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From Clouds to Streets to the Credit River: The Story of Rain Water Control and how it has Evolved in last 60 Years

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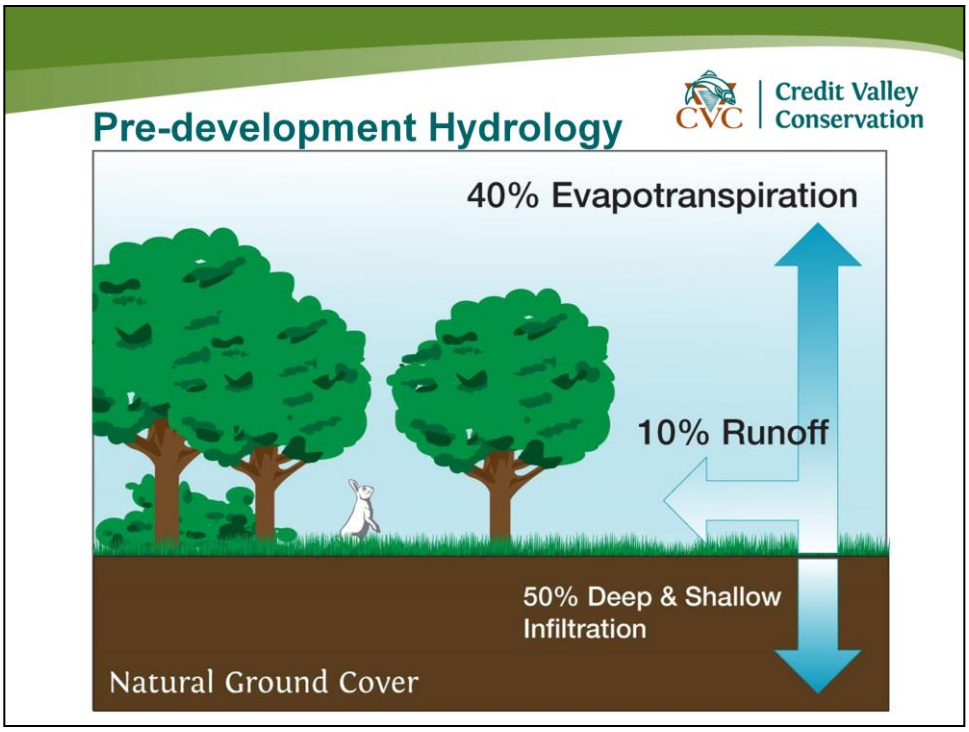
Rain Water is Stormwater and More

- Stormwater is more than just rain
- Includes water that run across impervious surfaces and into saturated soil, street curbs, storm drains, and water bodies
  - Includes pollutants, toxins, sediment
- Stormwater typically doesn't go to a water treatment plant; it enters creeks, rivers and lakes without treatment

-Here is an important understanding: rain water is stormwater.

-stormwater is any water that enters catchbasins, storm drains and water bodies. It's the runoff from rainfall events, snow melt

-Stormwater isn't bad water—its not a problem that needs to be removed from our lives, but something we need to learn to embrace and use as a resource. This hasn't always been the view though.



-A “brief” history of how rain water works in a pre-development setting.

-When it rains, the majority (50%) of the water is infiltrated into the ground. This occurs both deep and shallow. The ground naturally filters the water and becomes groundwater, which is responsible for baseflow in creeks and rivers.

-40% of the water is put back into the atmosphere through evapotranspiration—evaporation from the ground and transpiration from plants

-The remainder is considered runoff—water that is not infiltrated into the ground because the ground is already saturated with water or because its raining too intensely for it be absorbed

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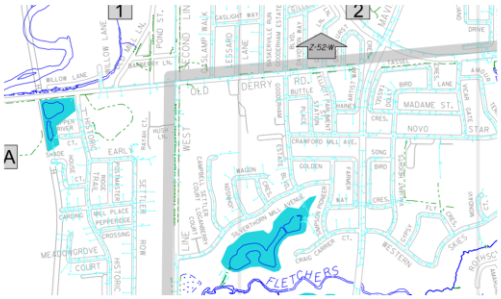
1. Storm Sewer Era (pre-1970s)

- Stormwater infrastructure is born in the post WWI era
- Catchbasins and pipes are used to direct runoff to the nearest stream (curb and gutter)
- Water bodies are seen as a place to dump what we don't want



Main concern: relocating runoff from urban areas

-One of the first eras of "urban" stormwater management was began in the post WW1 area. Stormwater infrastructure was installed to get rid of excess water in communities

-A sewer network was installed to convey stormwater to receiving water bodies, away from urban areas. This used CBs and pipes leading to the nearest stream

-Our local waterbodies were seen as outlets to simply get rid of whatever it is we don't want. It was not uncommon for trash and human waste to be added to creeks and streams.

-Slightly more modern, but this is a typical catchbasin installed in a curb and gutter drainage area.

-This is the kind of infrastructure used to accommodate frequent storm events in the range of 2 to 10 year event. This refers to the return period: the average number of years between floods of a certain size.
[a 2 year event has a 50% chance of happening in any given year; 10 year has a 10% chance…] relative to drainage area and infiltration rates

-This is a great solution but as a result, we have generated "stormwater superhighway"; hardened surfaces that have the ability to transport stormwater rapidly

Result: Flooding

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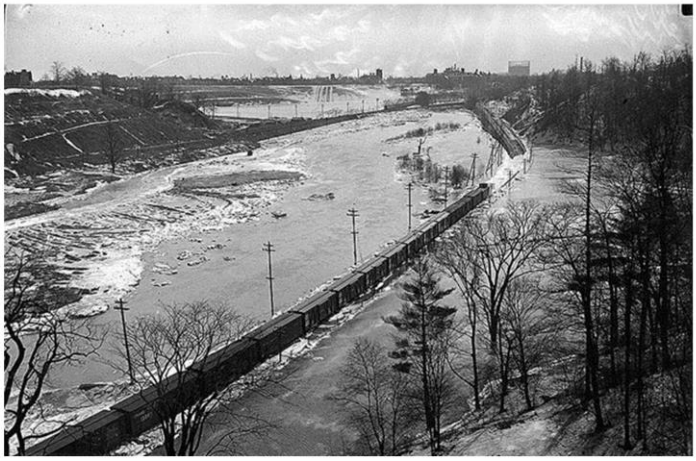
Don River, 1918



-With a growing population and an increased need for better transportation routes comes growing urban areas. This means more hardened surfaces allowing runoff to occur instead of infiltration.

-Greater flooding is experienced as a result of increased stormwater volumes and streamflows in urban areas.

[photo: Don River, Bloor Street]

Credit River, 1954

New main concern:

Getting water away from flood prone areas to protect properties from flood damage

-Hurricane Hazel struck only months after CVCA was formed. It dropped over 11 inches of rain in the Toronto area, causing $180 million in damages and claiming 81 lives.

-During less frequent event sizes, much larger storms like July 8 of last year, localized flooding still occurred and flooding was experienced in areas downstream of the sewer systems.

[a 100yr storm may not cause a 100yr flood-depends on where the rain fell in the watershed, how saturated the soil was before the storm, and the size of the watershed in relation to the storm duration]

-By now, the main concerns have shifted to getting water away from the flood prone areas to protect properties from flood damage

-We now see that the current system is not working

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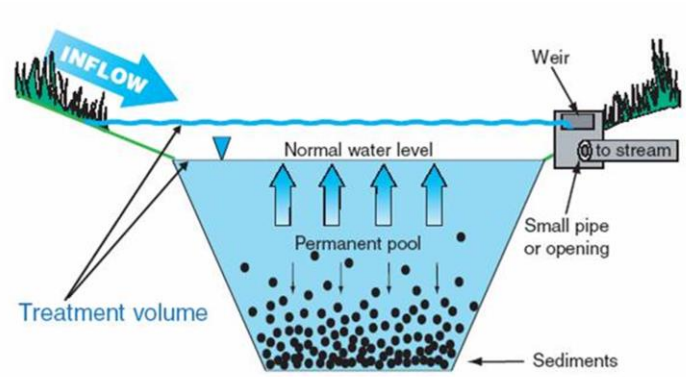
2. Stormwater Management Era (1970-1990s)

- Water is stored on-site in retention ponds (end-of-pipe facilities)
- The idea of stormwater master planning with a hydrology model
- Lots of plans but few are implemented: flood panic, to planning, to waiting for the next flood

-Increased stormwater volumes and stream flows in urban areas were controlled with stormwater management ponds. Retention ponds are built downstream of the storm sewer network, as an end of pipe treatment to hold water back. Major storm sewer systems used in roadway designs are installed to convey flows up the to 10 year storm-typically larger rainfall events, but not floods.

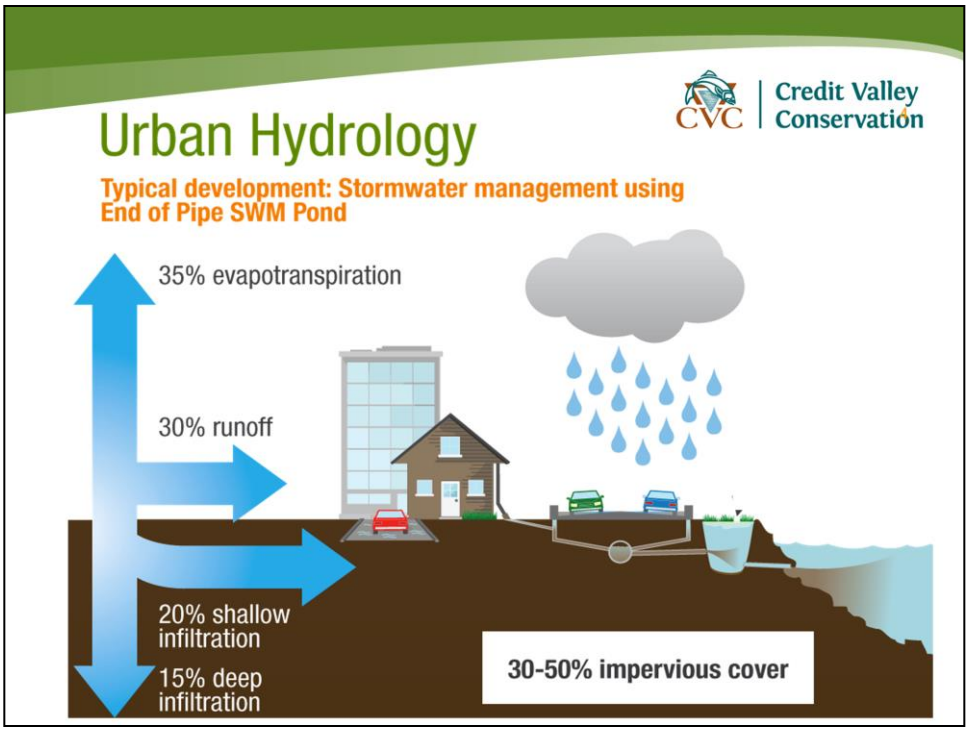
Retention Pond Design



-Basic figure

-SWM ponds were constructed with a wet component. An amount of water could be retained in the pond, letting sediment settle to the bottom that would be removed during maintenance…when it was completed!

-This only provided a limited level of quality treatment; may account for sediment removal but not contaminant removal. This reinforced the need for source and conveyance controls



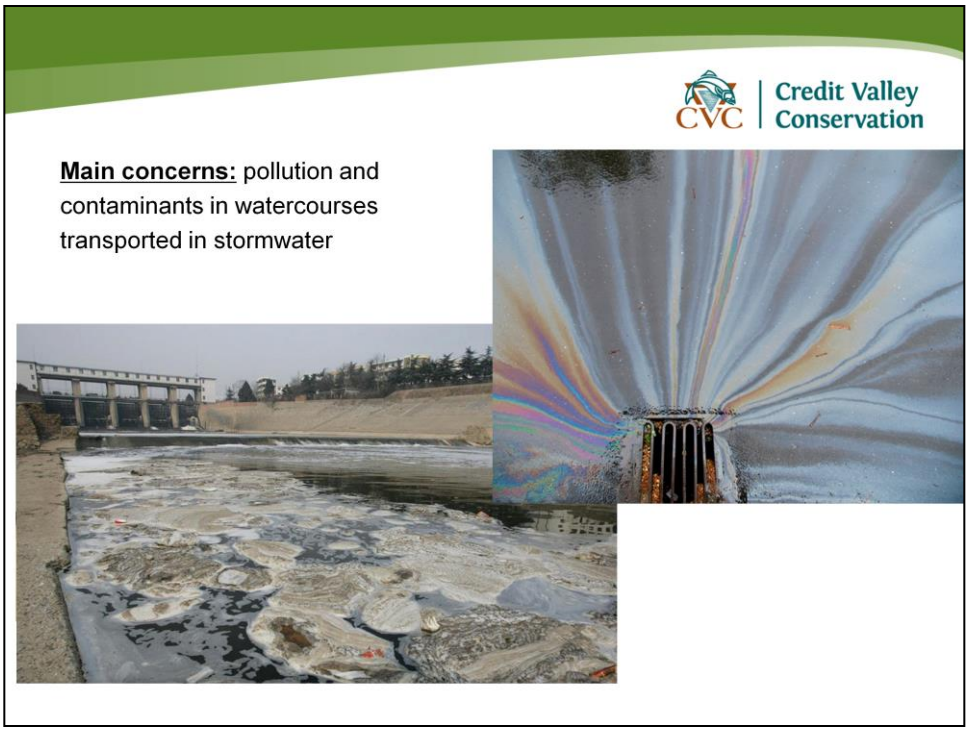
-This is what typical urban hydrology looks like. With more hardened surfaces we see:

-increased impervious cover

-reduced infiltration (50 to 35)

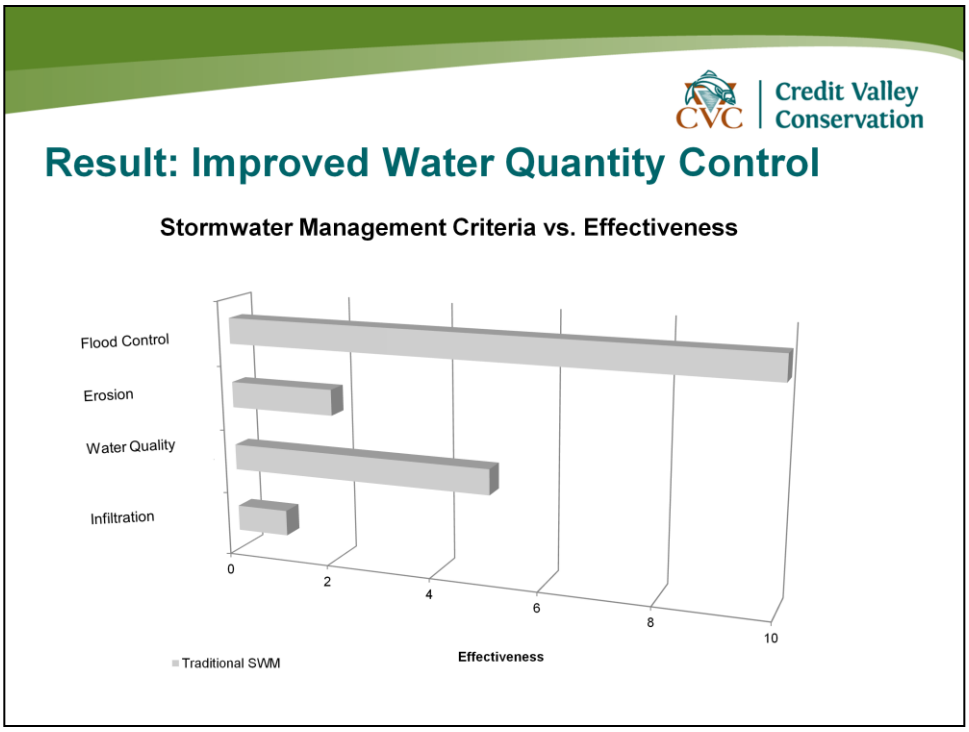
-reduced evapotranspiration (40 to 35)

-increased runoff (10 to 30)



-People often thought: “Dilution is the solution to pollution”…but sadly this isn’t the case

-Main concerns were still flooding, but now pollution and contaminants transported in SW



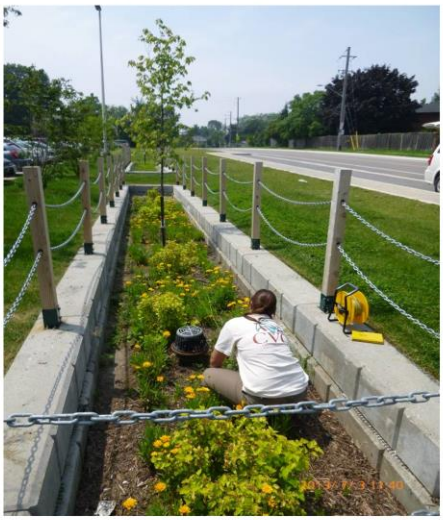
-Studies show that ponds can retain flood waters to mimic the pre-development flow rates to receiving waters effectively

….However: pre-development volume of runoff cannot be reproduced with ponds alone, and the increased runoff volume in addition to longer duration of flows entering the receiving watercourse after a storm event has resulted in significant stream erosion downstream of development.

-Looking at this graph, Traditional SWM techniques perform poorly in relation to Infiltration and Erosion criteria, moderately well in relation to Water Quality, but perform exceptionally well in the context of Flood Control criteria.

3. Urban Stormwater BMP Era (1990s-present)

- Stormwater as a valuable resource, not a problem
- Enhanced regulations and documentation for stormwater control
- Focus on source or lot level and conveyance controls through best management practices (BMP) and low impact development techniques (LID)

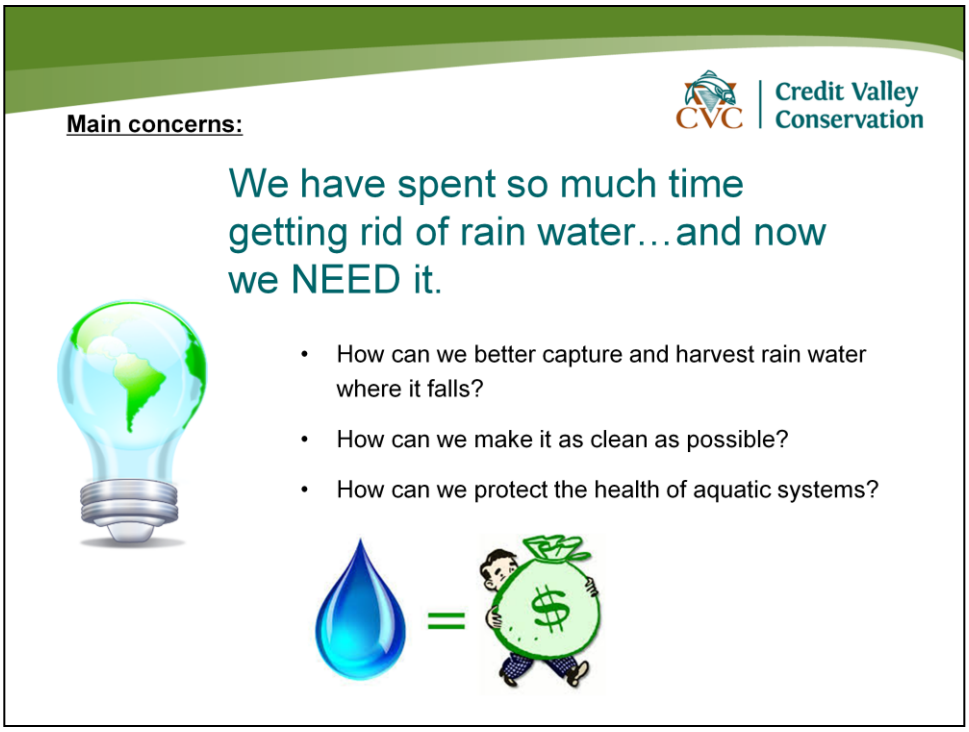


-With much concern for our polluted waterways, we now see that we haven't been doing enough.

-SWM ponds built in the 1970s-1980s did not provide water quality treatment or erosion control.

-This led to the expansion of requirements for SWM to include water quantity, quality and erosion controls and the generation of SW BMPs—focus on source or lot level controls like rain barrels and gardens and conveyance controls like grassed swales

-BMPs and LID techniques include harvesting (tanks, rain barrels), green roofs, bioretention (planters, rain gardens, tree pits), permeable pavement, riparian buffers



-Many more concerns!

-We finally realized that we have spent so much time trying to get rid of rain water when really we need it.

-**People are concerned with the effects on aquatic ecosystems, changes in the overall hydrology of urban areas (greater overland runoff volumes and reductions in evapotranspiration, infiltration and recharge to groundwater)

-Approaches to mitigate stream channel erosion were introduced to reduce the high velocity flows (ponds, infiltration trenches, underground storage…)

-**We can assign a value, a dollar sign, to water and what it means to us; impacts from flooding, impacts to swimming and fishing

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Where's the Value for the Great Lakes?

- 40% of Canada's economic activity
- Provides drinking water to 8.5 million Canadians
- Supports $33 billion annually in agriculture, 200,000 jobs
- Contributes $180 billion to Canada-US trade
- $450 million commercial and recreational fishing industry

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Where's the Value for the Credit River?

- 700,000 people, fastest growing community in North America
- 1,500 km of stream and creeks
- Extensive greenlands system containing 49 Environmentally Significant Areas
- One of the best recreational fishing rivers in Ontario and the most diverse cold water fishery in Ontario

Regulation and Guidance Documents

- Four policy documents released in 1993 and 1994
- Updated version in 2003:
  - **Stormwater Management Planning and Design Manual**
    - Impacts of urbanization on hydrologic cycle and ecosystems
    - Provided information on new "state of the art" practices
    - Updated operations and maintenance requirements
    - Provided retrofitting examples

Ontario Ministry of the Environment

-This led to the generation of several documents by the Ontario Ministry of the Environment

-1993: 3 policy documents released focusing on integrating water resources management and urban planning. Gave new approach to water management in Ontario; emphasized the need to focus on protecting the natural environment and expanded stormwater practices.

-1994: SWM manual is published to introduce practitioners to a broad range of stormwater management facilities to address water quantity, quality and erosion impacts

-2003: the SWM planning and design manual is released again, which significantly updated and expanded on the 1994 version

-focused on urbanization, new practices for treating stormwater, maintenance requirements and retrofits to existing practices

-For context, houses built up to 1995 may not have plans with stormwater quantity controls…it was not required by plans. Great deal of Mississauga's housing was built prior to 1995. There are lots of paved surfaces and runoff to our creeks and lakes without any control or treatment

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What BMPs and LID Practices Look Like

Rain water harvesting

Rain garden

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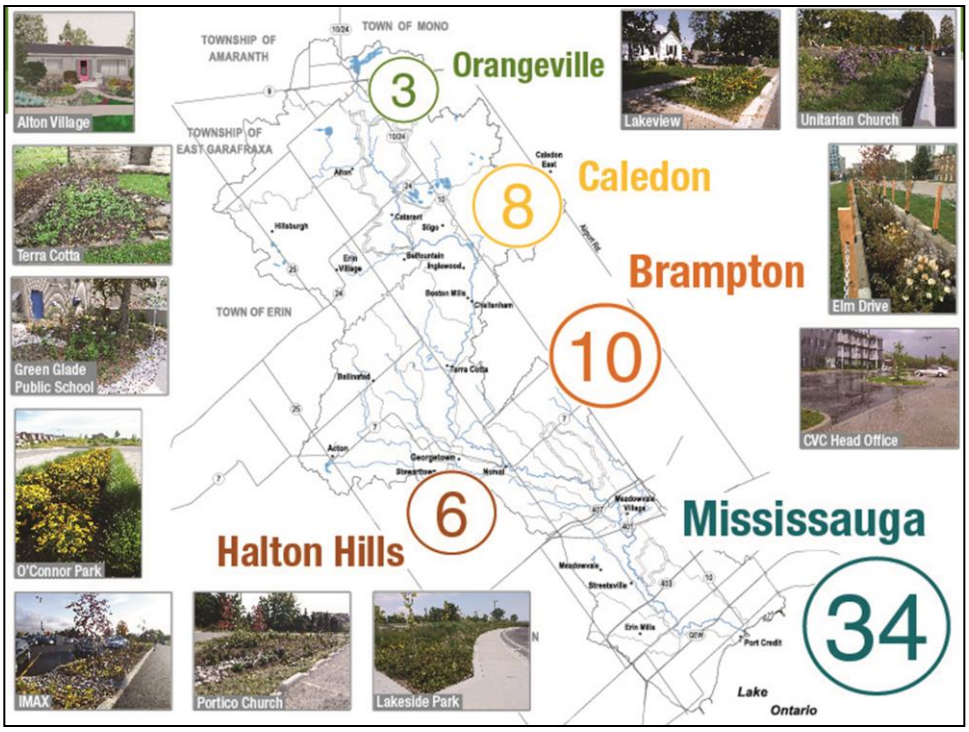
Permeable pavement

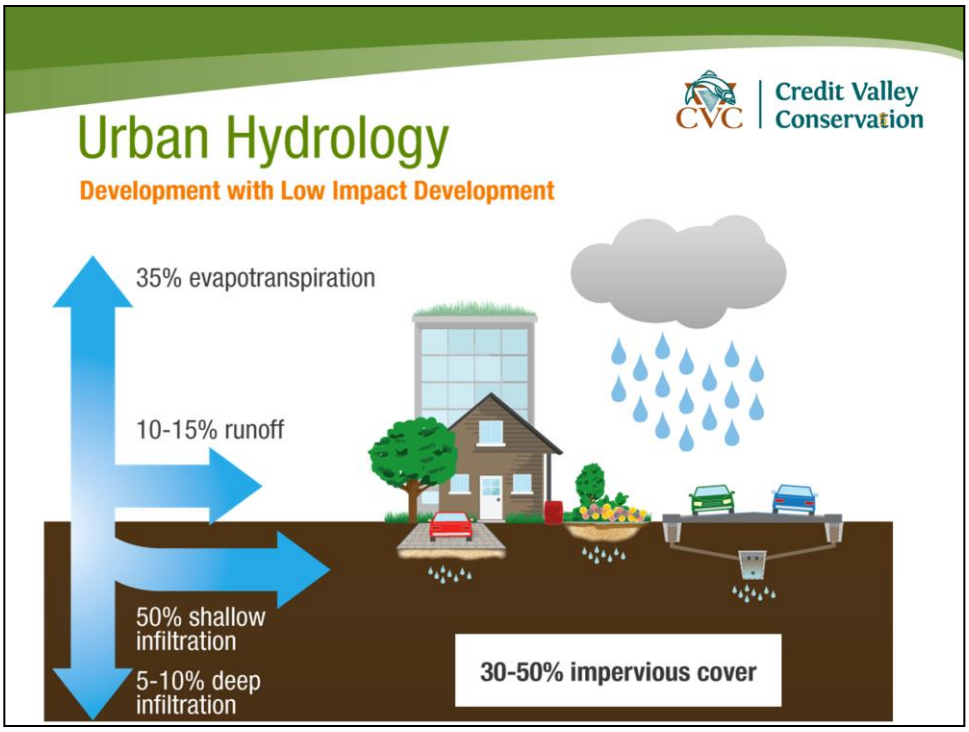
Bioretention planter



LID in the CVC watershed; more LID sites in Mississauga-more urban-small scale

Example: Kitchener, Ontario has installed LID bioretention planters along King Street

Retrofits mentioned earlier-example of what CVC has done in the Lakeview neighbourhood



When practices like LID are used, the urban hydrology changes:

-range of impervious cover

-increase infiltration (50 to 35 to 55/60)

-same amount of evapotranspiration or increased

-reduced runoff (10 to 30 to 10/15) –lot level control added

-Lot level SWM approaches have been advocated in Ontario since 1995 **(CVC LID SWM Guide, 2010…ref in here to another)**

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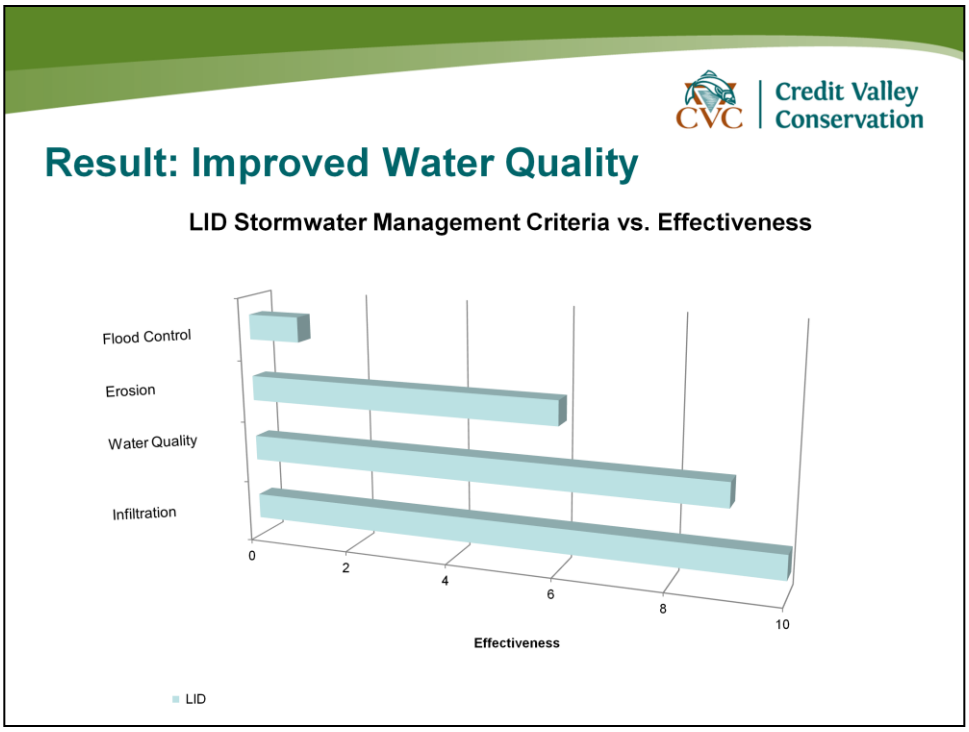
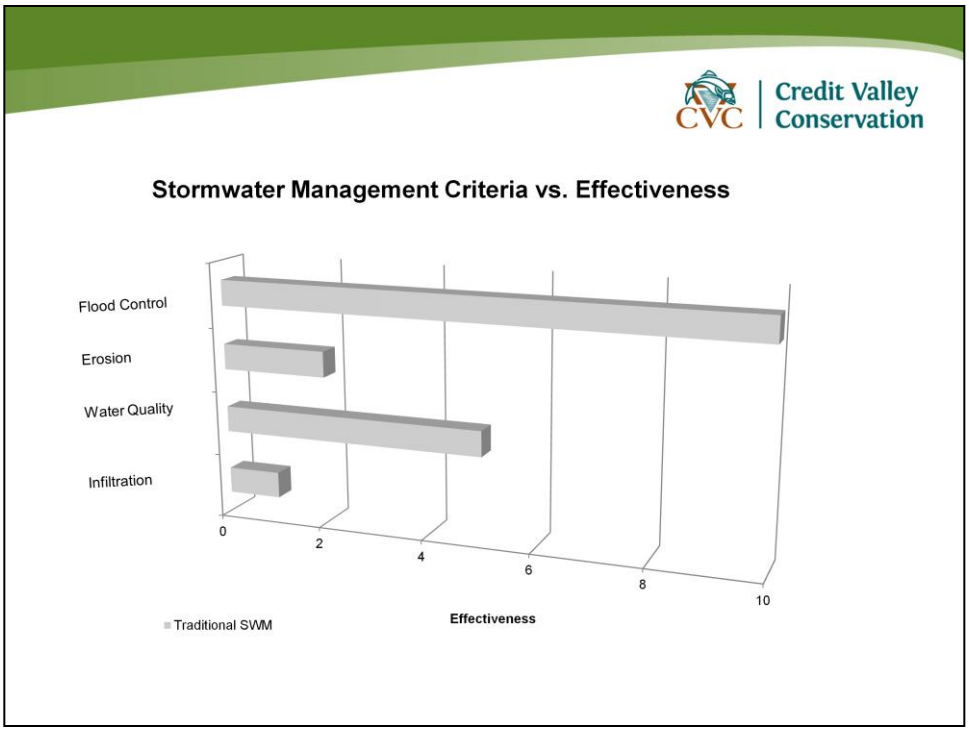
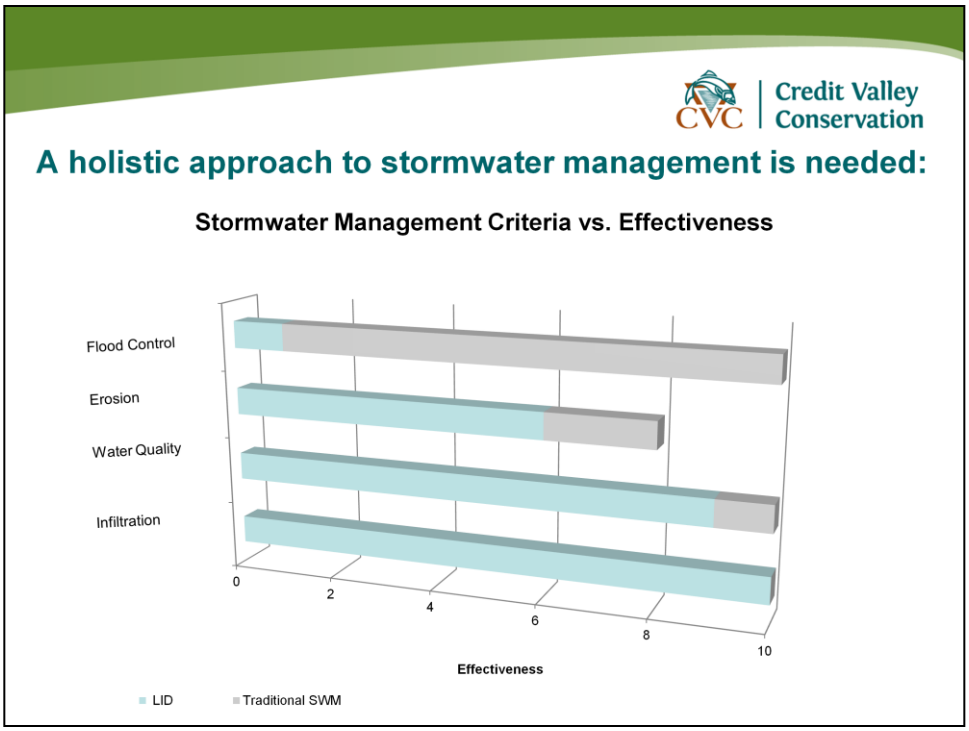


LID techniques are highly capable of satisfying the majority of the 4 design criteria (water quality, erosion, infiltration and water balance). While not typically designed for flood control, they some features can retain large volumes of water and release it at a slower rate to receiving waterbodies



Recap: effectiveness with traditional strategies



The best approach for stormwater management is to use a combination of traditional and LID techniques. A holistic approach is needed to treat and use stormwater to its full potential.

Source: Aquafor Beech, 2014

Water is a valuable resource for us and always will be. We have a chance to help make that water cleaner for everyone and help reduce the impacts of flooding.

Figure : www.the-macc.org

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SIXTY YEARS

Our Heritage to Conserve