



Clairfields, Westminster Woods and Pine Ridge Subdivisions

Location: Guelph

Constructed: May 2011

Case Study



Project Objectives, Design and Performance

- Three subdivisions located in the south end of Guelph that utilize large-scale infiltration practices called “greenways”.
- Use of on-site infiltration practices driven by ideal soil conditions and inability to connect to municipal storm sewer system.
- Greenways provide recreational amenity for residents through trail network, parks and playgrounds.

Overcoming Barriers and Lessons Learned

- During planning, concerns regarding cold weather performance required extensive geotechnical investigation.
- Multi-year monitoring has shown that subdivision-scale infiltration can operate successfully year-round.

Practices Implemented



Barriers & Issues Encountered



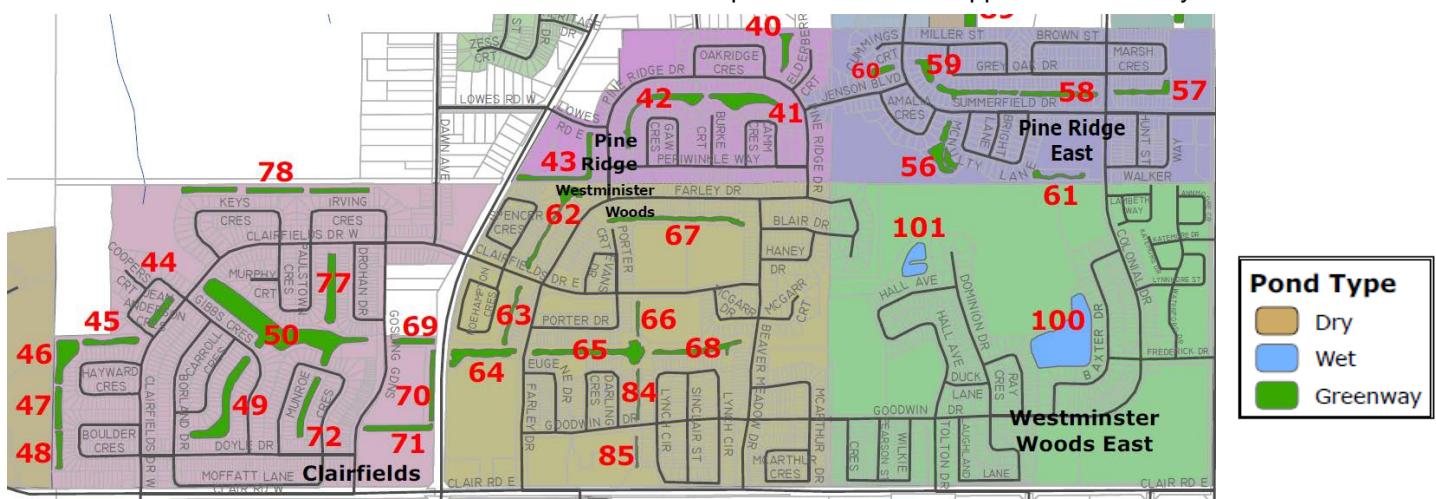
Overview

The Clairfields, Westminster Woods and Pine Ridge subdivisions (hereafter referred to as the "South End subdivisions") are located in the southern portion of Guelph, occupying lands immediately to the east and west of Gordon Street (bounded between Arkell Road and Clair Rd.). A unique feature of the South End subdivisions is their use of large infiltration practices, called "greenways," as the primary means of handling stormwater on-site.

Prior to development, the predominant land use was agricultural. The topography of the site was relatively flat, with a small kettle lake located in the area that would become Westminster Woods East. There were no existing natural or man-made connections to Hanlon Creek or its tributaries – all rainfall would infiltrate on-site. Only rainfall events greater than the regional storm would generate surface runoff that would leave the site.

The total size of the South End subdivisions is quite large (approx. 250 Hectares) and has developed through the course of multiple phases. The developments are mixed use, comprising single-detached housing, multi-residential townhouses and low rise buildings, as well as schools and commercial shopping areas. The subdivisions are well integrated within the community, and include an extensive recreational walking trail system and public transit routes that travel through the subdivision. The site also includes a number of green demonstration homes, including Canada's first LEED Platinum home and a water efficient Blue Built Home.

The layout of the subdivisions, including the location of the various greenways are highlighted in the map below.



Map of South End subdivisions, showing location of greenways and wet ponds

Goals & Drivers

There were a variety of drivers that motivated the use of infiltration practices at the South End subdivisions. These included:

- Challenges associated with connecting the subdivisions to Guelph's existing storm sewer system (existing grade at the site was below that needed to permit a connection).
- Maximizing the amount of groundwater recharge at the site.
- Ensuring that the infiltrated stormwater did not negatively impact groundwater quality.

As Guelph primarily relies upon groundwater for its potable water supply, ensuring that this important resource was not negatively affected was a key goal of this development.

Successes

The successes achieved with this project include:

Winter performance – the greenways in the South End subdivisions have continued to infiltrate successfully during the winter months (often exceeding initial expectations).

Multi-partner collaboration – the developers, consultants and the municipality worked together closely to ensure that the innovative large-scale infiltration practices were a success.

Stormwater features as amenities – a network of pedestrian paths, parks and playgrounds were established around many of the greenways, providing passive recreation opportunities for city residents.

Overcoming Barriers & Lessons Learned

As some of the first large-scale subdivisions in Ontario to incorporate infiltration as the primary means of handling stormwater, a number of barriers and challenges were encountered. The barriers encountered with this project included:

- Extensive pre-development groundwater and surface water monitoring required to support proposed greenway system,
- Concerns among stakeholders regarding long-term performance of infiltration practices, particularly cold weather performance,
- Some encroachment of greenway and disruption to rear yard infiltration trenches by residents following construction.

The following approaches were used to address these barriers:

- Data provided by multi-year groundwater and surface water studies demonstrated that large-scale infiltration would work,
- Stakeholders undertook a phased approach, first subdivision used as a pilot to demonstrate effectiveness of greenway system

Lessons learned:

- Better education is required to inform residents of the location and function of LID practices on (or near) their property.

Planning & Regulations

Prior to initiating the design and construction of the South End subdivisions, extensive planning and site investigation work was conducted.

Preliminary studies on the development of the site started as early as 1984, although much of the work took place throughout the 1990's. Some of the studies and reports, pertaining to the Westminster Woods development, include:

- *Hanlon Creek Watershed Plan, 1993*
- *Environmental Impact Study for Westminster Woods Ltd. Draft Plan of Subdivision, 1998*
- *Environmental Implementation Report, 1999*

These studies found that the site was ideal for infiltrating stormwater runoff, as virtually no surface runoff was observed at the site pre-development.

As large-scale infiltration practices were uncommon during this period, there were concerns among the parties involved (MOE, MNR, GRCA and the City) as to the long-term performance of infiltration practices. To address these concerns a smaller parcel of the available lands, Pine Ridge West, was selected to be developed first as a pilot project. Monitoring during and following construction found this development to be a success, which provided assurance to the stakeholders to continue.

Another concern expressed by one of the stakeholders - the City of Guelph - during the planning stages was the maintenance of the stormwater management practices. In the case of Westminster Woods, this concern was addressed in part through the creation of a condominium corporation for the subdivision, which has the legal name *Westminster Woods Ltd.* The corporation is responsible for maintaining all of the common elements, including performing general landscape maintenance (trash removal and mowing) of the stormwater management practices.

By working collaboratively, the developers, consultants and stakeholders were able to address the issues and concerns that arose, facilitating a streamlined planning and review process for the subdivisions.

Design

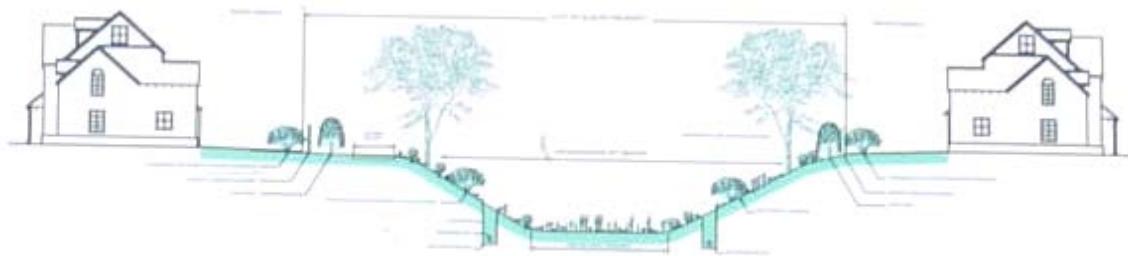
The South End subdivisions are unique in that they employ the principles of LID, but at greater scale than is considered typical for this type of best practice.

Greenway System

Throughout much of the subdivisions, stormwater runoff is collected from the roadways using typical catchbasins and piping. However, rather than discharging to a stormwater management pond, the runoff is directed to large-scale bioretention facilities, called "greenways."

The greenways have 3:1 side slopes, and the bottoms are essentially flat to distribute runoff to the largest possible ground surface and maximize infiltration. An illustrated schematic of the greenway system is provided on the following page.

As shown in the following graphic, the greenways are wide vegetated channels containing a variety of plant species. The low maintenance dry-mesic meadow seed mixture used throughout much of the greenway system is listed in the table below. In addition to these grasses, random clusters of native tree and shrub species were planted to provide habitat diversity and aesthetic value.



Schematic of greenway system, showing flat greenway base and infiltration trenches located on side-slopes

Greenway Meadow Seed Mixture	
25%	Canada blue grass
25%	Creeping red fescue
25%	Perennial ryegrass
10%	Red clover
10%	Black-eyed susan
5%	New England aster

The bottom layer of the greenways have a 300 mm thick sand layer covered with topsoil. The sand layer is used to prevent fine sediments from accumulating in the native gravel soils. If needed, the sand layer can be removed and new material added to improve infiltration rates within the subdivision.

The greenways at Westminster Woods were designed to infiltrate up to a 100 year storm event. The typical drawdown time for rainwater in the greenway is approximately 3 days (depending upon antecedent conditions). To facilitate infiltration during larger rainfall events, infiltration trenches were dug parallel to the greenway (along each side).

The greenways also act as a means of conveyance in the event of intense rainfall events. The greenways are slightly sloped towards a central floodway. The central floodway can handle a regional storm rainfall event, using overland flow to convey stormwater to the Hanlon Creek.

Stormwater Pre-treatment

In addition to the use of a sand layer on the bottom of the greenways to trap sediment a pre-treatment method is utilized at the subdivision. Prior to discharging stormwater to the greenways, stormwater is pre-treated by means of oil & grit separator units (OGS).

For larger catchments, forebays were installed at the storm sewer outfalls to trap additional sediment.



Manhole cover on Stormceptor oil & grit separator

One of the premier design features of the greenway system is its integration with passive recreation features within the community. A walking trail runs parallel to the network of greenways throughout Westminster Woods West, providing opportunities for residents to walk along the heavily vegetated corridors. Other amenities, like playgrounds are placed near the greenways, but are at a higher elevation for safety purposes. Houses also back onto the greenways, providing the developer the opportunity to sell premium lots.



Picture of the greenway network in Westminster Woods, showing the walking trail (left) and the greenway (right)

Utilization of Existing Site Features

Westminster Woods East utilizes a more conventional approach to stormwater management, although stormwater is still infiltrated on site. Stormwater is conveyed to a traditional stormwater management pond where suspended solids can settle. Treated stormwater is drained via a perforated riser pipe with an orifice plate.



Picture of stormwater management pond used to pre-treat stormwater prior to infiltration via kettle depressions

The stormwater drained from the ponds is discharged in kettle depressions, which existed pre-development. The use of these depressions is in keeping with the principles of LID – wherever possible, use existing site conditions to manage stormwater. This approach minimized the amount of site service work (particularly grading) required for the subdivision. It also helped to maintain water levels within the kettle.

Lot level Controls

To minimize runoff to roadways, lot level controls were implemented throughout much of the subdivision. Rear lot infiltration trenches are utilized in many areas, and were designed to infiltrate a 25 mm storm event. Runoff is further reduced by directing all eavestroughing and downspouts to discharge at the rear of the lot. By taking this approach, the designers ensured that the relatively clean roof runoff was directly infiltrated, rather than directed towards the roadways, where it would become mixed with road runoff.

Construction & Commissioning

Construction has taken place over many years, given the size of the subdivisions and the multiple developers involved. As of January 2012, construction activities are still ongoing within the Westminster community.

Ideal Site Conditions for LID

The South End subdivisions differ from many projects that are implementing LID in that the native sand and gravel soils were not an issue due to the very high infiltration rates. As such not even typical issues, like soil compaction by heavy equipment did not pose much of an issue during construction. The consultants and developers did however have to work with the site service contractors to communicate how the infiltration practices function and how to operate around them. In general, this unfamiliarity with LID did not slow down the construction schedule, but just required additional meetings and co-ordination between the various stakeholders involved.

Economics (Capital & O&M Costs)

A concern raised by one of the developers involved with the South End subdivisions was the amount of land that was required for the greenways. This land use was greater than if more conventional stormwater management methods were employed, thereby reducing the number of developable lots. One counterargument to this concern is that there are trade-offs associated with this type of development. The large greenway system created corridors of premium greenway-backing lots. The premium for these lots may often make up for the lost lots.

As part of the monitoring program, bi-annual measurements of sediment levels within the OGS units in Westminster Woods were conducted by the consultant. These observations revealed that the pre-treatment devices must be cleaned out on an approximately 4 year schedule. Although this amounts to a large number of units (approx. 15) that must be cleaned on a regular basis, the developer believed that these costs are less than if the OGS units were not in use and the sediment forebays had to be cleaned out instead. Although cost figures weren't readily available, the assumed cost savings from the use of OGS devices was based upon the ease of access (OGS units are adjacent to the subdivision roadways) and do not require the use of heavy equipment and skilled persons to conduct the operation.

Operations & Maintenance

Maintenance is a common concern expressed by municipalities considering implementing LID in residential settings. These concerns typically include questions such as: 'who is responsible for maintenance?', and 'what if the practices are not maintained?'. One potential way of addressing these

questions is through the formation of a condominium corporation to maintain the common elements – including the LID practices. This is the case in the Westminster Woods development – all units, even those that are single-detached private households pay a monthly condominium fee, which pays for maintenance of the common elements, pedestrian walkways, and general landscaping of the greenways. The stormwater management features are still owned by the City, and the ultimate responsibility for maintenance rests with them, but the aesthetics and long-term performance of the greenways are maintained by trash removal, weeding and mowing performed by a landscaping firm hired through funds managed by the condominium corporation.

Both the developers and the City have expressed satisfaction with this arrangement. For the developer, it permits them to provide a greater level of maintenance (i.e., trash removal, frequency of grass cutting, weeding, etc.) than that if the property was managed to City standards. For the City, it provides them with reassurance that potential issues with the greenway system will likely be identified more quickly, and that any costs associated with addressing those issues will be borne by the condominium corporation and not the City.

To ensure the continued successful operation of the greenway system, consultants for one of the developers provided a list of maintenance activities to the City. These maintenance activities are applicable to most LID practices, and are highly recommended:

- Monitor the conditions of LID practice(s) [the greenway system], paying close attention to areas where decreased infiltration rates are observed.
- Monitor levels of sediment accumulation in LID practice(s) and pre-treatment facilities (OGS units, forebays, etc.) and schedule cleanouts of these facilities as required.
- Perform regular landscape maintenance activities, and instruct maintenance crews to control weed proliferation and replace dead/dying plants and trees.

Long Term Performance

Minimal Groundwater Quality Impacts

As part of ensuring the safety of Guelph's groundwater supply, infiltrating high quality stormwater was one of the major goals of the development. Collection of samples from monitoring wells spread throughout the site revealed that for many of the water quality parameters, this target was achieved. Although higher

than the ODWS limit, nitrate concentrations throughout the shallow aquifer system showed a decreasing trend over the years, which was attributed to conversion of the land use from agricultural to residential. Some other water quality parameters, like dissolved organic carbon, hardness, iron, and manganese were higher than the maximum permitted concentrations, but these concentrations were present prior to development.

Groundwater monitoring yielded mixed results on chloride concentrations (associated with roadway salting). The majority of monitoring wells showed steady chloride concentrations over the monitoring period, although one monitoring well experienced a significant increase, from 84 mg/L in 2007 to 220 mg/L in 2008. This well was located near Claire Rd. E., a major municipal road. Other monitoring wells also experienced increasing chloride levels, although most were still below the ODWS. It is recommended that the City review its road salting program and reduce oversalting (if present), as a means of addressing this issue.

Variations in Infiltration Rates over Time

Surface water and groundwater monitoring also revealed the impact of the groundwater table on the performance of the infiltration practices. The large majority of the greenway system has had no issues with slow infiltration rates or ponding. However, one section of the greenway did experience ponding due to the presence of an elevated groundwater table in the area.



Portion of greenway affected by high groundwater table

As seen in the above picture, the original meadow grasses and plantings have been replaced by more wetland species, including cattails.

These observations stress the importance of conducting geotechnical studies in the planning stages to ensure that LID practices are placed in the appropriate location ensuring a minimum 1 metre distance between the bottom of the LID underdrain and the water table.

Despite the ponding issue, the City of Guelph has received very few complaints from residents. Engineering staff with the City estimate that roughly four complaints are received per year, a minimal number given the large number of houses spread across three subdivisions that back onto the greenway.

Greenway Encroachment & Private Property Issues

Several instances of encroachment upon the greenway space have been observed following construction. For instance, in the image below, of the greenway is used for storage. Other incidences reported include the placement of sod on the greenway adjacent to private property, establishment of vegetable gardens and dumping of yard wastes.



Example of homeowner encroachment upon greenway

Another type of encroachment experienced with this subdivision is homeowners digging up some or all of the rear yard infiltration trenches while installing a garden or other feature. As this occurs on private property the City of Guelph has not intervened to prevent this from occurring, nor has it required homeowners who have dug up the trench to replace it. One reason why this has occurred is that homeowners may not be aware of the presence of these practices within their backyards and do not know what purpose they serve.

To help address this knowledge gap, the city and developer of Westminster Woods partnered together to develop a *Homeowners Environmental Stewardship Manual*, which was provided to each original purchaser in the development. Unfamiliarity with the current state of the rear-lot infiltration practices may be due to new purchasers (who were not made aware of the trenches), or existing homeowners, who did not read the original educational materials. It is recommended that municipalities and/or other environmental organizations partner to better educate homeowners on the presence of any stormwater management practices

on their property, and provide instructions on how to protect and maintain them.

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Disclaimer: City of Guelph will not be responsible for any risk, loss and claim from the accuracy, correctness, completeness or use of any of the information included in the case study and report.

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