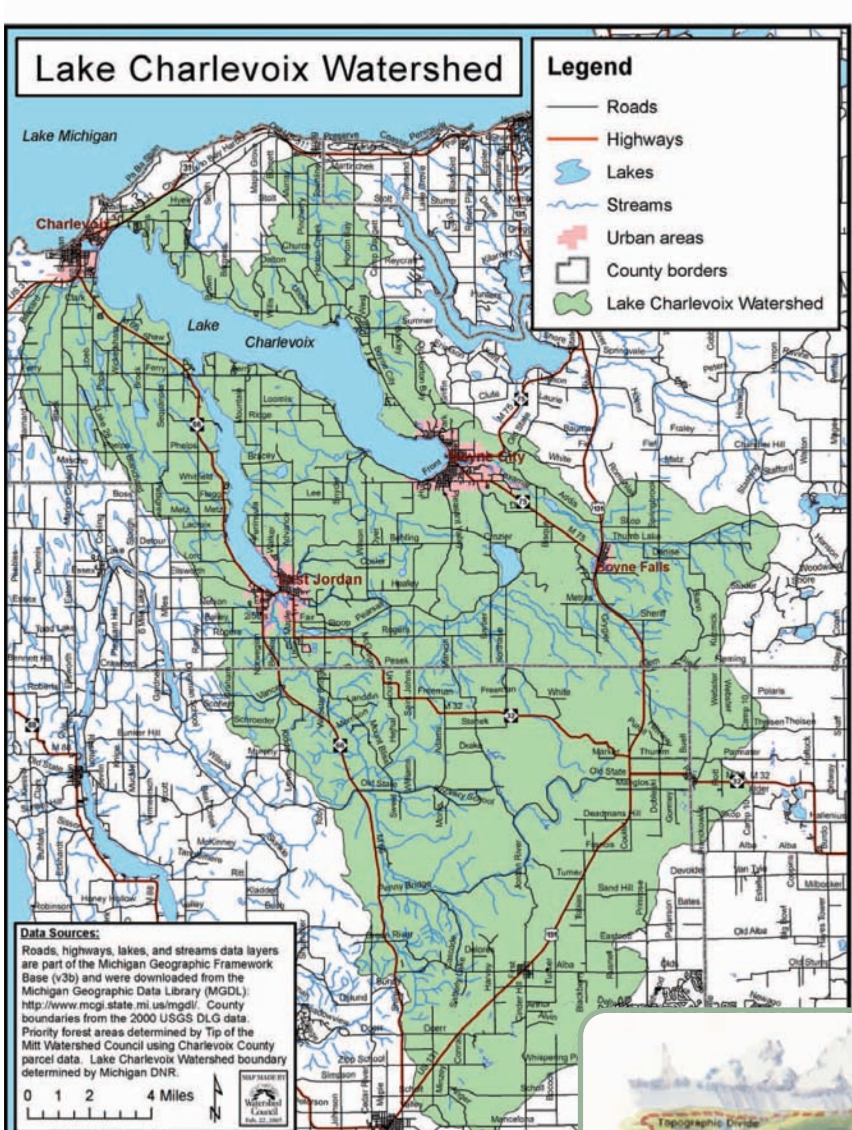
City of Charlevoix
Park Avenue Drainage Area:
Stormwater Management Recommendations and Streetscape Guidelines

Tip of the Mitt Watershed Council,
March 2009

Funding for this project provided by the Frey Foundation



Watershed Background

The 17,200 acre Lake Charlevoix collects water from a 214,400 acre watershed. A healthy lake depends on a healthy watershed. The presence of pollutants anywhere in the watershed can easily end up in Lake Charlevoix. Land directly adjacent to a lake as well as several miles from a lake can contribute nonpoint source pollution in the form of excess sediment, nutrients, toxic chemicals, and/or bacteria. Bit by bit, nonpoint source pollution can not only harm fish and wildlife habitat but also degrade the recreational quality of Lake Charlevoix and its tributaries. Likewise, any logging, farming, livestock grazing, recreational practices, and land development activities within the watershed can contribute to nonpoint source pollution and affect the quality of our lakes and streams.

In the late nineties local government officials, conservation groups, environmental organizations, regional planning agencies, health departments, and other stakeholders gathered within the Lake Charlevoix Watershed to discuss concerns about water quality. The group identified many different issues and committed to working together in a partnership to develop a watershed management plan. ***The Lake Charlevoix Watershed Project Nonpoint Source Pollution Inventory and Watershed Management Plan*** was developed to address sources of nonpoint source pollution and water quality issues in the watershed (Charlevoix Conservation District and Tip of the Mitt Watershed Council 2001).

What is a watershed? A watershed is the land area surrounding a body of water that when it drains or snow melts it all drains to that waterbody. The Lake Charlevoix Watershed includes the Boyne River, Jordan River, and many other streams.

Stormwater ~ What is it?

Stormwater is recognized as a serious nonpoint source pollution problem in watersheds. All substances which find their way onto impervious surfaces (streets, roofs, sidewalks, etc.) are likely to wash into nearby water bodies by rainfall or snowmelt, especially when streets are curbed, guttered, and drained by roadside ditches or underground pipes. Phosphorus and sediment are considered some of the most serious pollutants, but storm sewers also contribute many other pollutants such as oil, salt, bacteria, and other toxic substances.

Management of stormwater has become an important aspect of water resource management. Basically, the goal is preserve or restore pre-development hydrologic characteristics through a variety of techniques, including minimizing impervious surfaces, preserving open or green space, detention of runoff, infiltration trenches, water quality treatment basins, and other types of best management practices (BMPs).

As part of the development of the ***Lake Charlevoix Watershed Project Nonpoint Source Pollution Inventory and Watershed Management Plan***, Tip of the Mitt Watershed Council staff conducted an assessment of the storm sewer impacts from the three urban areas located on Lake Charlevoix (Boyne City, East Jordan and Charlevoix) in the fall of 2000.

Two important pollutants, sediment and phosphorus, to Lake Charlevoix were estimated. Annual pollution from total phosphorus was estimated at 435 pounds (with a potential to stimulate 217,620 pounds of aquatic plant growth), and sediment pollution was estimated to be 122,976 pounds (or 5 dump truck loads). The findings for Charlevoix, as well as for Boyne City and East Jordan, are summarized in the following table:

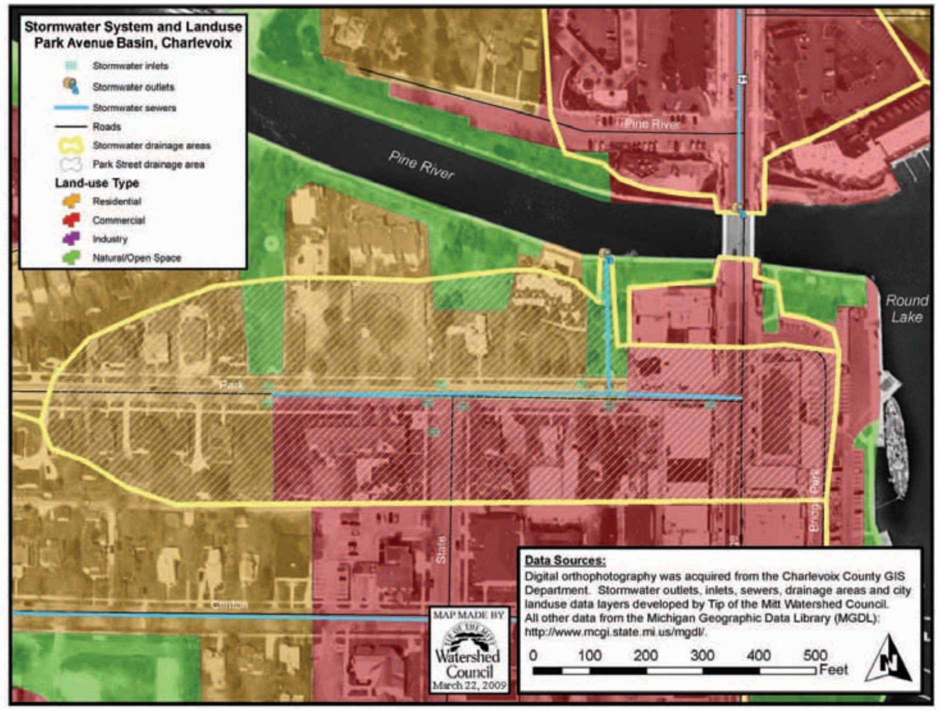
LAKE CHARLEVOIX STORM SEWER SURVEY SUMMARY

	Charlevoix	Boyne City	East Jordan
Area (acres)	1,280	2,377	1,714
Land Use			
Undeveloped	29.8%	49.6%	55.5%
Commercial/ Industrial	16.4%	12.5%	11.8%
Residential	48.4%	36.2%	29.8%
Water	5.4%	1.7%	2.9%
Impervious surface	31%	24%	22%
Estimated Pollution			
Phosphorus	435 pounds	714 pounds	253 pounds
Sediment	122,976 pounds	201,685 pounds	71,591 pounds

Park Avenue

In 2008, Tip of the Mitt Watershed Council staff discussed stormwater management plans and upcoming street projects with City of Charlevoix staff. The Park Avenue street improvement project is a city priority, with construction scheduled to begin in fall 2009. Tip of the Mitt Watershed Council decided to conduct a stormwater analysis of the Park Avenue drainage basin, and develop stormwater recommendations and streetscape guidelines. The series of best management practices recommended and utilized in the Park Avenue street project can be used as a demonstration project for other drainage basins within the city, as well as for other similar neighboring communities.

The Park Avenue drainage area is a small 11 acre basin within the Lake Charlevoix Watershed. Nine storm drain inlets collect stormwater from this drainage area and discharges to the Pine River Channel through one stormwater outfall. Using the Simple Method (Smullen and Cave 1998) to estimate pollutant contributions, it is estimated that the Park Avenue drainage basin alone is contributing 1,788 lbs of sediment and 8.5 lbs of phosphorus annually.



EXAMPLES OF EXISTING CONDITIONS

Park Avenue Stormwater Mananagement Recommendations and Streetscape Guidelines

INLET DEVICE

Install a water quality inlet treatment device.

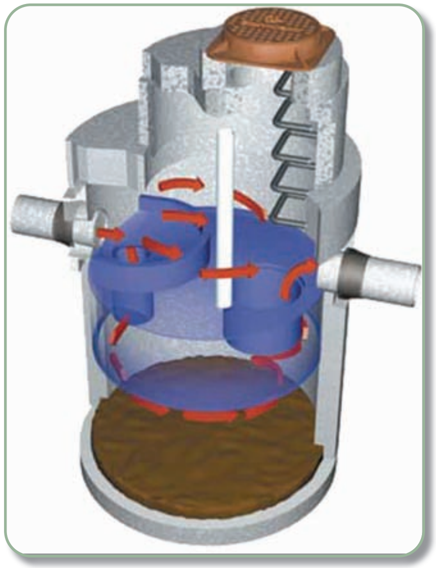
Water quality devices are generally proprietary, commercially available units designed to improve the quality of stormwater by removing pollutants as the stormwater flows through the system (SEMCOG, the Southeast Michigan Council of Governments 2008). These water quality devices vary in size and function, but all utilize some sort of settling and filtration to remove particulate pollutants from stormwater runoff. One advantage of manufactured devices is that they are easily adaptable to urban retrofit situations, where they can be installed beneath most surface infrastructure such as roads and parking lots (SEMCOG 2008). A water quality treatment device is an acceptable best management practice for the Park Avenue drainage basin because of the high impervious cover and limited area in the downtown blocks of Park Avenue. There are many proprietary water quality treatment devices on the market today. The City of Charlevoix can work with their street project contractor to determine the best device for the Park Avenue drainage basin. However, water quality treatment devices only work best when maintained regularly, and long term maintenance must be considered when specifying these devices.

Pollutant reductions with the use of a water quality treatment device vary with the performance of the specific type and brand of device. An independent study in Wisconsin evaluating the effectiveness of the Stormceptor® showed a reduction by 21% of total suspended sediments and 17% total phosphorus over the nine month study period (Greb et al. 1998). However, pollutant removal efficiencies of the Stormceptor® in this study was dependent of the depth of rainfall (Schueler and Holland 2000).

BIORETENTION

Utilize bioretention areas in the city-owned right-of-ways and curb extentions to collect and filter stormwater.

Bioretention areas, or rain gardens, are landscaping features adapted to provide on-site treatment of stormwater runoff (USEPA 2006). Bioretention is a method of managing stormwater by pooling water within a planting area and allowing the water to infiltrate the garden. (SEMCOG 2008). Rain gardens collect and filter stormwater runoff while sediments and other pollutants settle out. Bioretention systems are generally applied to small sites and can be used in urbanized settings, and can be applied in many climatological and geologic situations, with some minor design modifications. In the City of Charlevoix, the right-of-ways between the street and sidewalks that are currently turfgrass are opportune areas to utilize bioretention. Curbs that line the street can have curb cuts incorporated to convey stormwater into the rain gardens for collection and filtration. Curb cuts may be depressed curbs or may be full height curbs with openings cast or cut into them (SEMCOG 2008).



Stormceptor Unit

(source: http://www.oscoconstructiongroup.com/2216.aspx)

BIORETENTION continued

Curb extentions may also provide opportune placement of bioretention areas. They may be located where street parking can be limited to one side. Curb extensions also have added benefit of slowing traffic and street beautification.

Utilizing native plant species in the rain gardens are the most environmentally friendly and low-maintenance choice. Some maintenance will be required to get the plants established, such as watering and weeding, but once established will require little to no maintenance. And since native plants are adapted to local conditions they do not require the use of pesticides or herbicides.

Many communities have successfully utilized this technique to reduce stormwater runoff and improve water quality. Locally, the City of Grayling has incorporated 86 rain gardens in city-owned right of ways between the sidewalks and streets as one component of stormwater treatment with the Grayling Stormwater Project. The rain gardens vary in shape and size but all share the same characteristics of sloped sides and bottom below street level to allow water to collect; cuts in the curb to allow water to enter; and native shrubs and perennials to filter pollution out of the stormwater (Huron Pines 2005). More information about the Grayling Stormwater Project can be found at http://www.huronpines.org/project/16.

Pollutant removal data for bioretention or rain gardens in Maryland has shown that rain gardens could remove 70-83% of phosphorus, 90% of sediments, 49% of nitrogen, and 93-98% of metals from the stormwater runoff directed to that site (Davis et al. 1998).

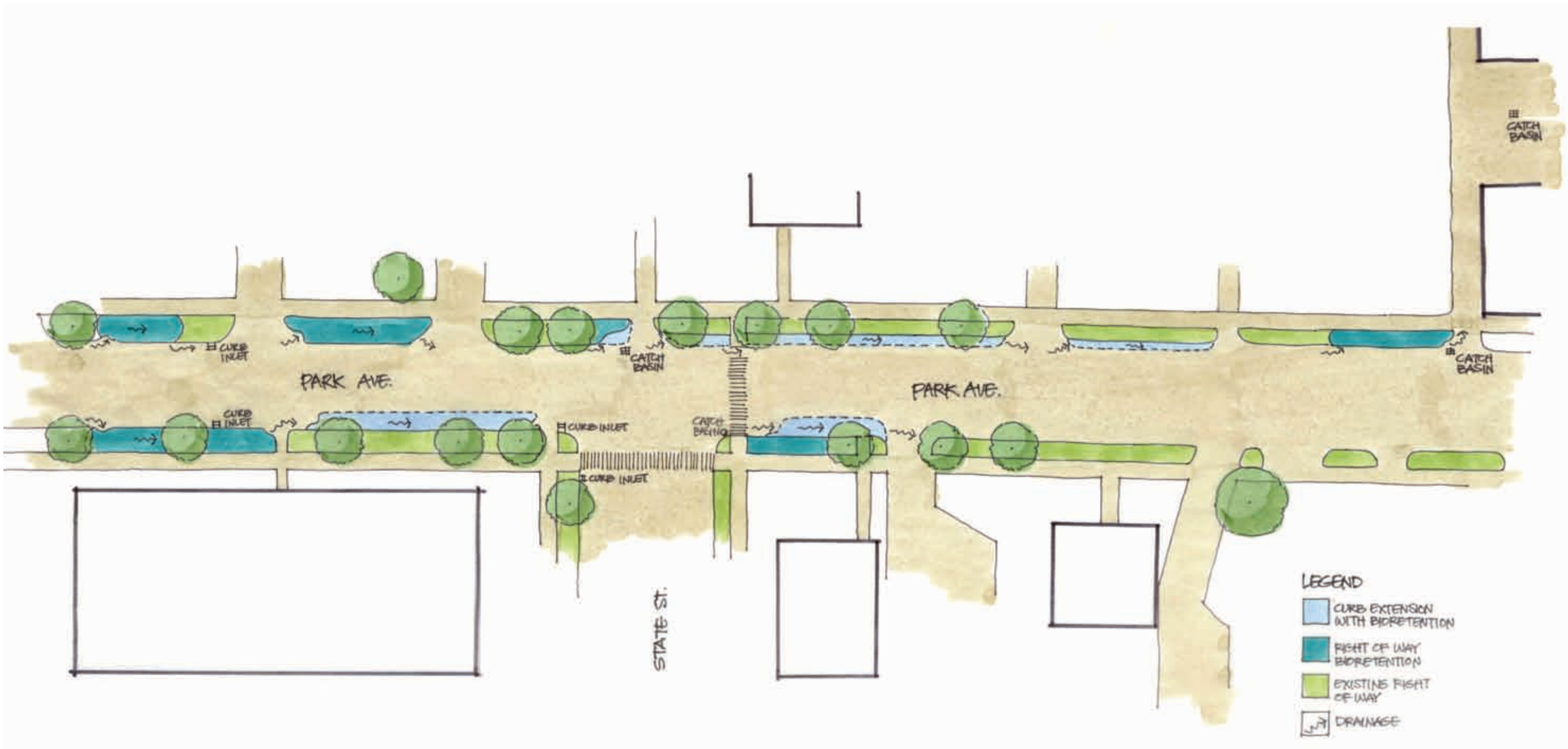
Before Rain Garden Installation in City of Grayling

(source: www.huronpines.org)

After Rain Garden Installation in City of Grayling

(source: www.huronpines.org)

(source: www.huronpines.org)

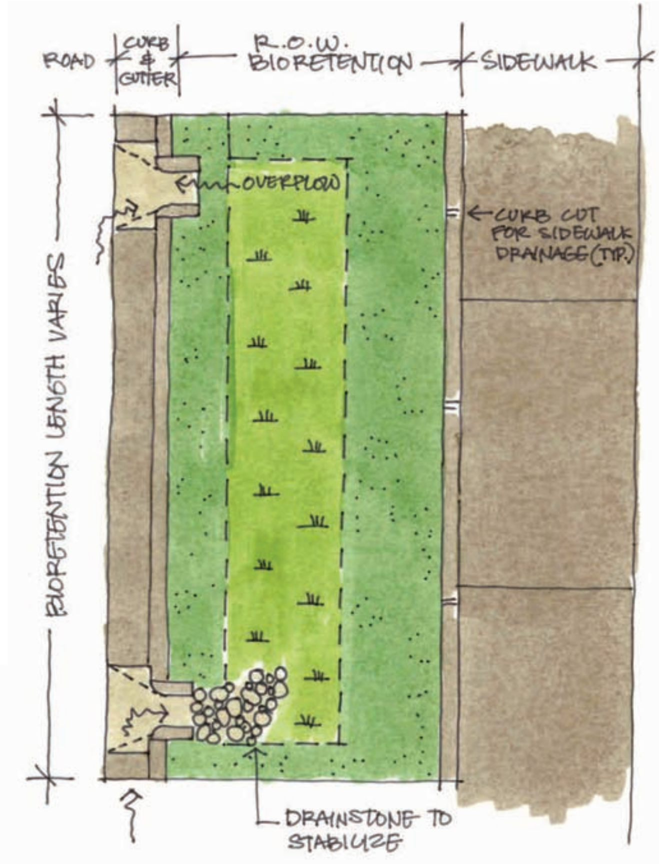


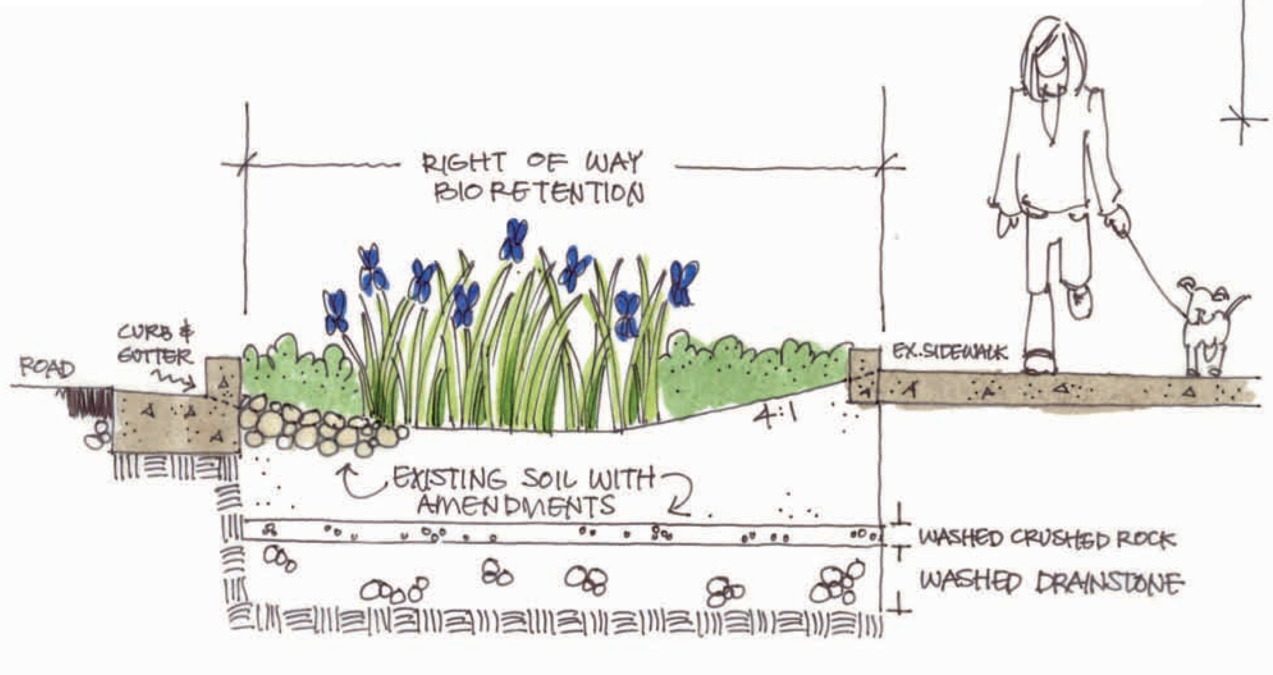
Park Avenue Stormwater Streetscape Conceptual Plan

Bioretention areas are integrated into rain gardens within the city right-of-way (ROW) and curb extensions (see legend). ROW rain gardens require less infrastructure modifications. Curb extension rain gardens offer more flexibility in location and design due to existing trees and utilities located within the ROW. Curb extension rain gardens have the added benefits of reducing traffic speeds and decreasing impervious surfaces. Both the ROW and curb extension rain gardens will improve the streetscape aesthetic and enhance the street character.

Typical bioretention area (rain garden) within Park Avenue Right-of-Way

Curb cuts allow drainage to enter rain gardens from street and sidewalk, and also allow return flow to street stormwater system in the event of flooding. Gentle side slopes are planted with drought tolerant native plants; bottom of rain gardens are planted with more moisture-loving species. Short, ornamental plantings keep views open while enhancing the streetscape aesthetic. Washed drainstone and rock base layers below the amended planting medium allow for greater drainage.





PERMEABLE PAVEMENT

In addition to resurfacing Park Avenue, pave the public parking lot and alley that are presently unpaved.

While there is not much difference in permeability between dirt and paved road surfaces, dirt road and parking surfaces can contribute a lot of sediment when it is eroded off the surface. This causes sediment pollution when the dirt surfaces are in proximity of water bodies, particularly when surface runoff drains directly to inlets, and the storm sewer lines convey the runoff rapidly and directly to a lake or stream. In the Park Avenue drainage area, surface runoff of the unpaved areas contributes a considerable amount of sediment to the Pine River Channel. It is recommended that paving be done in addition to the Park Avenue street project and other recommended best management practices.

Permeability of paved areas can be improved by using an alternative paving material, such as a porous pavements or permeable pavers. They reduce stormwater runoff by allowing water to soak through the pavement or voids between pavers into the ground beneath. Collectively known as permeable pavements, they range from a variety of mediums, from porous concrete and asphalt, to plastic grid systems and interlocking paving bricks (USEPA, 2006).

The use of permeable pavements for pollutant removal can reduce 82-95% of total suspended sediments, 65% of total phosphorus, 80-85% of total nitrogen, and 98-99% of metals (USEPA, 2006).

Charlevoix public parking lot off Park Avenue.

Sediment laden stormwater runoff from Charlevoix public parking lot.

(Source: www.unilock.com)

Parking lot with permeable interlocking pavers.

(Source: permeable pavement/ www.flickr.com)

Parking lot with porous asphalt pavement.

MONITORING

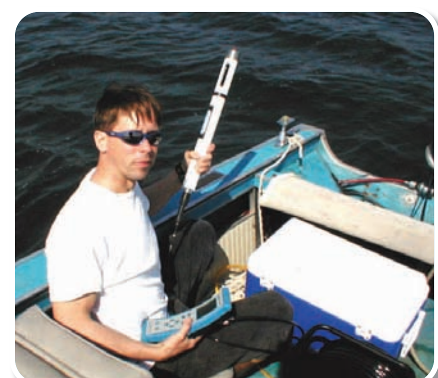
Monitoring of the stormwater outfall will serve to document baseline conditions and improvements in water quality due to implemented best management practices in the Park Avenue drainage basin. Water quality monitoring of the stormwater runoff from this basin will help quantify the effectiveness of the best management practices used, which can guide future recommendations in other drainage basins within the city.

Pollutant concentrations in stormwater are typically highest during the first flush following a storm event, particularly after an extended period of no precipitation. Therefore, sampling should be carried out immediately following storm events and during low flow conditions to determine pollutant concentrations during normal flows. Field data collection should be conducted at the stormwater outfall site under high flow conditions during the spring, summer and fall and under low flow conditions in the summer. Data collection would consist of collecting field and water samples for laboratory analysis. Parameters to analyze include:

- Temperature
- pH
- Dissolved oxygen
- Conductivity
- Total phosphorous
- Soluble reactive phosphorus
- Total nitrogen
- Nitrate-nitrogen
- Chloride
- E. coli bacteria
- Total suspended solids
- Biological oxygen demand (BOD)
- Lead
- Oil and grease
- Arsenic
- Cadmium
- Chromium
- Mercury
- Zinc

Park Avenue stormwater outfall into Pine River channel.

Tip of the Mitt Watershed Council offers stormwater monitoring as a contract service. Watershed Council staff collects water samples at the stormwater outfall, distribute samples for processing, analyzes data and compiles the report. The majority of physical water quality parameters (temperature, pH, dissolved oxygen, conductivity, and turbidity) are measured with monitoring equipment, specifically a Hydrolab Mini-sonde®. Water samples collected are shipped next-day air to SOS Analytical, Inc. in Traverse City to measure total suspended solids, BOD, oil and grease, and all metals. Additional water samples are collected and delivered directly to the University of Michigan Biological Station in Pellston for phosphorous, nitrogen, and chloride analyses. A third set of samples are collected and delivered to the Northwest Michigan Community Health Agency Laboratory in Gaylord for bacteriological analyses. Flow at the stormwater outfall is also measured to calculate pollutant loads. Upon completing the field work and receiving all results from the laboratories, the data is entered into a database, analyzed, and used for a comparative analysis of change over time. Project methods, results, and discussion are included in a comprehensive report. Results from the proposed project will help assess the quality of stormwater entering into the Pine River Channel via the Park Avenue drainage basin. Furthermore, this project will provide accurate base-line data for comparisons with historical and future stormwater data collection efforts.



Good Housekeeping for Municipal Operations

Municipalities conduct numerous activities that can pose a threat to water quality if practices and procedures are not in place to prevent pollutants from entering storm drains. These activities include parking lot and street cleaning, winter road maintenance, minor road repairs and other infrastructure work, automobile fleet maintenance, landscaping and park maintenance, and building maintenance. Municipalities can also conduct activities that remove pollutants from the storm drain system when performed properly, such as parking lot and street sweeping and storm drain system cleaning. Finally, municipal facilities can be sources of stormwater pollutants if best management practices are not in place to contain spills, manage trash, and handle non-stormwater discharges. The following charts outline common pollutants typically associated with municipal facilities and activities in general (USEPA 2006). Municipal activities specific to the City of Charlevoix that the Watershed Council felt deserved more attention because of their relevance are street sweeping, yard waste collection, and snow management and removal, and are described more in depth in the following sections.

Potential pollutants likely associated with specific *municipal facilities*

Municipality Facility Activity	Potential Pollutants								
	Sediment	Nutrients	Trash	Metals	Bacteria	Oil & Grease	Organics	Pesticides	Oxygen Demanding Substances
Building and Grounds Maintenance and Repair	X	X	X	X	X	X	X	X	X
Parking/Storage Area Maintenance	X	X	X	X	X	X	X		X
Waste Handling and Disposal	X	X	X	X	X	X	X	X	X
Vehicle and Equipment Fueling			X	X		X	X		
Vehicle and Equipment Maintenance and Repair				X		X	X		
Vehicle and Equipment Washing and Steam Cleaning	X	X	X	X		X	X		
Outdoor Loading and Unloading of Materials	X	X	X	X		X	X	X	X
Outdoor Container Storage of Liquids		X		X		X	X	X	X
Outdoor Storage of Raw Materials	X	X	X			X	X	X	X
Outdoor Process Equipment	X		X	X		X	X		
Overwater Activities			X	X	X	X	X	X	X
Landscape Maintenance	X	X	X		X			X	X

Source: California Stormwater BMP Handbook (http://www.cabmphandbooks.com/)(slightly modified)

Potential pollutants likely associated with *municipal activities*

Municipal Program	Activities	Potential Pollutants								
		Sediment	Nutrients	Trash	Metals	Bacteria	Oil & Grease	Organics	Pesticides	Oxygen Demanding Substances
Roads, Streets, and Highways Operation and Maintenance	Sweeping and Cleaning	X		X	X		X			X
	Street Repair, Maintenance, and Striping/Painting	X		X	X		X	X		
	Bridge and Structure Maintenance	X		X	X		X	X		
Plaza, Sidewalk, and Parking Lot Maintenance and Cleaning	Surface Cleaning	X	X			X	X			X
	Graffiti Cleaning	X	X		X			X		
	Sidewalk Repair	X		X						
	Controlling Litter	X		X		X	X			X
Fountains, Pools, Lakes, and Lagoons Maintenance	Fountain and Pool Draining		X					X		
	Lake and Lagoon Maintenance	X	X	X		X			X	X
Landscape Maintenance	Mowing/Trimming/Planting	X	X	X		X			X	X
	Fertilizer & Pesticide Management	X	X						X	
	Managing Landscape Wastes			X					X	X
	Erosion Control	X	X							
Drainage System Operation and Maintenance	Inspection and Cleaning of Stormwater Conveyance Structures	X	X	X		X		X		X
	Controlling Illicit Connections and Discharges	X	X	X	X	X	X	X	X	X
	Controlling Illegal Dumping	X	X	X	X	X	X	X	X	X
	Maintenance of Inlet and Outlet Structures	X		X	X		X			X
Waste Handling and Disposal	Solid Waste Collection		X	X	X	X	X	X		X
	Waste Reduction and Recycling			X	X					X
	Household Hazardous Waste Collection			X	X		X	X	X	
	Controlling Litter			X	X	X		X		X
	Controlling Illegal Dumping	X		X		X	X		X	X
Water and Sewer Utility Operation and Maintenance	Water Line Maintenance	X				X	X			
	Sanitary Sewer Maintenance	X				X	X			X
	Spill/Leak/Overflow Control, Response, and Containment	X	X			X		X		X

Source: California Stormwater BMP Handbook (http://www.cabmphandbooks.com/)

STREET SWEEPING

Street and parking lot cleaning involves employing pavement cleaning practices, such as street sweeping on a regular basis, to minimize pollutant export to receiving waters. These cleaning practices are designed to remove sediment, debris, and other pollutants from road and parking lot surfaces that are a potential source of pollution impacting urban waterways (Center for Watershed Protection 2000). Street sweeping is practiced in many urban areas, often as an aesthetic practice to remove sediment buildup and large debris from curb gutters. In colder climates, such as in Northern Michigan, street sweeping can be used during the spring snowmelt to reduce pollutant loads from road salt and to reduce sand export to receiving waters. Seventy percent of cold climate stormwater experts recommend street sweeping during the spring snowmelt as a pollution prevention measure (Center for Watershed Protection 2000).

The effectiveness of street sweeping in reducing pollutant loads depends on the street sweeper used. Improvement in sweeper technology has improved its efficacy. High powered street sweeping can reduce total suspended sediments 45-90% and total phosphorus 30-90% (USEPA 2006).

YARD WASTE COLLECTION

Many municipalities, such as the City of Charlevoix, offer curbside yard waste collection for its residents. Items such as grass clippings, leaves, and brush are picked up at the curb and transported away. Yard wastes such as these can clog storm drains, cause flooding, and are a source of excess nutrients to waterways. It is recommended the City of Charlevoix modify its yard waste collection program to not facilitate the introduction of excess nutrients to storm drains. Some solutions to this may be to provide bins to residents to place their yard waste in curbside (similar to curbside recycling bins), require the use of compostable or biodegradable bags for yard waste collection, or develop a residential composting program. It is also important to emphasize to residents that when raking leaves or other yard waste to the curb for collection, to be sure to keep them out of the road and away from storm drains.

SNOW MANAGEMENT AND REMOVAL

Potential water pollution associated with melting snow is a concern in northern climates like Northern Michigan. In many urban areas a substantial amount of the annual load of pollutants comes from snowmelt and early spring runoff events (Oberts 1995). Aspects of snow management that are of concern to municipal operators are snow removal, and the application of deicers and abrasives (salt and sand).

For snow removal, snow should be dumped in pervious areas where snow can infiltrate. Snow should be stockpiled in flat areas of at least 100 feet from stream or floodplain, and stockpile areas should be planted with salt-tolerant plant species (Oberts 1995). Sediments and debris should also be removed from the dump areas each spring to prevent excess sediments from entering nearby waterways.

The City of Charlevoix utilizes a salt and sand combination for snow and ice management in the winter months. According to the Center for Watershed Protection's Stormwater Practices for Cold Climates, deicers are a pollutant source in cold climates. Road salt (NaCl) is the most commonly used deicer, primarily because of its low cost (Ohrel 1995). Several changes can be made to traditional deicing to decrease the impacts to the environment. These include: apply less salt, apply alternate deicers, use additives to reduce deicer application, change the timing of application, modify spreaders and implement salt storage regulations (Center for Watershed Protection 2000). Abrasives help retain traction on in icy and snowy conditions. Sand is the most commonly used abrasive. Three measures are proposed to reduce pollution from sand application: use of a clean sand source, street sweeping during and immediately after the spring runoff and operator training focusing on application of the minimum amount of sand necessary (Center for Watershed Protection 2000).

For more information on these and other municipal good housekeeping recommendations:

- **Urban Subwatershed Restoration Manual 9: Municipal Pollution Prevention/ Good Housekeeping Practices**
  www.cwp.org
- **Fact Sheets on Municipal Pollution Prevention Practices**
  www.stormwatercenter.net
- **USEPA NPDES Parking Lot and Street Cleaning Fact Sheet**
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=99&minmeasure=6

Future Recommendations

Engineering of Bioretention Areas

Upon securing community support and funding, the City of Charlevoix should consider contracting with an engineering firm to further develop and engineer the Park Avenue Stormwater Streetscape project. Engineering will advance the project from the conceptual phase to the construction drawing phase. Specifically, the bioretention areas should be optimally located to accept stormwater, and they should be sized to accommodate the volume of runoff generated in their respective drainage areas. The number of bioretention areas shown on the conceptual streetscape plan does not necessarily correlate with the actual volume of stormwater. Additionally, their placement on the plan is based on observed drainage, existing stormwater inlets, and relationship to vehicular traffic and pedestrians. Planting plans should be developed concurrently with the engineering plans and will include planting medium specifications, plant species, sizes and placement within the bioretention areas. Plant species should be native to Michigan, tolerant of the conditions likely found in the bioretention areas, and enhance the aesthetic appeal of the streetscape.

Implementation and Installation

After construction drawings complete are completed, the City of Charlevoix should consider pursuing implementation of the project. Funds for implementation may be available through foundations, grant programs, and private donors. Cities interested in stormwater initiatives are strong competitors for funding through the appropriate grant programs. The Watershed Council is able to assist the City of Charlevoix with securing potential grant funds. A cost estimate would be advantageous; grant proposals oftentimes require detailed costs estimates of proposed projects. Installation of the project would not require any specialty contractors; the City of Charlevoix Street Department is capable of installation. Installation should take place during an appropriate planting window as to minimize stress to newly installed plants. Maintenance of the plants will be critical during the first growing season.

Paired Drainage Area Study of Local Streetscapes

A future collaborative project between Tip of the Mitt Watershed Council and the City of Charlevoix could be a paired drainage area study for conducting a nonpoint source pollution water quality study. The basic approach requires a minimum of two watersheds or drainage areas - control and treatment - and two periods of study - calibration and treatment (Clausen and Spooner 1993). The basis of the paired watershed approach is that there is a quantifiable relationship between paired water quality data for the two drainage areas, and that this relationship is valid until a major change is made in one of the drainage areas.

The Park Avenue drainage area could be used as the treatment drainage area, while another drainage area in the city could be the control. This type of study is a way to quantify the effectiveness of the best management practices implemented in the Park Avenue drainage basin, and make conclusions regarding which practices could or should be replicated in other drainage areas within the city.

Improved Partnerships and Funding Opportunities

The City of Charlevoix should continue to partner with Tip of the Mitt Watershed Council and other groups/ organizations affiliated with the Lake Charlevoix Watershed Project Advisory Committee to implement stormwater best management practices and further protect water quality in the Lake Charlevoix Watershed. Joining forces with other organizations will help to increase opportunities for funding as groups pool resources and work together to accomplish joint goals. Funding opportunities for municipal stormwater best management practices may be available through local, state, and federal grants, as well as contributions from local organizations. Open communication with watershed partner groups will help keep the City of Charlevoix aware of these funding opportunities as they arise.

Community Outreach and Involvement

Outreach to the community and gaining community involvement is also key to the success of stormwater BMP project implementation. Tip of the Mitt Watershed Council and other watershed partner groups are available to help the City of Charlevoix reach out to the community to gain support for these efforts through implementation of demonstration sites in the city, as well as education programs.

The rain garden at the Charlevoix Public Library is a previously installed BMP project that can be used as "demonstration site" to provide an educational opportunity for the public to learn more about stormwater and its negative effects on water quality, while also having a visual representation of a BMP that will help improve water quality. The proposed streetscape guidelines for Park Avenue, if implemented, will also be a great demonstration project that can be monitored and replicated in other parts of the city if it is determined that the BMPs are having the desired effect. There are other possibilities for demo sites within the city limits, such as a permeable paver parking lot demo at the Palmer Street lot behind the Michigan Department of Natural Resources office.

Aside from demo sites are education programs that can be targeted towards any group involved with or impacted by stormwater management. Providing information about the benefits and potential applications of stormwater BMPs can increase support from public officials, engineers, designers, developers, and members of the local community. Other elements of an education program could include press in the local media, advertising, or public campaigns to help increase community buy-in. An example of a campaign such as this is the Kansas City "10,000 Rain Gardens" Initiative, where community members are encouraged to install rain gardens on their properties to reduce the burden on the existing stormwater system (www.werf.org/livablecommunities/studies_kc_mo.htm).

Palmer Street Parking Lot Conceptual Design

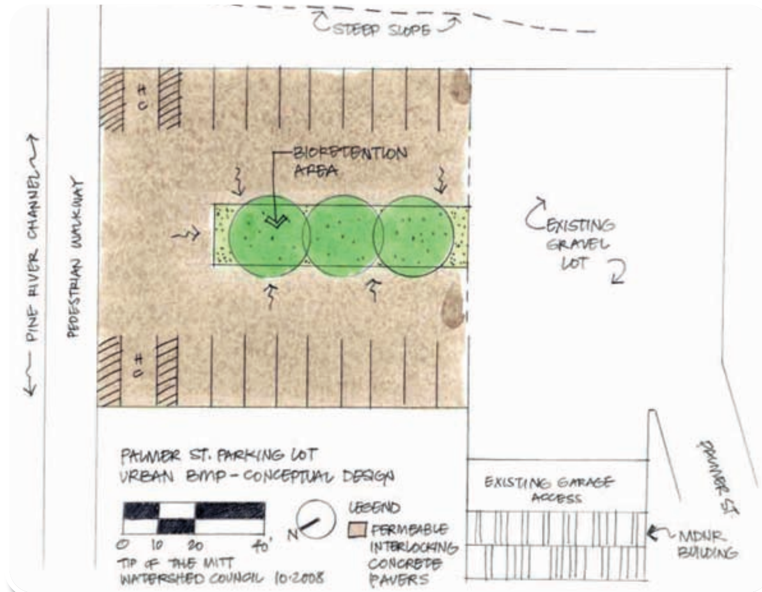


Photo: Charlevoix Courier

Charlevoix Public Library Rain Garden

ACKNOWLEDGEMENTS

Frey Foundation

Pat Elliott of the City of Charlevoix Street Department

Performance Engineering

REFERENCES

Center for Watershed Protection, Inc. 2000. Stormwater Manager's Resource Center (SMRC) Website. www.stormwatercenter.net. Ellicott City, Maryland.

Charlevoix Conservation District and Tip of the Mitt Watershed Council. 2001. Lake Charlevoix Watershed Project Nonpoint Source Pollution Inventory and Watershed Management Plan. 108 pp.

Clausen, J.C. and J. Spooner. 1993. Paired Watershed Study Design. EPA 841-F-93-009. U.S. Environmental Protection Agency, Office of Water, Washington D.C.

Davis, A., M. Shokouhian, H. Sharma, and C. Henderson. 1997. Bioretention Monitoring-Preliminary Data Analysis. Environmental Engineering Program of the University of Maryland, College Park, MD.

Greb, S., S. Corsi, and R. Waschbusch. 1998. Evaluation of Stormceptor® and multi-chamber treatment train as urban retrofit strategies. In Proceedings: National Conference on Retrofit Opportunities for Water Resource Protection in Urban Environments, Chicago, IL, February 9-12, 1998. U.S. Environmental Protection Agency, Washington, DC.

Huron Pines. 2005. Grayling Stormwater Project. http://www.huronpines.org/project/16. Grayling, MI.

Oberts, G.L. 1995. Influence of Snowmelt Dynamics on Stormwater Runoff Quality. Watershed Protection Techniques. 1(2): 55-61.

Ohrel, R. 1995. Rating Deicing Agents-Road Salt Stands Firm. Watershed Protection Techniques. 1(4): 217-220.

Schueler, T.R. and H.K. Holland. 2000. Performance of a proprietary stormwater treatment device: The Stormceptor®. In The Practice of Watershed Protection. Section 8, p.584-587.

Smullen, J. and K. Cave. 1998. "Updating the U.S. Nationwide Urban Runoff Quality Database." 3rd International Conference on Diffuse Pollution: Aug 31-Sep 4, 1998. Scottish Environment Protection Agency, Edinburgh, Scotland.

Southeast Michigan Council of Governments (SEMCOG). 2008. Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers. Detroit, MI. 497pp.

U.S. Environmental Protection Agency (USEPA). 2006. National Menu of Stormwater Best Management Practices. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/. Washington D.C.

U.S. Environmental Protection Agency (USEPA). 2006. Pollution Prevention/Good Housekeeping for Municipal Operations. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/goodhousekeeping. Washington D.C.

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