# Applied Stormwater Management Workshop

## Participants Report


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## Introduction

Changes in the amounts and intensity of precipitation associated with climate change in conjunction with problems associated with aging infrastructure and an ever expanding area of impervious surfaces in most cities make managing stormwater a critical issue. Environment Canada climate change models predict that Halifax Regional Municipality (HRM) will see a 12% increase in precipitation and an increase in rainfall intensity within the next 80 years[1]. The Climate Change Risk Management Strategy for HRM states the anticipated impacts of more frequent and severe extreme precipitation events include 1) possible increased incidents of storm sewers and sanitary systems unable to deal with more frequent, high-intensity rainfall and storms, 2) projected increased insurance costs associated with damage to vulnerable infrastructure and buildings; and 3) potential for increased incidents of aquatic pollution associated with runoff and flooding[1]. These impacts are felt primarily in urban landscapes where the high area of impervious surface cover reduces potential for infiltration, evaporation, evapotranspiration and groundwater recharge and greatly increases the volume, velocity and pollutant load of surface runoff.

The purpose of this workshop was to raise awareness on issues associated with stormwater and innovative Low Impact Development techniques that can be applied to mitigate these impacts for new and existing developments. The workshop was an excellent opportunity to bring people from various backgrounds together to network, talk about issues, share information and knowledge and discuss what is needed to improve stormwater management in HRM. All workshop presentations are available online at: http://www.ecologyaction.ca/content/stormwater-workshop-presentations-march-2012

The workshop was hosted by the Ecology Action Centre (EAC), Halifax Regional Municipality (HRM) Department of Energy and Environment, Halifax Water and Insurance Bureau of Canada- Atlantic (IBC) and funded by Nova Scotia Environment's Climate Change Adaptation Fund. The EAC has worked towards sustainability for Nova Scotia's communities and environment for 40 years with a reputation of offering well–researched, cost-effective, solutions to environmental challenges facing Nova Scotia's communities. The EAC has been involved in many research and capacity building projects, both with community partners and in collaboration with government and academic institutions. We have considerable expertise in climate change adaptation research and education. Community engagement for climate change adaptation is a strong component of our coastal, water, energy, forestry, and food security initiatives.

The Department of Energy and Environment is the organizational lead for environmental sustainability at HRM. Halifax Water is responsible for municipal water, wastewater and stormwater infrastructure in HRM. IBC is the national industry association representing Canada's private home, car and business insurers. IBC is well aware of the costly effects of severe weather events, and are actively engaged in developing, promoting and implementing adaption measures for homeowners and municipalities.

## Workshop Overview

A 1 ½ day workshop on stormwater management issues and solutions was held at Dalhousie University of February 20-21. Fourty-four participants attended the workshop including municipal planners, engineers, provincial government representatives, consultants and environmental organizations (See Appendix I – Workshop Participants). The workshop included presentations, an interactive stormwater scenario exercise designed to increase capacity of workshop participants to identify and implement stormwater Best Management Practices (BMPs) to reduce infrastructure damage, flooding and impacts to marine and freshwater systems and a half day field trip.

The morning portion of the workshop included presentations on issues associated with stormwater runoff and changing weather patterns, followed by presentations on innovative stormwater management practices which included examples of projects that have incorporated Low Impact Development in Canada and beyond (See Appendix II - Workshop Agenda). All workshop presentations are available on-line at [http://www.ecologyaction.ca/content/stormwater-workshop-presentations-march-2012](http://www.ecologyaction.ca/content/stormwater-workshop-presentations-march-2012) . Presentations included:

- John Sheppard, Director, Environmental Services - Halifax Water - “Introduction to Stormwater Management in Halifax Regional Municipality”
- Bill Adams, Vice President – Insurance Bureau of Canada Atlantic - “The Costs and Impacts of Storm Events on Homeowners and Municipalities”
- Paul Morgan, Senior Planner - Halifax Regional Municipality – “Halifax Regional Municipality: Stormwater Policy and Initiatives”
- Jeff Pinhey, Engineer - ABLE Engineering - “Reducing Runoff, Restoring Recharge”
- Jiri Marsalek, Emeritus Scientist, Water Science and Technology Directorate - Environment Canada, Burlington, Ontario - “Municipal Stormwater Management: 40 Years of Experience and Still Learning”

The workshop participants took part in a stormwater scenario exercise during the afternoon. The purpose of this exercise was to allow participants to practice selecting appropriate BMPs to improve stormwater management on an individual property and neighbourhood scale. The participants were divided into four groups and assigned to work on one of two different scenarios. The participants were encouraged to identify opportunities to reduce the velocity, volume and pollutant load of runoff on their site by reducing impervious surface area, selecting tools to allow water to infiltrate into the ground and promoting water capture and reuse. Each group was given a large map of their site, smaller additional site photos, a write-up describing the site and various water issues being impacting the area, a table describing of stormwater BMPs and tracing paper (See stormwater scenario materials in Appendix III).

The groups each had 45 minutes to work through the exercise and select appropriate BMPs that could be implemented on their site. A handout describing several stormwater BMPs was provided to each group (Appendix IV).The groups drew various BMPs on the site map using tracing paper and then reported their design plans back to the larger group. A large group discussion, facilitated by Dr. Jiri Marsalek, was then held to compare results and explore alternative solutions. This presented an excellent opportunity for participants to learn from each other’s experience as well as receive feedback on their design ideas from a national stormwater expert.

The workshop ended with an hour for participants to view display booths showcasing various rainwater harvesting and stormwater management treatment technologies. Booths were displayed from the following Halifax-based companies:

- Grun-Sol Technologies (rainwater harvesting, gray and black water recycling)
- Soleno (Stormwater collection, storage, treatment)
- Shaw Group (Stormwater treatment)
- EMCO Ltd (Stormwater treatment)

A half day field trip was offered on the morning of February 21st to discuss appropriate BMPs and retrofit options for three sites currently being considered as future stormwater management demonstration sites in Halifax. Sites visited were the George Dixon Community Centre, University Avenue Fire Station and Duffus Street Fire Station. Guided by leading Canadian stormwater expert, Dr. Jiri Marsalek, the field trip identified site-specific bioretention and rainwater capture and storage solutions to reduce stormwater runoff volume, rate and pollutant load. This was a unique and interactive learning opportunity for participants and provided valuable ideas that were incorporated into our demonstration site design plans.

## Workshop Content

**Key Points on Issues Associated with Stormwater Management:**
Summary from John Sheppard (Halifax Water) and Bill Adams (IBC) presentations

- We are experiencing more intense and frequent precipitation events due to climate change
- Nova Scotia's coast and water resources (including residential, municipal, and industrial infrastructure) are increasingly vulnerable to extreme weather impacts.
- Development and land use patterns (increased impervious surface area coverage) are changing peak volume, speed and quality of runoff.
- Old development patterns led to encroachment and loss of natural water filtering/storage systems (floodplain and wetlands). These valuable systems capture and gradually release runoff.
- Impacts include flooding, erosion, degradation of receiving water bodies, higher costs, risks to human health and safety, prevention of groundwater recharge.
- Impacts of thermal water pollution also need to be considered
- Older areas of Halifax and Dartmouth (pre-1960’s) are treated by combined sewer systems
- Stormwater entering wastewater systems is a serious operational and maintenance issue that leads to sewage overflows, basement backups, washout of treatment processes
- Halifax Water leads investigation and assessment to increase compliance
- Old infrastructure/past standards do not meet reality of today’s weather
- Inadequate investment to upgrade infrastructure.
- National municipal water supply, wastewater and stormwater system deficit stands at $31 billion for existing infrastructure, with new needs estimated at almost $57 billion ($88 billion total)
- Several different regulators are involved. Nova Scotia Environment regulates freshwater environments, Department of Fisheries and Oceans regulates marine environment
- Across Canada, extreme weather has replaced fire as the highest cost of insurance payouts. Water related damage (mostly basement flooding and sewage backups caused by increasingly intense and unpredictable precipitation) costs the insurance industry 1.2 billion dollars annually in insurance payouts.

- These costs are rising quickly. In Atlantic Canada, home insurance claims resulting from water damage, increased by 143% between 2005 and 2009**.**
- Consumer awareness is an issue. Many people do not know what their policy covers.
- Adaptation is local. Individuals can make a difference.

**Key Points on HRM Stormwater Policy and Initiatives:**
Summary from Paul Morgan (HRM) presentation

- HRM Regional Plan requires watershed studies prior to secondary planning strategies for new communities
- Watershed studies will:
  - recommend water quality objectives for key watercourses
  - determine assimilative capacity and areas suitable/not suitable for development
  - recommend stormwater management measures, regulatory controls
  - recommend water quality monitoring plan
- Example was given of Bedford West Secondary Planning Strategy which includes 3 components: Environmental Protection, Municipal Services and Land Use. Stormwater management plans fall under Environmental Protection, along with preservation of Environmentally Significant Areas and watercourse setbacks and tree replanting program
- Stormwater Management Functional Plan is required by Regional Plan – objective is to determine appropriate measures to improve quality of stormwater into natural receiving waters and reduce peak discharges
- A stormwater management and lot-grading by-law is being prepared for approval by HRM

**Key Points on Innovative Stormwater Management Approaches:**
Summary from Jeff Pinhey (ABLE Engineering) and Jiri Marsalek (Environment Canada) presentations

Key Concepts:

- Watersheds include land (forests, fields, urban/rural developed areas), not just streams, rivers and lakes. Any activity on land will impact how runoff through the environment and contaminants enter the water from many sources.
- Innovative stormwater management approaches aim to keep it simple. Look for opportunities for multiple gains and simple approaches rather than a giant solution. Favour passive, low energy solutions.
- Our biggest gains come from mimicking natural functions, i.e. working with gravity (grading, sloping) of land using, natural drainage paths and land features that already slow water or retain water (wetlands, floodplains). Allow ecology of the land to determine what development should take place (theory of ecological determinism)
- Investigation and assessment
- Pre-development conditions determines how we should develop
- Stormwater management solutions are site specific
- Geology matters. Consider soil type, bedrock depth when selecting appropriate BMPs.

Key Approaches:

- Stormwater management starts with good planning
- Reducing runoff volume commonly looks for opportunities to increase infiltration, increase storage and slow peak flows. ( I.e., Slow it, spread it, sink it)
- Enhancing runoff quality commonly uses settling, filtration, vegetation measures, or a combination of practices where possible.
- Runoff can be viewed as either a resource (chronic events can be source of water to reuse)or hazard (catastrophic, intense rainfall events lead to flooding)
- Sites should be designed to have same pre and post peak flow and volume of runoff for the chronic storms
- 3 tiers of stormwater management - on-site, neighborhood level and watershed level
- On-site measures attempt to:
    - reduce directly connected impervious areas,
    - divert runoff from impervious to pervious
    - increase water storage and reuse.
- Neighbourhood measures attempt to:
    - Reduce impervious surfaces, avoid curb & gutter street design
    - Compact stormwater treatment devices
    - Stormwater ponds and wetlands
    - Parking lots with pervious pavement
    - Source controls (street sweeping, reduce road salting, contaminants retention, restoration of contaminated areas)
- Watershed measures attempt to:
    - Establish riparian buffer zones
    - Provide passive or active treatment for all stormwater
    - Designate and maintain temporal flood waters storage areas
    - Maintain natural stream channels
- Policy (non-structural) measures are an important component
- To sustain benefits, monitoring and maintenance are needed
- Education and incentives
- Importance of watershed planning – cumulative impacts

Considerations:

- Water Balance over different timescales
- Green field developments (GFD) vs. retrofit developments GFD have space for SW BMPs and costs covered by new homeowners. Retrofits have more space and financial constraints. Focus depends on rate of municipal growth. GFD important in areas that are growing, retrofits important in areas that are shrinking.
- Residential features need to be dovetailed with education and consideration of practicality (climatic conditions, expense)
- Seasonal changes of rain events

## Stormwater Scenario Exercise Summary

### Scenario One: Cattail Lake


**Site Description:**

- Suburban lakeside development with many new homes, a school and a community centre recently constructed
- Untreated stormwater enters into the lake
- Algal blooms have been occurring over the past several years
- The large parking lot frequently floods
- A recently introduced 'Stormwater Surcharge' has motivated homeowners to reduce imperviousness and runoff in the neighbourhood

**Options presented by groups to improve stormwater management on-site:**

To reduce runoff leaving homes/streets:

- Plant trees on front lawns
- Reduce driveway imperviousness by using pervious materials or narrowing width
- Remove or create cuts in curbs to allow runoff from road to enter bioswales
- Vegetative island in centre of cul-de-sac and street intersections. Regrade so runoff flows to centre area
- Encourage homeowners to install of rainbarrels and raingardens
- Green roof and rainwater harvesting system for school or community centre
- Disconnect downspouts and direct runoff toward infiltration trench

To reduce parking lot flooding:

- Use permeable pavement on large parking lot, or reduce size of parking lot
- Create underground storage beneath parking lot

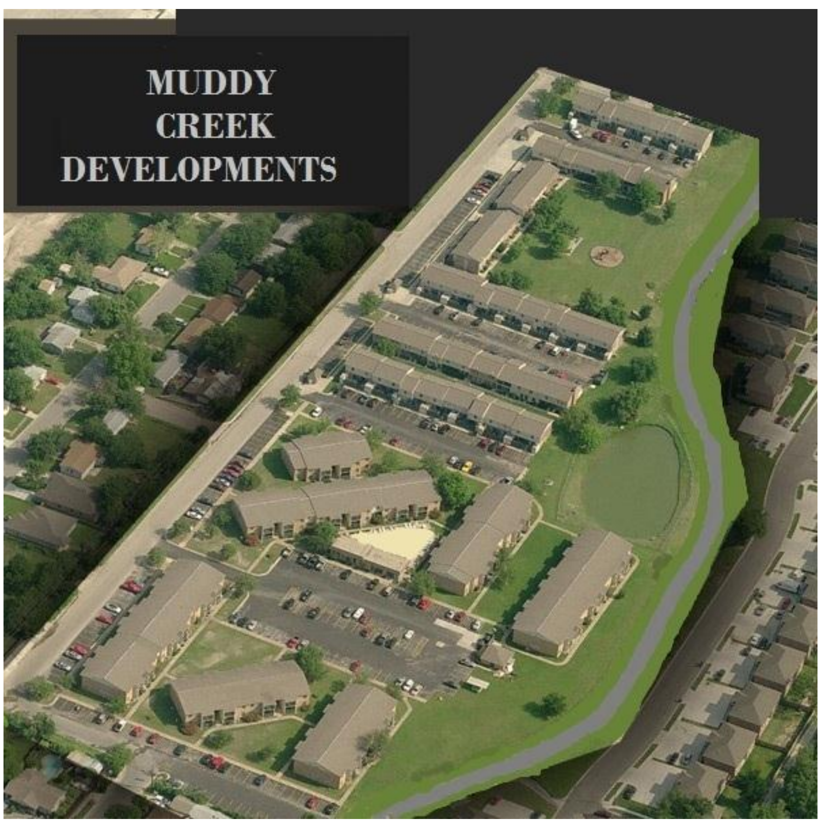
To improve water quality in lake:

- Engineered wetland between parking lot and lake
- Storm septor at outfall to treat stormwater
- Install hypolimnion aerator to improve oxygen flow
- Native species planted along shoreline

Non-structural BMPs:

- Homeowner education program to encourage use of native plants, riparian zone planting, organic fertilizers, reduce pet waste
- School outreach program
- Use phased approach beginning with education (phase I), consultation with others and work in common areas, ie. Wetland for parking lot runoff (phase II), engage residents around entire lake and encourage more individual actions (phase III)

**Scenario Two: Muddy Creek Developments**




**Site Description:**

- Muddy Creek Developments consists of rows of apartments and townhouses with ample parking, landscaped green space, paved bike trail and interest to plant a community garden
- Unfiltered stormwater enters the small pond and growing algal blooms are a concern for residence

- Water has been collecting between the rows of apartments and a few homes are experiencing basement flooding following heavy rain events

**Options presented by groups to improve stormwater management on site:**

To reduce flooding on site:

- Lot grading away from building and toward pond to reduce basement flooding
- Runoff from roof drains collected in Z-boxes
- Daylight downspouts
- Install french drains
- Use rainbarrels to collect rooftop runoff
- Reduce parking surface area and add swales or bioretention area in the middle of the lot, or remove curb and create a bioswale along edge of parking lot
- Undulate surface of parking lot

To improve water quality of pond:

- Plant vegetation along shore of pond (create riparian buffer) to increase nutrient uptake, improve habitat
- Add stormwater septor/ oil grit separator to treat runoff and ensure proper maintenance

Other non-structural BMPs:

- Create community association to manage, maintain systems and create policies to reduce pesticides and pet waste

## Field Trip Overview: Stormwater Demonstration Site Preliminary Assessments

During Spring/Summer 2012, the EAC, in partnership with HRM, Halifax Water and IBC, will be constructing a stormwater management demonstration site to improve capacity of developers, the planning community and the general public to identify and implement site appropriate stormwater management techniques. The stormwater demonstration sites will showcase a range of innovative stormwater BMPs to reduce infrastructure problems caused by flooding and heavy rainfall including downspout disconnection, water capture and storage, rainwater harvesting, permeable pavement and bioretention. Three candidate demonstration sites are being considered:

- University Avenue Fire Station
- Duffus Street Fire Station
- George Dixon Community Centre

The field trip was an opportunity to conduct a preliminary assessment of our three candidate sites with stormwater expert, Dr. Jiri Marsalek. This exercise generated several ideas that are contributing to the development of site retrofit design plans. A detailed site description and summary of Dr. Marsalek's comments are included below. Videos of the site assessments are posted on the Ecology Action Centre's stormwater management blog –www.stormwatercentral.ca.

## Candidate Demonstration Site Descriptions

### Site: George Dixon Community Centre
2502 Brunswick Street


**Site description:**

This community centre is located in Halifax's North End. The building has a gymnasium, pottery room, rental spaces and offices. The community is connected to the building and there is high walking traffic through the park. This large site has a significant area coverage of both pervious (lawn and small planted garden) and impervious (paved paths, parking lot, rooftop, water park) areas. The steeply sloping and terraced grounds contain 4-5 distinct levels that contain a basketball court, playground and small water park. There are plans to construct a community garden this summer.

The community centre building has a large flat roof. Runoff is collected on the roof and enters into the building through internal spouts. The building has no eavestroughs or downspouts. The large parking lot is curbed and has one catchbasin. Several asphalt pathways exist on the site and the site is serviced by combined sewer systems.

BMPs that will likely be demonstrated on this site are bioretention, water capture and reuse, lot grading and tree planting.

**Comments from site assessment with Dr. Jiri Marsalek:**

- Theoretical annual runoff could be 20,000 $m^3$

- Work with the terracing theme that already exists. Additional terraces could be added.
- Terracing and steep slopes may indicate presence of rock or bedrock (soil infiltration opportunities may be limited)
- Options to enhance soil storage of water exist
- Opportunities for several water features (pond, fountain) exist, but may need treatment if used for recreational purposes (wading pool)
- Opportunities exist for water capture and reuse (irrigation of community garden)
- Paved paths that run through the path will contribute to generation of runoff. Could be reduced by discharging runoff onto neighbouring pervious surfaces (ie. crowning) or regarding the surface so water quickly leaves path.
- Could use weir rings on rooftop inlets to slow inflow of water and increase evaporation
- Add trees and shrubs to increase evapotranspiration and rainfall interception

## Site: University Avenue Firehall
**5988 University Avenue**

Photo: www.halifax.ca/fire/images/station_2.jpg

**Site description:**
This centrally located fire station is located adjacent to Dalhousie University and the IWK Health Centre. The area is highly urbanized with limited pervious cover. The large building is surrounded by paved sidewalks, roads and has a gravel parking lot and is serviced by combined sewer systems. There are raised garden beds around one side of the building. Runoff is collected from the large roof into several downspouts which are connected to the building’s internal piping. Opportunities exist to disconnect the downspouts and allow for water infiltration or storage.

The land is graded toward the building on one side. There is one stormwater inlet at the low point of the sloping side the building. The gravel parking lot at the back of the building may be larger than necessary as there only appears to be two rows of parking. Downsizing the parking lot could provide additional space for water infiltration or storage opportunities.

The area has high foot traffic and could be a highly visible location for a demonstration site. The site resembles a house, so retrofit options can be transferrable to homeowners and developers. BMPs considered for this site are bioretention, permeable pavement, downspout disconnection, water capture and reuse.

**Comments from site assessment with Dr. Jiri Marsalek:**

- Site is approximately 1000m2, and is nearly 100% impervious
- Theoretical annual rainfall runoff~1000$m^3$
- Solutions are somewhat limited on such small parcel or land, perhaps could explore collaboration with neighbouring IWK garden (directly across the road) i.e. Add water feature/fountain, irrigation for garden
- Concrete at front of building is necessary for firetrucks, but runoff could be intercepted using a grated drainage channel. This would divert runoff to either side of the building
- Could increase storage on sloping side of building (ie. Large planter box –box could have two levels one for vegetation (evapotranspiration) and one for storage and reuse). Water from storage would slowly be released to reduce peak flow discharge
- Imperviousness of parking lot could be improved. Current gravel parking lot is highly compacted
- Water could be captured and reused for washing fire trucks, garden irrigation or potentially as a pickup location for HRM water trucks.

## Site: Duffus Street Fire Station

**5830 Duffus Street**


**Site description:**

The fire station is located beside a school in a residential area of Halifax. There is a considerable amount of lawn space and including some landscaped gardens exist at the front of the building. There is a large amount of impervious area including concrete pathways and a large parking area.  The back of building is mostly paved.

The firehall has a large flat roof. Runoff is collected on the roof and enters into the building through internal spouts. There are no eavestroughs or downspouts. This area is serviced by combined sewer systems.

**Comments from site assessment with Dr. Jiri Marsalek:**
-Site is an example of poor stormwater management planning. (Angular lot with excessively large driveway)
- Gardens, increased vegetation and bioretention areas could be added to slow runoff and beautify grounds
- Firefighter monument could be highlighted and enhanced with more vegetation
- Replace access driveway with more pervious surface. Could also be sloped to bring more runoff toward newly created pervious areas
- Add weir rings on rooftop inlets to slow inflow and keep layer of water on roof surface for evaporation

## Next Steps

The Ecology Action Centre, along with project partners HRM, Halifax Water and IBC will be leading the construction of two stormwater demonstration sites in HRM, the first in Nova Scotia. During the Spring/Summer of 2012, the University Avenue Fire Station and the George Dixon Community Centre will be retrofit with a range of stormwater BMPs. The sites will become valuable long-term education tools and will allow a wide audience to learn about innovative stormwater management techniques and see them being applied. The George Dixon Community Centre will showcase water capture and reuse tools, tree planting and other landscape based approaches to improving stormwater management. The more urbanized University Avenue Fire Station will demonstrate water capture and reuse methods, bioretention and improved permeability of the site's compacted gravel parking lot. The diversity of these two sites will highlight a range of tools that can be transferrable to different locations and building types. The retrofit process will be documented and shared on our blog (www.stormwatercentral) to build capacity and encourage others to implement Low Impact Development techniques to reduce flooding, infrastructure damage and degradation of water quality regionally. A public event and site tours will be organized to celebrate the launch of Nova Scotia's first stormwater management demonstration sites. Workshop participants will be invited to this event.

## Other upcoming Items of Interest

**Urban Wetlands Restoration Course: April 30- May 2. Register by April 16th.**

The Fern Hill Institute for Plant Conservation, in collaboration with the Nova Scotia Department of Environment, is organizing a wetland restoration training course bringing the expertise of Kevin L. Erwin, Consulting Ecologist Inc., to bear on the local situation. A steady loss of wetland, wetland function and infiltration capacity has accompanied growth and development in most municipalities around the province. This three day Urban Wetland Restoration course will teach participants how to begin to reverse this trend. A day of classroom lecture and discussion with wetland guru, Kevin Erwin, and local ecologists will instill the theory and practice of wetland restoration. Lectures are based on case study of local, Canadian and international examples. Two days of field trips throughout HRM will demonstrate restoration opportunities and techniques. For more information visit: http://fernhillns.ca/fernhillnsWP/

**Water Strategy Implementation Workshop**

Members of the Nova Scotia Environmental Network, along with Nova Scotia Department of Environment, will be holding a workshop on the implementation of the provincial Water Strategy in May. More details on this event will be posted on www.nsen.ca

**References:**

**1.** Halifax Regional Municipality. (2007). Climate SMART: Climate Change Risk Management Strategy for Halifax Regional Municipality. Halifax Regional Municipality, Government of Canada, Governt of Nova Scotia, Federation of Canadian Municipalities, Dillon Consulting, de Romilly & de Romilly, Ltd., ClimAdapt network. Halifax, NS.

## Appendix I: Workshop Participants

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## Appendix II: Applied Stormwater Management Workshop Agenda

Room 307 Student Union Building, Dalhousie University
February 20th, 2012

| Time | Activity | Presenter |
|---|---|---|
| 8:30 | Welcome and overview of day | Ashley Sprague, EAC |
| 9:00 | Introduction to Stormwater Management in HRM | John Sheppard, Halifax Water |
| 9:30 | Costs and Impacts of Storm Events to Homeowners and Municipalities | Bill Adams, IBC |
| 10:00 | Summary and Discussion | Jennifer Graham, EAC |
| 10:15 | Break | |
| 10:30 | Stormwater policy and initiatives in HRM | Paul Morgan, HRM |
| 11:00 | Innovative stormwater management: Examples in HRM | Jeff Pinhey, ABLE Engineering |
| 11:30 | Municipal Stormwater Management and Low Impact Development | Jiri Marsalek, Environment Canada |
| 12:15 | Lunch | |
| 1:15 | Stormwater Scenario Exercise: Introduction | Ashley Sprague, EAC |
| 1:45 | Stormwater Scenario Exercise: Group Work | All participants |
| 2:30 | Break | |
| 2:45 | Stormwater Scenario Exercise: Presentations and Facilitated Discussion | Jiri Marsalek, Environment Canada |
| 3:30 | Wrap Up, Evaluations | |
| 4:00 | Visit Display Booths | |
| 5:00 | End | |

Tuesday, Feb 21: Field Trip: Assessment of Potential Retrofit Sites with Dr. Jiri Marsalek

8:45 - Meet outside of DAL Student Union Building

9:00-12:00 – Guided field trip to assess potential stormwater retrofit sites

Ecology Action Centre | HALIFAX Regional Municipality | NOVA SCOTIA | IBC | BAC | Halifax Water

## Appendix III: Stormwater Scenario Exercise

***Why a Stormwater Scenario Exercise***?
The participants at this workshop represent many different types of expertise and experience about stormwater management. To maximize the opportunity to learn from each other, we will be spending some time today working in groups on stormwater scenario exercises.

We are using a scenario exercise format because it allows participants to apply the concepts presented in today's workshop, as well as their own expertise to hypothetical (yet realistic) urban stormwater management situations.

The purpose of this exercise is to practice selecting appropriate Best Management Practices (BMPs) to improve stormwater management on an individual property and neighbourhood scale. Try to identify opportunities to reduce the velocity, volume and pollutant load of runoff on your site by reducing impervious surface area, selecting tools to allow water to infiltrate into the ground and capturing and reusing rainwater.

***How the activity works***
Each group will work on one of two stormwater scenarios. Your scenario, along with a description of stormwater BMPs, are included in the workshop kit. The groups will work together to answer specific questions and prepare to report back to the larger group. Each group will find more photos of their site, flip chart paper and markers to help prepare to report back to the larger group. There will be a facilitated large group discussion after the small group session, to compare results and explore alternative solutions.

***Getting started***

- Introduce yourselves to each other. Find out about the background each member brings to the group.
- Read through your group's stormwater management scenario. Ask each other or the facilitators for clarification as needed.
- Lay the clear sheet provided on top of your site map and use a marker to draw changes to your site and selected BMPs.
- Assign a note taker to record highlights from the discussion for reporting back to the larger group.
- Figure out who will present your results to the larger group.

Answer these questions, keeping in mind the particular condition of your site, as well as the need to incorporate essential stormwater management concepts:

1. What are the opportunities and challenges for improving stormwater management on your site?
2. What are the on-site retrofit locations opportunities on your site? (rooftops, parking lots, underground, streets, parks, etc.)
3. What BMPs are the most appropriate to improve stormwater management on your site? Use a minimum of 3 different tools.
4. What additional benefits will your retrofit design plan create? (i.e., habitat, aesthetic value, water reuse, etc.)

5. What maintenance considerations apply to your design plan?

During the large group discussion you will have **5 minutes** to:

- Introduce your scenario
- Describe the on-site retrofit location opportunities on your site
- Present the various BMPs you have chosen to implement in your scenario
- Explain your reasoning behind the citing of various BMPs and how they will function to reduce velocity, volume and pollutant load of stormwater runoff.

***Other tips***

- It's your site! Feel free to add relevant information about existing land use, water use, habitat value, and human activities on the property. Also, you can make assumptions about your site if you feel the scenario is incomplete. For example: the size of stormwater outflows, drainage area, presence of bedrock.
- You can use additional BMPs that are not listed in the handout (i.e., tree planting, daylighting, education and awareness tools such as brochures for homeowners).
- If helpful, use sketches or additional drawings to explain your design plan when presenting back to the large group
- If time remains, feel free to discuss costs of your design plan based on your experience

**Stormwater Scenario 1: Muddy Creek Apartment Development**

Site Description:
Muddy Creek Developments is a spacious housing complex located only 20 km outside of the urban centre of Waterville, Nova Scotia. Land use has changed quickly in this area with several new housing developments, a school, community centre, and a shopping mall constructed in the past eight years. Only 10 years ago, the area was primarily forest with some land developed for agricultural purposes.

Muddy Creek Developments offers a range apartments, townhouses and condominiums at affordable prices. Ample parking space exists for residents and their guests. Rooftop rainwater is collected into downspouts which drain onto the site. The beautifully landscaped grounds consist of large grassed areas, a small water park and playground for kids, and a pond where you can relax and watch the resident ducks swim. A paved bike trail runs adjacent to the Development. Several youth in the area have recently decided to plant a community garden.

Stormwater Runoff Concerns:
The developer has recently started receiving complaints from tenants who are concerned about the health of the pond. Over the past two summers, the usually clear water has become covered with algal blooms. Families are no longer able to enjoy this space and the beloved ducks did not return to the pond this Spring. Storm drains collect runoff from the roofs and parking lots of the site, which drain into the pond unfiltered via one stormwater outlet. Wet areas have started to develop in between the rows of apartments and a few homeowners are also experiencing basement flooding following heavy rain events.

Additional Site information:
Soil type: Well-draining loam (60% sand, 30% silt, 10% clay)
Depth of water table: 4 m

**Scenario #2: Cattail Lake**

Site Description:
Development is rapidly growing around this suburban lake. The lake is very popular for recreation purposes, with canoeing, kayaking, swimming, fishing and bird watching all taking place during the spring and summer months. A large parking lot and paved road was built to provide public access to the lake. Many new homes, a school and a community centre have been constructed in the past 15 years.

Many of the lakefront homes have removed a high percentage of the existing vegetation in order to have an unobstructed view of the lake. The use of cosmetic pesticides is common practice for many homeowners. Untreated stormwater from the developments drains into the lake unfiltered via 10 different stormwater outlets.

Stormwater Runoff Concerns:
In the past 12 years, users of the lake have reported algal blooms and eutrophication, and for the past 5 years the local beach has had to be closed on days following heavy rain events. A local residents committee was formed to raise awareness about the health of the lake. The committee began testing the lake's water quality and found high levels of phosphorous.

The site slopes toward a depression where the parking lot was constructed to provide public access to the lake. Several large pools of water form in this area following heavy rain events and accelerated shoreline erosion has been reported in this area.

The municipality has recently introduced a 'Stormwater Surcharge' and rates are based on the area of impervious surfaces in a neighbourhood. The rates can be greatly reduced if the neighbourhood can demonstrate a reduction in runoff volume through of on-site retention and reuse or a reduction of impervious surface area.

In order to address these growing concerns, a community meeting was held and several homeowners committed to making changes on their individual properties.  Residents also agreed to look for opportunities to help reduce the amount and pollutant load of runoff entering the lake in shared, public areas of the neighbourhood.

Additional Site information:
Soil type: Well-draining loam (60% sand, 30% silt, 10% clay)
Depth of water table: 4 m

**Appendix IV: Stormwater Retrofit Best Management Practices Handout**

| BMP | Description | Location possibilities | Pollutant Removal | Other benefits | Other Considerations |
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| **Detention (Dry) Ponds** | - stores runoff after a rain event for some minimum amount of time (ex. 24 hours)<br>- dry between rain events | - watershed or neighbourhood scale<br>-existing ponds<br>-roadway culverts<br>-below outfalls<br>-large parking lots | -fair removal of particulates<br>-poor removal of soluble pollutants | -flood and erosion protection of downstream channel<br>-groundwater recharge | -best used with other BMPs such as wetland or wet pond.<br>-can be designed with pool at inlet and/or outlet<br>-can be used with slopes up to 15%<br>-most soil types appropriate<br>-impermeable liner may be needed in sandy soils |
| **Retention (Wet) Ponds** | -permanent pool of standing water that temporarily holds stormwater<br>- runoff from each new storm displaces water from previous storm | - watershed or neighbourhood scale<br>-existing ponds<br>-below outfalls<br>-large parking lots | -moderate to high removal rate of all stormwater pollutants<br>-both settling and biological uptake (i.e., algae) occur | -aesthetic value (community acceptance)<br>-groundwater recharge | -need sufficient drainage area to maintain permanent pool<br>-can be used with slopes up to 15%<br>-most soil types appropriate |
| **Constructed Wetlands** | -shallow depressions that received stormwater inputs for treatment<br>- runoff from each new storm displaces water from previous storm | - watershed or neighbourhood scale<br>-existing ponds<br>-roadway culverts<br>-below outfalls<br>-large parking lots<br>-conveyance | - moderate to high removal of all stormwater pollutants<br>-range of physical (settling), biological, chemical and microbial processes | -replicate natural wetland ecosystems<br>-habitat value<br>-aesthetic value (community acceptance) | -potential to take up a lot of space (not suitable for all urban areas)<br>-need sufficient drainage area to maintain permanent pool<br>-can be used with slopes up to 15%<br>-most soil types appropriate |

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| **Filtration** | -captures and temporarily stores runoff<br>-runoff passed through an engineered filter media, collected in an underdrain and returned to storm drain system | -neighbourhood/ individual property<br>-small parking lots<br>-small, highly impervious sites | - moderate particulate pollutant removal<br>-low soluble nutrient removal<br>-mainly physical treatment (filtering, settling, straining) | -good for areas with limited space (use little surface land) | -several filter variations including surface sand filters, underground sand filters, organic media filters, multi-chamber treatment train<br>- can have two chambers, one for settling and one serves as filter bed (i.e., sand)<br>- Other engineered filtering systems exist (CDS separators, etc) |
| **Infiltration (i.e., infiltration trenches, basins)** | -shallow impoundment designed to capture and temporarily store runoff before infiltrating into soil<br>-runoff initially passes through other treatment (i.e., swale) then is stored in rock filled chamber with no outlet before infiltrating into the ground | -neighbourhood/ individual property<br>-small parking lots | -high pollutant removal<br>-most pollutants trapped by soils | -increase groundwater recharge<br>-reduce runoff volumes to prevent CSOs (runoff does not enter storm drain system) | -perforated pipe or other proprietary materials can be used instead of stone to increase storage capacity<br>-effectively used in narrow, linear areas along property boundaries<br>-soil requirements can limit applicability<br>-bottom of basin must be completely flat to ensure infiltration throughout |
| **Swales (bioswales, dry swales, grassed swales)** | -linear vegetated open channel to slow and treat runoff<br>-vegetation slows runoff allowing sedimentation<br>-do not have underground rock-filled chamber, but may require fabricated soil bed to improve filtration | -neighbourhood/ individual property<br>-small parking lots<br>-individual streets | -moderate pollutant removal through settling, filtering, infiltration and plant uptake | -groundwater recharge | -improvement over conventional roadside ditch<br>-most require widening, or deepening existing open channel<br>-can be used for conveyance, or with other BMPs (i.e., rain garden)<br>- best on slopes < 4%<br>- not well suited for highly impervious soil types |

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| **Rain Garden** | -small landscaped depressions that capture, filter and infiltrate rooftop runoff<br>-sand/soil mix planted with grasses, shrubs, plants | -neighbourhood/ individual property<br>-small parking lots<br>-rooftop runoff | --moderate pollutant removal through settling, filtering, infiltration and plant uptake | -recharge groundwater<br>-personal stewardship and increased watershed awareness<br>-habitat value<br>-aesthetic value | -allows at least 30% more water to infiltrate into the ground than conventional lawn (UWEO, 2002)<br>-need proper maintenance<br>-should be minimum of 10 ft. away from house to prevent basement flooding<br>-well drained soils work best |
| **Green Roofs** | -layer of vegetation and soil installed on conventional roof designed to store and treat runoff | -neighbourhood/ individual property<br>-commercial, industrial and residential buildings<br>-rooftop runoff | -moderate removal of nitrogen and phosphorous due to soil microbial processes and plant uptake | -increased thermal insulation and energy efficiency<br>- increased acoustic insulation<br>-increased durability and lifespan compared to conventional roofs<br>-habitat value | - extensive green roofs have < six inches of growing medium and usually have moss/grass cover (lower maintenance and cost)<br>-intensive green roofs have > 6 inches of substrate and can support wide range of plants<br>- flat roofs most common, but can be installed on 30% sloping roofs with special strapping<br>-structural analysis of roof required to meet weight bearing requirements |
| **Rain Barrel** | -stormwater collection device to capture, store and reuse runoff from rooftop downspouts | -neighbourhood/ individual property<br>-small parking lots<br>-rooftop runoff | -low<br>-designed for capture, not treatment | -water conservation through reuse (i.e., irrigation, car washing, etc.) | -should be drained and disconnected in winter months |
| **Cisterns** | - capture rooftop runoff from non-residential sites in aboveground or underground storage tanks | -neighbourhood/ individual property<br>-small parking lots<br>-rooftop runoff | - low<br>-designed for capture, not for treatment | -water conservation through reuse (i.e., irrigation, grey water, etc.) | -generally much larger than rain barrels (typical capacity of over 40,000 L) |
| **Stormwater Planters** | -confined planters that store runoff and/or | -neighbourhood/ individual property | -low-moderate removal of nitrogen and phosphorous | -aesthetic landscaping feature | - infiltration planters allow runoff to pass through the planter and |

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| | infiltrate runoff through soil bed<br>-generally receive runoff from rooftop downspouts | -small parking lots<br>-rooftop runoff | due to soil microbial processes and plant uptake | -useful in highly urban areas | into natural soil bed<br>-filter boxes does not allow infiltration into natural soil bed<br>-treat small drainage area |
| **Permeable Pavers** | -porous or semi-porous material used on driveways, parking lots and walkways to reduce and treat runoff<br>-runoff infiltrates into soil or gravel bed | -neighbourhood/ individual property<br>-small parking lots<br>-rooftop runoff | -moderate pollutant removal | -groundwater recharge<br>- aesthetic value | -can be porous asphalt or interlocking concrete blocks<br>-maintenance required to ensure pores are not clogged |
| **French Drains (Dry Wells)** | -shallow underground trench with perforated pipe along bottom<br>-runoff from rooftop leaders are directed to trench via swale or downspout | -neighbourhood/ individual property<br>-small parking lots<br>-rooftop runoff | -moderate removal of particles and soluble nutrients | | -small drainage area<br>-limited opportunities in very high density neighbourhoods<br>-do not function in winter months<br>- minimum of 10 ft. from house to prevent basement flooding<br>-<br>-regular maintenance required |

Created by Ecology Action Centre (2012), based on:

Centre for Watershed Protection. 2007.Urban Subwatershed Restoration Manual No.3: Urban Stormwater Retrofit Practices Version 1.0. (Prepared by: Tom Schueler, Hirschman,D., Novotney, M., and Zielinski, J.)

U.S. Environmental Protection Agency. National Menu of Stormwater Best Management Practices. www.cfpub.epa.gov/npdes/stormwater/menuofbmps/