Design: 2015
Planting Phase 1: 2015
Planting Phase 2: 2016
Planting Phase 3: 2017

Wild by Design's biggest ongoing project is an organic farm south of Picton, Ontario. The goal for the project is to create a tapestry of immersive gardens, wild naturalized meadows, heirloom fruit tree orchards, and native hedgerows that will both enrich and respect the inherent magic of the farm's pastoral landscape.

The landscape has been planted in phases, and has so far proved to be immensely successful, with perennial gardens establishing quickly, performing over a long season, and requiring minimal ongoing maintenance.

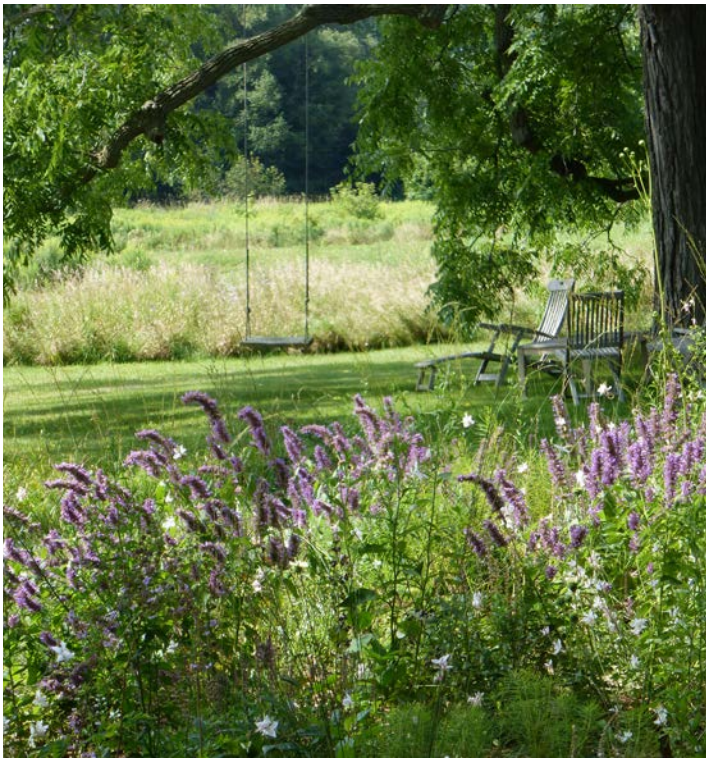


wild by design

Farm Garden

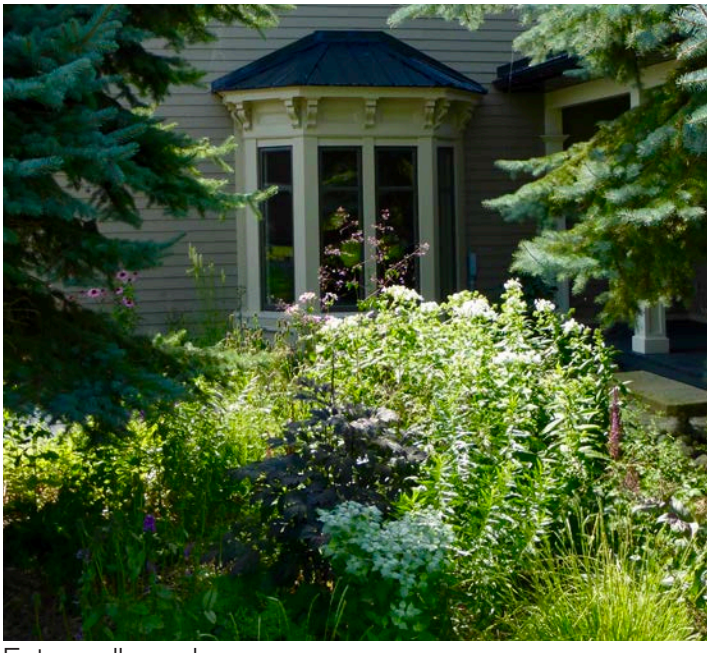
Design: 2015
Planting Phase 1: 2015
Planting Phase 2: 2016
Planting Phase 3: 2017

The design for the 120 acre property involves the creation of richly planted perennial gardens and naturalized lawn meadows surrounding the farmhouse. Native shrub hedgerows enclose a layered woodland garden inspired by the nearby Beaver Meadow Conservation Area. Both create functional habitats for local songbirds and other wildlife. A fruit tree orchard has been planted where the farm's original orchard once existed. The fruit trees are set within a meadow grid that incorporates the remnant apple and pear trees with the newly planted apples, cherries, and plums.

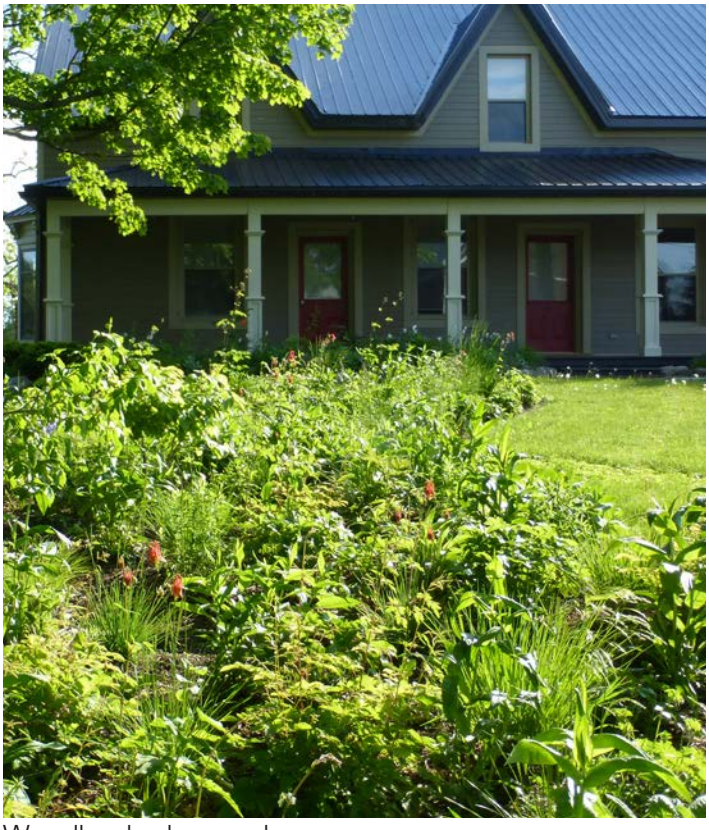


Meadow garden

Re-planted heritage fruit tree orchard



Entry walk garden



Woodland edge garden

wild by design

Country House Garden
Design: 2014 - 2015
Planting: 2015

Wild by Design's first commission was for a perennial garden sweeping across the front of a grand country house in southern Prince Edward County. The aesthetic of the new front garden aims to combine classic old-world garden plants like columbine and phlox with native plants like wild bergamot, foxglove beardtongue and button eryngo as well as more recent perennial varieties. This combination ensures the garden feels both contemporary and authentic to the period of the house. The planting has grown vigorously, and endured the intense summer drought of 2016 with no irrigation.