TO: Development and Infrastructure Committee
FROM: Capital Works
SUBJECT: Report providing an update regarding the Flood Vulnerability, Prioritization and Mitigation Study

Report Number: CW-09-15 Wards Affected: All
File Numbers: 155-08-2
Date to Committee: July 6, 2015 Date to Council: July 15, 2015

Recommendation:

Receive Report CW-09-15 and related presentation by Amec Foster Wheeler as a basis for actions to reduce flood risk potential in the City of Burlington; and

Direct the Executive Director of Capital Works to include the Storm Water Infrastructure Improvements contained in report CW-09-15 Table 4 at a total incremental estimated cost of $20.04M for consideration in the 2016 Capital Budget and 2017-2025 Capital Forecast; and

Direct the Executive Director of Capital Works to undertake a Storm Water User Fee Implementation Study, including proposed rate structure options and public consultation as a long term sustainable funding alternative for storm drainage capital and operating costs, based on a user pay approach at an estimated cost of $250,000, funded from the existing balance of account SD0113 “Climate Change and Flood Mitigation Measures” with a target implementation of 2018; and

Approve the extension of a grant program to the end of 2016 to offset the cost of plumbing permit fees for the installation of backwater valves, disconnection of foundation drains from the sewer system and the installation of sump pumps for homes qualifying under the Region of Halton’s Basement Flooding Prevention Subsidy Program. The recommendation of $50,000 is proposed to be funded from the Tax Rate Stabilization Reserve Fund; and

Direct the Executive Director of Capital Works to report back to Development & Infrastructure Committee annually on the progress of the Flood Vulnerability, Mitigation and Prioritization program, prior to the Capital Budget approvals; and
Approve the addition of a full-time Stormwater Management Technician position in the Development and Environmental Engineering section of the Capital Works Department who is dedicated to stormwater works including responding to lot grading and drainage concerns, at an estimated annual cost of $95,000; and

Direct the Executive Director of Capital Works to undertake public consultation and outreach as outlined in report CW-09-15

**Purpose:**

The purpose of this report is to present the findings and recommendations of a comprehensive review of the city’s storm drainage system and outline the actions taken to date; present preliminary recommendations for storm water management capital upgrades and operational enhancements to improve the level of service provided by the city’s storm drainage system and reduce the risk of flooding in light of extreme weather events, such as the storm of August 4, 2014.

Results and recommendations arising from Flood Vulnerability, Prioritization and Mitigation Study being performed by Amec Foster Wheeler will be presented.

In addition to the above, updates are being provided with regards to, coordination with Halton Region’s Basement Flood Mitigation Study, coordination with Conservation Halton and related works undertaken by MTO, Highway 407 and CN Rail along their corridors through the City of Burlington

**Background:**

On Monday, Aug. 4, 2014, the City of Burlington received nearly two months of rain (191 millimeters) in approximately eight hours. The record rainfall caused significant flooding and damage in parts of the city. Roads and highways were flooded, creeks filled with debris and more than 3000 homes were flooded.

Weather Network chief meteorologist Chris Scott called the summer storm an "epic flash flooding event," caused by training storms, a series of thunderstorms that moved over the same area several times in a short period of time.

Over the last 10 months, the City of Burlington has worked with its partners to help individuals, and families to rebuild and recover from the August 4, 2014 flood. A significant amount of work has also been done to repair flood damage to city infrastructure and to assess and analyze Burlington’s storm water management system through a Flood Vulnerability, Prioritization and Mitigation Study led by Amec Foster Wheeler.
Discussion:

Approach

1. Flood Steering Committee Established

The city established a Flood Response Steering Committee to coordinate follow up action on the city’s storm response. This group meets on a regular basis to provide direction, support and updates on the work related to the flood. The chart below identifies key actions taken by the subcommittees, and this is expanded upon further in the sections that follow. In addition, regular coordination meetings between the City, Region of Halton and Conservation Halton staff have taken place to ensure coordination amongst these public agencies.

<table>
<thead>
<tr>
<th>Subcommittee</th>
<th>Key Actions Taken</th>
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<tbody>
<tr>
<td>Flood Vulnerability, Prioritization and Mitigation Study</td>
<td>• This team acted as the main liaison for the Amec study and also coordinated with consultant studies undertaken for the Region of Halton (GM Blue Plan) and Conservation Halton’s assessment of the August 4, 2014 Storm by Environmental Water Resources Group</td>
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<tr>
<td>Creek Erosion and Maintenance</td>
<td>• Established enhanced level of service for creek maintenance.</td>
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<td>• In coordination with Conservation Halton, revise the authorization protocols and process for routine and emergency maintenance works in the flood plains.</td>
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<tr>
<td>Private Property and Lot Grading</td>
<td>• Enhanced &quot;Drainage Concerns and Response database&quot; for logging and responding to resident drainage calls.</td>
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<tr>
<td>Data Management and Geographic Information Systems</td>
<td>• Incorporate collected flood data into GIS mapping.</td>
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<td>• Development of post-event data collection and coordination protocols between agencies.</td>
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<tr>
<td>Ontario Disaster Relief Assistance Program (ODRAP)</td>
<td>• Coordination with Burlington Community Foundation</td>
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<td>• the 314 claims have been reviewed and adjudicated by Cunningham Lindsay, the insurance adjuster</td>
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Flooding Mechanisms

Storm drainage is provided through many interconnected components including building drains (foundation drains, eavestroughs and downspouts), catchbasins, inlet grates and storm sewers, (collectively referred to as the minor system) and overland flow routes including lot grading, swales, ditches, roadways, creeks, culverts and bridges (i.e. overland flow routes or the major system). A more comprehensive background on this is provided in the city’s 2007 White Paper on Storm Drainage (COMSERV-09/07). In addition sanitary sewer systems can be impacted by storm runoff or groundwater entering into this system. Flooding to buildings can occur through riverine flooding (creeks exceeding their channel capacity), water entering a building overland due to poor grading, subsurface entry of ground water through foundation cracks, back up of storm foundation drainage or back up from the sanitary sewer system or a combination of the above.

This report will present an analysis on the various components of the city’s storm drainage system and recommendations to reduce the risk of future flooding. Recommendations in the report reflect the complex nature of the drainage system and include infrastructure upgrades, stormwater management flood control facilities, operational improvements and homeowner education and assistance programs.

The Region of Halton is taking the lead on basement flooding resulting from sanitary sewer back up through its Basement Flood Mitigation Study and has retained the consulting firm of GM Blue Plan. However recognizing the interrelationships between the two systems there has and continues to be a high degree of collaboration between the City and the Region.

Ultimately reducing flooding risk will require coordinated action on the part of the City, Region, transportation corridor agencies and the public. There is no one singular action or program but rather concerted action from all these parties will be required to address the threats from severe weather and climate change impacts.

2. Amec Foster Wheeler Flood Vulnerability, Prioritization and Mitigation Study

The City retained Amec Foster Wheeler to undertake a Flood Vulnerability, Prioritization and Mitigation Study. Phase 1 of this study assessed the areas impacted by the August 4, 2014 flood in order to better understand how the various components of the city’s drainage system functioned and the mechanisms leading to flooding damage. Computer modelling has been used to undertake an overall assessment of the drainage system across the whole city, recognizing that the August 4, 2014 rainfall was concentrated in the areas between Guelph Line and Appleby Line but wanting to understand how the drainage system would have responded if this storm had occurred elsewhere in the city. Once areas with risk were identified a long list of flood mitigation options was evaluated
for their effectiveness in reducing flood risk and recommendations made for upgrades to be implemented on a priority basis.

Phase 2 of the study dealt with flood mitigation assessment for specific localized areas impacted by the August 4, 2014 flood.

**Phase 1 – Flood Vulnerability and Prioritization**

This Phase of the Study consisted of the following tasks:

- Task 1: Data Collection and Background Review
- Task 2: Rainfall Characterization
- Task 3: Flood Characterization
- Task 4: Riverine Flood Vulnerability Modelling
- Task 5: Major System Flood Vulnerability Assessment
- Task 6: Preliminary Flood Mitigation Opportunities
- Task 7: Phase 1 Documentation

Tasks 1 and 2 were reported at the Development & Infrastructure Committee meeting of November 17, 2014 (CW-03-14). Tasks 3 through 6 are now substantially complete and a summary of these findings and recommendations follows. Technical Progress Update memos have been prepared documenting the analyses as the study has progressed. Final documentation of the Phase 1 findings will be provided by Amec Foster Wheeler in the fall 2015.

**Flood Characterization: (Task 3)**

The rainfall of August 4, 2014 was concentrated over the central part of the city impacting the Upper Rambo/Hager, Roseland, Tuck, Shoreacres, Appleby and Sheldon Creek watershed areas as outlined in Figure 1, attached in Appendix “A”. These watersheds are of similar size extending from the slopes of the Niagara Escarpment, just north of Dundas Street/Highway 407 and outletting to Lake Ontario. The upper parts of the watersheds are comprised primarily of rural agricultural lands and the lower 2/3 of urban lands developed under various stormwater design standards. Also along the length of these watercourses they cross the Highway 407, CN Halton, MTO and CN Oakville Subdivision corridors. The lands within these corridors are under the jurisdiction of the related operating authority. In relation to the flood situation, there is nothing that the City is aware of that could bring any portion of these lands under the regulatory control of either the City or Conservation Halton. This part of the study focused on assessing the ability of the major
creek systems and related culvert/ bridge crossings and any creek enclosures to convey the flood flows.

**Upper Rambo/Hager System**

The Upper Rambo and Hager creeks are diverted along the 407 Corridor and directed through a series of stormwater management flood control ponds to the Diversion Channel south of Fairview Street and outlet into Burlington Bay at the bottom end of Indian Creek. This system was developed to address historic flooding along these watercourses south of the QEW. This system performed well during the flood event with no reported riverine flooding. However localized flooding in proximity to culverts under the CN Halton subdivision was reported.

**Roseland Creek**

The Roseland Creek watershed was developed through the 1960’s and 70’s without modern stormwater management controls. Significant enclosures to the watercourse exist from Dundas Street downstream to Guelph Line, just north of Upper Middle Road and from the QEW, to south of Prospect Street. Past studies and capital works have identified and implemented various strategies to enhance flood protection in the lower reaches of this watershed including, partial diversion of flows to the Rambo/Hager/407 Diversion Channel, twinning of the enclosure from the South Service Road at the Holiday Inn, as well as channel upgrades. Flooding in the Roseland Creek Watershed was limited to localized areas as a result of the lack of overland conveyance system and inlet capacity constraints to capture flows. Downstream of the QEW this system performed well, with no reported riverine flooding south of the QEW. However north of the QEW, surface flooding was experienced particularly in the area between the CN Halton Subdivision and the North Service Road.

**Tuck Creek**

The lower reaches of Tuck Creek were largely developed in the 1960’s and the upper sections, north of Upper Middle Road in the Headon Community, were developed in the 1980’s. There is an enclosure of the upper reach of the creek from Driftwood Park conveying flows under Hwy 407 and outletting to an open channel in Ireland Park at Berkshire Lane, otherwise the creek is open. The lower reaches of Tuck creek south of the QEW have been channelized during a period when the design standard was the 50 year flood (+/-). Historically Tuck Creek has not had a history of riverine flooding. During the August 4, 2014 storm there was considerable riverine flooding along Tuck Creek with 65 buildings reporting flooding and 13 culverts overtopping, including:
- Driftwood Park flooded
- 407 overtopped
- Headon Road overtopped
- Palmer Drive overtopped
- Elwood Road/New Street/Regal Road overtopped
- Spruce Avenue overtopped

**Shoreacres Creek**

The upper reaches of Shoreacres Creek largely developed in the 1980’s and 90’s, with some stormwater management controls and a creek channel with Regional Storm conveyance capacity. Downstream of Fairview Street the area developed in the 1960’s with an open channel section.

During the August 4, 2014 event it appeared that there was a partial diversion of flows from Shoreares Creek down the Hwy 407 corridor to Tuck Creek, causing damage to the highway drainage system and contributing to flood flows in Tuck Creek. Flooding of the creek was reported in the area including:

- Mainway overtopped
- Heritage Road overtopped
- North Service Road and QEW overtopped
- creek through Nelson Park overtopped
- south of New Street to Shoreacres Road (major creek bank erosion)

**Appleby Creek**

Appleby Creek drains through the Alton Community, Millcroft and Tansley Communities. This section of the creek system has been developed to Regional Storm Standards. Downstream of the QEW, various culvert and channel upgrades have been undertaken in the past. During the August 4, 2014 event, flooding of the Appleby Line Railway Underpass occurred.

**Sheldon Creek**

Sheldon Creek drains through the Alton and Orchard Communities and has been developed with contemporary stormwater management controls. During the August 4, 2014 event there were no reports of buildings or roadways overtopped as a result of riverine flooding.
Riverine Flood Vulnerability Modelling (Task 4)

All creeks within the urban boundary were assessed through computer modelling for performance. The purpose of this exercise was to stress test the capacity of all creek systems across the city under various flooding scenarios, and not just those where the August 4, 2014 storm was centred. The results of this analysis identified flood vulnerable areas under two primary categories:

- “Riverine Flood Vulnerable Areas” - 75 flood vulnerable areas along urban creeks were mapped and analysed. These areas were prioritized in order of their risk of flooding to properties and buildings.

- “Flood Vulnerable Roads” – 132 bridge and culverts were analysed at creek crossings under various levels of storms. These bridges and culverts were prioritized in order of the risk of overtopping of the roads.

The above foregoing was used in the subsequent evaluation of mitigation opportunities undertaken as part of Task 6

Major System Flood Vulnerability Assessments (FVA) (Task 5)

This analysis sought to identify and prioritize areas in the city that have depression areas with no positive surface (urban major) system outlet. Areas were assessed using 3D digital topographic mapping utilizing GIS technology. 110 identified areas were subsequently prioritized based on flood frequency potential and number of impacted buildings. Areas with adjacent reverse grade driveways were assigned the highest priority in this analysis.

Preliminary Flood Mitigation Opportunities (Task 6)

A long list of flood mitigation alternatives for each flooding mechanism identified under Tasks 4 & 5 (riverine and urban major) was generated to assess potential mitigation opportunities. These included stormwater management facilities (ponds) for flood control, culvert, channel and storm sewer upgrades to increase conveyance capacity, diversion, flood proofing and property acquisition. A listing and more complete discussion of these alternatives is included in Appendix “B”.

Stormwater Management (SWM) flood control ponds were evaluated for their effectiveness in reducing flooding. This included a review of 17 potential SWM pond sites throughout the city on vacant properties, parks, open spaces, unused road allowances and hydro corridors. The construction cost of SWM facilities and the value of the land can vary widely depending on the size and location of the site as well as the nature of the property ownership (i.e.: city-
owned land or privately owned land requiring purchase). These factors were considered as part of the evaluation.

**Creek and Storm Water Infrastructure Improvement Scenarios**

The above two comprehensive analyses were the basis for proceeding with the establishment of a long list of 50 potential creek and storm water infrastructure improvement scenarios.

- Detailed modelling of 33 of these scenarios was undertaken.

- A Cost Benefit Analysis to provide a relative comparison of the 33 modelled creek improvement scenarios was completed.

As a result of these analyses, the capital works projects summarized on Table 1, along with preliminary estimated costs are recommended over the next 10 year period (+/-). Implementation of each of these projects will be subject to the specific requirements of a Class Environmental Assessment Study, applicable permitting requirements and available funding.
Table 1 - Recommended Flood Mitigation Opportunities

<table>
<thead>
<tr>
<th>Description of Proposed Work</th>
<th>Estimated Cost</th>
<th>Minus Funding allocated in previous budgets and forecasts</th>
<th>Additional Capital Funding Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuck Creek – Upgrade Regal Rd culvert and channelization between New St and Regal Rd</td>
<td>$3.50M</td>
<td>$1.93M</td>
<td>$1.57M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade New St culvert and channelization upstream of New St.</td>
<td>$3.80M</td>
<td></td>
<td>$3.80M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade Spruce Ave culvert</td>
<td>$1.36M</td>
<td></td>
<td>$1.36M</td>
</tr>
<tr>
<td>Roseland Creek – Upgrade Lakeshore Rd culvert</td>
<td>$2.10M</td>
<td>$2.10M</td>
<td>$0.00M</td>
</tr>
<tr>
<td>Appleby Creek – Channelization of creek south of Fairview St., along bike path &amp; Upgrading of Pinedale Ave Culvert</td>
<td>$2.76M</td>
<td></td>
<td>$2.76M</td>
</tr>
<tr>
<td>Roseland Creek – Upgrade New St. culvert</td>
<td>$3.60M</td>
<td></td>
<td>$3.60M</td>
</tr>
<tr>
<td>Roseland Creek – Construct SWM pond on Leon’s property north of North Service Rd</td>
<td>$3.70M</td>
<td>$1.73M</td>
<td>$1.97M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade Rexway Dr culvert</td>
<td>$1.37M</td>
<td></td>
<td>$1.37M</td>
</tr>
<tr>
<td>Falcon Creek – SWM</td>
<td>$2.00M</td>
<td></td>
<td>$2.00M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade Rockwood Dr culvert</td>
<td>$1.37M</td>
<td></td>
<td>$1.37M</td>
</tr>
<tr>
<td>Provisional allowance for areas still under investigation (Major System FVA)</td>
<td>$4.25M</td>
<td></td>
<td>$4.25M</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td><strong>$29.81M</strong></td>
<td><strong>$5.76M</strong></td>
<td><strong>$24.05M</strong></td>
</tr>
<tr>
<td>Minus funding allocated in 2016-2024 account SD0113 “Climate Change &amp; Flood Mitigation Measures”</td>
<td></td>
<td></td>
<td>- $4.07M</td>
</tr>
<tr>
<td><strong>Total Phase 1</strong></td>
<td></td>
<td></td>
<td><strong>$19.98M</strong></td>
</tr>
</tbody>
</table>

**Further Analysis Required for Major System – Overland Flow**

Further analysis is to be undertaken in 2016 to determine the potential for major system overland flow routes in areas identified by Amec as the top 20 prioritized Urban Flood Vulnerable Areas (FVA) (localized depression areas which do not have an overland flow route to convey surface rainwater drainage away).

Capital costs to implement those solutions will be reported back to committee in the form of a recommendation report. A provisional item has been included in Table 1 to address this at this time.
Phase 2 – Flood Mitigation Projects

The following specific sites were identified as locations where improvements could be undertaken without undertaking comprehensive Environmental Assessments and design processes. Amec’s scope of work for this phase includes a detailed review of the minor and major storm systems at each location and modelling of proposed infrastructure improvement scenarios, as necessary. The projects were divided into 3 groups. The schedule for receipt of recommendations for the three groups is as listed below.

- **Group 1 (recommendations complete)**
  - Brant @ Cavendish Drive
  - Grenallen Drive hydro ROW
  - Bennett Road hydro ROW
  - Ingersoll Drive (further analysis in progress)
  - Overton Drive / Kirkburn Drive

- **Group 2 (recommendations in Q3 2015)**
  - Driftwood Park
  - Beaufort Drive
  - Auburn Crescent
  - Bristol Drive
  - Mullin Way
  - Bridle Wood

- **Group 3 (recommendations in Q4 2015)**
  - Hadfield Court
  - Ayr Place
  - Itabashi Way
  - Ashland Drive
  - Shoreacres Creek @ Hwy 407 ETR

The “Phase 2 – Group 1” analyses and recommendations are complete, with the exception of Ingersoll Drive which requires additional work as a result of the complex nature of this project. Staff is proceeding with design of the recommended works. Construction is planned for Q3 and Q4 2015. The recommendations for these works are summarized in Appendix “C”

“Phase 2 – Group 2” analyses are in progress.

“Phase 3 – Group 3” analyses are to start in July 2015.
Staff will proceed with design of the recommended Group 2 and 3 works upon receipt of recommendations. Construction is proposed to proceed in late 2015/spring 2016.

The 2015 Capital Budget included funding of $1.5M in account SD0113 “Climate Change and Flood Mitigation Measures” to address the implementation of Phase 2 works. The final budget requirements will be reported in the fall of 2015 upon completion of additional work on these projects, in particular mitigation works required at Ingersoll Drive and Driftwood Park.

3. Creek Erosion and Maintenance Operations

A Creek Erosion and Maintenance sub committee has been established with representation from Capital Works, RPM and Conservation Halton to review creek erosion and maintenance programs. Included in this review is the establishment of maintenance and approval protocols with Conservation Halton to allow for more timely review and approval of routine creek maintenance and erosion control activities. Following the August 4, 2014 flood, Roads and Parks Maintenance removed major debris from over 120 locations in the city’s urban creeks. RPM also provided assistance for major debris clean-up on private properties.

Council approved an additional $100,000 in the 2015 RPM base operating budget for creek maintenance. This funding is being used for:

- Debris clean-up program
- New bi-annual creek debris inspection program
- New equipment to assist debris clean-up in areas with access challenges
- Rural ditching program

Further details regarding RPM's 2015 Debris Clean-up Work Plan for $100,000 Additional Funding are provided in Appendix “D”

Climate Change weather patterns are very likely to result in more frequent severe storms which have the potential to cause severe creek bank erosion. The creek erosion capital works program will continue to focus on creek bank rehabilitation projects to improve the overall condition of all City urban creeks.

The 2015 City-wide Creek Condition Inventory Inspection is scheduled for the summer and fall. The following are being added to the scope of work:
1. Geo-referenced “Go-Pro” video inspection. This will provide video footage of all creeks within the urban boundary. Geo-referencing will allow exact locations to be identified using our GIS program.

2. The identification of locations of major debris accumulation. The identification of major debris locations in combination with ongoing RPM debris monitoring and maintenance will be used to identify candidate locations for the installation of debris catchers.

An assessment of the effectiveness of the additional $100,000 annual funding for creek maintenance is to be completed by RPM staff prior to the 2016 Budget process in order to provide recommendations regarding this level of funding for future years.

RPM has adopted an enhanced level of service with regards to creek maintenance and debris removal. Where flood vulnerable areas are located downstream of debris accumulations, the debris is being removed from the creek property. Standard Operating Procedures that reflect the enhanced level of service are being finalized.

4. Private Property Drainage and Lot Grading

A significant amount of flood damages incurred during the August 4, 2014 event could have been mitigated with improved building drainage measures and lot level grading on private property. To assist with this City staff has responded to a significant number of resident calls including one-on-one meetings with residents. This is a time consuming but value-added process. A subcommittee has been established to review the city’s policies and practices for responding to these enquiries, develop tools for logging and tracking calls utilizing GIS, reviewing applicable by-laws and public education and outreach programs. One program under development for implementation in 2016 is to standardize these assessments into a Flood Prevention Home Check Up. Previously, in response to similar issues resulting from flooding in 2007, staff initiated a Residential Drainage Assistance program (E-31/13). The Flood Prevention Home Check Up would be a simplified evaluation intended to convey non binding information to homeowners on measures they can undertake to reduce flooding risk on their property.

Related to this are the potential impacts from intensification and the need to ensure that stormwater management and lot grading activities on these developments are coordinated to the highest degree possible, with the needs and limitations of the overall storm drainage system. To achieve this, the Site Engineering Group in the Planning and Building Department will be moved back to the Development and Environmental Engineering section in Capital Works. This shift will not impact the commitment to timely delivery of the city’s
one window development review services. It will however afford a greater coordination and consistency in the review of all private property and development related stormwater and grading issues with both existing and new development. It is worth noting up until 2005, the Site Engineering Group was in the Engineering Department and in 2013 the subdivision review technologists were also moved from Engineering to the Planning and Building Department.

In 2013 the Development and Environmental Section of the Capital Works Department eliminated the position which coordinated and responded to residential drainage concerns. Those responsibilities were distributed to the remaining staff. Since that time, particularly with the August 4, 2014 storm, staff has been significantly challenged to respond in a timely manner to these issues. The level of service and response time to residents has suffered as a result.

In the summer/fall of 2015, Halton Region’s Downspout Disconnection program will require assistance from Capital Works with regards to approving downspout discharge locations. This is considered a high priority work assignment that will also require resources to address.

As a result, the following action is recommended:

1. Re-establish a full-time Stormwater Management Technician position in the Development and Environmental Engineering section of the Capital Works Department who is dedicated to stormwater works including responding to lot grading and drainage concerns at an estimated annual cost of $95,000.

Legal staff will work with the Capital Works staff to develop appropriate parameters around the activities/programs undertaken on private property to ensure that there is no increased risk to the City’s liability arising from advice given in respect of private property lot drainage issues

5. Burlington Community Foundation (BCF) and Ontario Disaster Relief Assistance Program (ODRAP) – Application for Provincial Funding

Following the August 4, 2014 flood the Burlington Community Foundation was approached to assist with the establishment of a Flood Disaster Relief Committee to address the financial needs of the many residents impacted by the storm. The Burlington Community Foundation, staffed with professional fundraisers, was chosen to lead the fundraising efforts as well as the claims application and disbursement program. As outlined in the ODRAP Guidelines, the DRC and it sub-committees must act as autonomous bodies. Committee
members cannot be members of council and should have no potential conflict of interest in the collection or distribution of funds.

Working with a team of volunteers the DRC committee raised $896,000, in a hundred day campaign, from the community. They also helped secure provincial ODRAP funding of up to $3 million, to cover the provincial matching funds for paying eligible claims from individuals, small businesses, farmers and non-profit organizations impacted by the flood.

There were 314 claims received from the community. All of the 314 claims have been reviewed and adjudicated by Cunningham Lindsay, the insurance adjuster, and the DRC’s claims subcommittee. The city’s claim request for provincial funds has been filed and approved by the province. The community fundraising dollars, $896,000, were matched on a 2:1 basis by the province. Final payments will be issued and mailed to claimants in the coming weeks. The DRC expense portion of the ODRAP funding will be finalized in the coming weeks.

6. Coordination with Partners

Halton Region

City staff is currently coordinating with Halton Region staff on the following three programs:

Program #1 - Basement Flooding Prevention Subsidy Program

The City of Burlington is continuing to coordinate with Halton Region on its Basement Flooding Prevention Subsidy Program.

Houses constructed prior to approximately 1968 have no storm laterals draining the foundation drain or weeping tile. As a result, the foundation drains are connected directly to the sanitary sewer laterals. In these cases, rain water or ground water can be collected in the foundation drains and conveyed to the sanitary sewer. This is an old design standard. This construction practice has not been authorized in the City of Burlington since the late 1960’s.

City staff has been assisting and directly coordinating with Halton Region to mitigate this situation through involvement in the Region’s Basement Flooding Prevention Subsidy Program in the following ways:

- Planning and Building Department and Capital Works Department are expediting the permit approvals process for the disconnection of weeping tiles from sanitary laterals as well as the installation of sump pumps and back water valves.
Planning and Building Department staff are performing plumbing inspections for the disconnection of weeping tiles from sanitary laterals, installation of sump pumps and back water valves.

Capital Works staff is inspecting and approving sump pump discharge locations on-site with the contractors.

553 Building Permits have been issued by the City. For the remainder of 2015, residents are not required to pay the respective fees to the Planning and Building Department for these permits.

Halton Region is continuing this program throughout 2015, with the City providing coordination and assistance.

It is anticipated that several hundred more permits will be applied for over the coming months. Significant staff time has been and will continue to be allocated to this work in order to allow construction to be completed in a timely and coordinated manner.

It is recommended to continue to provide the grant program in 2016 for Building Permit fees related to Halton Region’s “Basement Flooding Prevention Subsidy Program” for the installation of back water valves, disconnection of foundation drains from sanitary sewer lateral, installation of foundation drain sump pumps, in cases where the houses have experienced basement flooding. In 2014, a total of $176,983 was funded from the Tax Rate Stabilization Reserve Fund. In 2015, a total of $38,885 has been funded to date. It is estimated that the cost of a grant program to offset these fees for 2016 is in the order of $50,000.

Halton Region retained GM Blue Plan Engineering Limited to review and assess their sanitary sewer system and the sewer back-up flooding. This study has resulted in the recommendations of the following two programs, which are being implemented in 2015 in 7 priority areas within Burlington (refer to Appendix “E” for detailed Priority Area maps)

Priority Areas 1- 5: generally described as the south-east section of Burlington, east of Walkers Line and south of the Hydro ROW.

Priority Areas 6 -7: generally described as bounded by the 407 ETR to the north, QEW to the south and on the east and west sides of Guelph Line.

Program #2 - Downspout Disconnection Program.

This program will be initiated in the early summer of 2015 and continue through the fall. The City will be providing coordination and assistance as follows:
- Capital Works coordination and inspection for the approval of downspout discharge locations.
- These inspections will require a Capital Works field inspector to assist Halton Region.
- Downspout disconnections are not to be undertaken in the Top Twenty Urban Flood Vulnerable Areas. These areas will not be included in Halton Region’s program.
- Program details are currently being finalized by Halton Region.

**Program #3 - Sanitary Sewer Improvements Program.**

This program will be initiated in the summer 2015 and continue through the fall.

- Capital Works staff is working with Halton Region staff to coordinate these works with the City’s capital roads reconstruction and “shave and pave” programs.
- Program details are currently being finalized by Halton Region.

**Conservation Halton**

In April 2015, Conservation Halton (CH), in association with Environmental Water Resources Group Limited (EWRG), finalized its “August 4th, 2014 Storm Event, Burlington” report. This report includes:

- Storm Characterization
- Flood Damage Characterization
- Watershed Response
- Recommendations

The following are Conservation Halton’s report recommendations. Capital Works staff is in agreement with the following four recommendations:

1. *An investigation should be conducted in partnership with the City of Burlington to determine what mitigation measures can be implemented to reduce future riverine flood damages along Tuck Creek upstream and downstream of New Street.*

2. *An investigation should be conducted in partnership with the City of Burlington to determine the extent of runoff diverted from Shoreacres Creek into Tuck Creek at Highway 407 ETR during the August 4th, 2014 storm event. Also, the investigation should determine what mitigation measures could be constructed to*
prevent or reduce any future spills from Shoreacres Creek into Tuck Creek in this location.

3. An assessment should be conducted in partnership with the Regional Municipality of Halton and the City of Burlington to inventory the number and location of telemetered rainfall and streamflow gauges within their respective networks to identify potential gaps. Expansions to the networks should be undertaken in a collaborative and coordinated manner to facilitate data sharing and enhance flood forecasting and emergency response capabilities within the City of Burlington. These improvements will help to better equip all agencies to respond to similar events in the future as more frequent short intense storms are expected as a result of a changing climate.

4. Consideration should be given to updating the watershed studies for Roseland, Tuck, Shoreacres, Appleby and Sheldon Creeks in an effort to explore opportunities to reduce storm runoff rates and volumes.

In addition, the City and Conservation Halton are developing revised authorization and permitting protocols for emergency and routine maintenance infrastructure works in regulated flood plains and watercourses. The intent is to simplify and expedite the approval process for:

1) Routine channel maintenance and debris clearing.
2) Emergency channel maintenance and debris clearing.

These protocols are currently being refined in a coordinated manner between both parties. We anticipate that formalized protocols will be implemented by Q4 2015.

7. Coordination with Highway and Railway Authorities

Neither the City of Burlington nor Conservation Halton has regulatory authority over the design, approval or construction of storm water infrastructure on the 407 ETR, QEW right-of-way, and railway corridors. Works related to culverts and storm water drainage has the potential to impact the conveyance of storm water through these corridors. Capital Works staff is currently coordinating with the following authorities to move forward in a more coordinated and cooperative manner.

407 ETR
In 2009, the 407 ETR initiated a multi-year storm sewer rehabilitation program for highway cross culverts and storm sewers in its road allowance, in order to reline or replace aging infrastructure with structural deterioration. The 407 ETR has provided the City with details of this program this past winter. Amec Foster Wheeler has included these data in its modelling. The City and Amec have been consulting with 407 ETR regarding its design and construction activities. Concern has been raised by city staff with 407 ETR regarding the need to better understand the works being constructed and the potential impacts to the city’s storm water infrastructure and property owners. Regular communication and coordination meetings have been initiated with 407 ETR.

Ministry of Transportation (MTO)

Design and construction coordination for repair works for culverts crossing the QEW at Tuck Creek and Shoreacres Creek. This work includes coordination with Halton Region and Union Gas.

Regular communication and coordination meetings have been initiated with MTO regarding these works.

CN Railway

58 cross culverts under CN tracks are located in Burlington.

11 agreements exist where the City is responsible for the maintenance and replacement if required. Locations other than these 11 have no agreements in place. It is the City’s position that CN is responsible for these locations.

A review of all cross culvert locations is underway, regarding condition, capacity, ownership and maintenance responsibilities.

Regular annual communication and coordination meetings are being scheduled with CN.

8. Infill Storm Water Design Standards

Design standards for high density and commercial/industrial infill developments were revised in early 2014 to require the control of the 100 year post-development peak flow to the 2 year pre-development peak flow. The application of this policy will result in the post-development peak storm water flows being reduced relative to the pre-existing peak flows, improving system capacity/resilience.

9. Stormwater Inlet Structures
1-2 stormwater inlet structures are currently included in the annual capital budget on an ongoing basis. The “Minor Storm Inlet/Outlet/Drainage Improvements” account typically has $100,000 of funding annually. The “Climate Change and Flood Mitigation Measures” account established following the August 4, 2014 storm is also being utilized to fund this type of work. Recommended works from the Amec Foster Wheeler study will be the focus at present, however in future years additional selected storm inlet structures will be retrofitted or replaced with higher capacity inlet grates in locations that have need of a greater inlet capacity or are have a high risk of debris blockage.

10. Updating of Watershed Models

The engineering analyses undertaken in the Amec “Flood Vulnerability, Prioritization and Mitigation Study” provide the basis for continued improvements to the existing watershed models. Subject to the approval of an additional FTE in the Development and Environmental Engineering section, staff will maintain and update the watershed models as opposed to undertaking formal Master Plans for all urban creeks.

The updating of 2 watersheds per year over the next 6 years will proceed in the following prioritized order:
   i) Tuck Creek
   ii) Roseland Creek
   iii) Appleby Creek
   iv) Indian Creek
   v) Falcon Creek
   vi) Shoreacres Creek
   vii) Sheldon Creek
   viii) Aldershot Creeks
   ix) Hager-Rambo Creeks
   x) Grindstone Creek
   xi) Bronte Creek

Where major creek improvement projects are recommended, as a result of this work, Environmental Assessments will be necessary. Consultation with the public regarding these projects will be a key component of the process.

11. Southern Ontario Municipalities’ Responses and Best Practices
A number of municipalities across southern Ontario have experienced significant flooding in the last 15 years. The increase in extreme weather and heavy rainfall is not unique to the
City of Burlington. The chart below identifies various municipalities and their responses to significant rainfall events.

Table 2 - Municipal Survey

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Date of Storm Event</th>
<th>Rainfall Amount</th>
<th>Flood Response</th>
</tr>
</thead>
</table>
| Cambridge        | July 15, 2004 and Sept, 16 2006 | rainfall events comparable to the 100 year return period. | • Initiated flood study and Storm Water Master Plan  
• Recommendations included installation of a new culvert and improvement of a natural water channel through the Galt Golf Course and an on-line flood control structure. |
| Hamilton (Binbrook) | July 22, 2012 | 160 mm in 3 hours | • Area-specific storm water studies  
• Sewer pipes rehabilitation program through Cured in Place technique ($47 million)  
• Protective Plumbing Program for rebates for private homeowners for installation of backwater valves and sump pumps and disconnection of downspout ($5 million) |
| Mississauga      | July 8, 2013 | 126 mm in 2 hours | • Initiated flood study  
• Funding provided to accelerate storm water capital projects  
• Storm Water User Fee system passed in May 2015 |
| Peterborough     | July 15, 2004 | 193 mm in 12 hours | • Initiated flood study and development of Flood Reduction Master Plan  
• Backwater Valve Subsidy program ($1 million)  
• Sanitary Sewer rehabilitation program ($5 million) |
Thunder Bay | May 28, 2012 | 77 mm in 2 hours | • Initiated flood study  
• Subsidy program for installation of backwater valves and sump pumps and disconnection of downspout  
• Developed Climate Change Adaption Plan

A review of municipalities that have not had major flooding events but are changing policies to provide alternate methods of future funding for storm water infrastructure was undertaken. The chart below provides a summary.

**Table 3 - Municipal Stormwater User Fees**

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Alternate Method of Storm Water Infrastructure Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guelph</td>
<td>• Aug. 2013 initiated Storm Water Funding Study to explore alternative ways to pay for city’s storm water management program based on its City-wide Stormwater Management Master Plan 2011.</td>
</tr>
</tbody>
</table>
| Kitchener    | • Adopted Storm Water User Fee in 2011  
• Storm Water Master Plan – initiated in 2014, guide next 15 years |
| Waterloo     | • Adopted Storm Water User Fee in 2011  
• Finalized Master Drainage Study for Urbanized Sub watersheds in 2015 |

As the number of extreme rainfall events increase, municipalities in Southern Ontario are finding ways to deal with the large costs associated with managing the storm water infrastructure. In most cases, flood studies reveal that flooding is an issue of capacity during an unprecedented rainfall event and not the structural condition of the system.

12. **Mayor Goldring’s Climate Change Summit**

Plans are currently underway for a November 2015 event where elected officials from all levels of government, representatives from the insurance industry, the Insurance Bureau of the Canada, the Institute for Catastrophic Loss Reduction and Conservation Authorities will all come together to discuss how communities can build resiliency against the impacts of
overland flooding whether through investment in infrastructure, changes in behavior or the offering of affordable overland flood insurance.

An evening “Inspire Burlington” free community event focused on climate change is also being planned for November 3, 2015.

More information on both events will be shared as the details are firmed up.

Financial Matters:

Total Financial Impact

The following chart provides a financial summary which includes recommendations for city staff initiatives and the recommended capital projects from Table 1.

Table 4 - Recommended 10 Year Capital Program

<table>
<thead>
<tr>
<th>Description of Proposed Work</th>
<th>Year</th>
<th>Estimated Cost</th>
<th>Minus Funding allocated in previous budgets and forecasts</th>
<th>Additional Capital Funding Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm Water Utility Rate Study</td>
<td>2015</td>
<td>$0.25M</td>
<td>$0.25M</td>
<td>$0.00M</td>
</tr>
<tr>
<td>Storm Water Design Standards – Climate Change Study</td>
<td>2016</td>
<td>$0.03M</td>
<td></td>
<td>$0.03M</td>
</tr>
<tr>
<td>Storm Water Design Standards – Update the “Storm Water Design Criteria Manual”</td>
<td>2016</td>
<td>$0.03M</td>
<td></td>
<td>$0.03M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade Regal Rd culvert and channelization between New St and Regal Rd</td>
<td>Tbd</td>
<td>$3.50M</td>
<td>$1.93M</td>
<td>$1.57M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade New St culvert and channelization upstream of New St.</td>
<td>Tbd</td>
<td>$3.80M</td>
<td></td>
<td>$3.80M</td>
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<tr>
<td>Tuck Creek – Upgrade Spruce Ave culvert</td>
<td>Tbd</td>
<td>$1.36M</td>
<td></td>
<td>$1.36M</td>
</tr>
<tr>
<td>Roseland Creek – Upgrade Lakeshore Rd culvert</td>
<td>Tbd</td>
<td>$2.10M</td>
<td>$2.10M</td>
<td>$0.00M</td>
</tr>
<tr>
<td>Appleby Creek – Channelization of creek south of Fairview St., along bike path and culvert upgrade at Pinedale</td>
<td>Tbd</td>
<td>$2.76M</td>
<td></td>
<td>$2.76M</td>
</tr>
<tr>
<td>Roseland Creek – Upgrade New St. culvert</td>
<td>Tbd</td>
<td>$3.60M</td>
<td></td>
<td>$3.60M</td>
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<tr>
<td>Roseland Creek – Construct SWM pond on Leon’s property north of North Service Rd</td>
<td>Tbd</td>
<td>$3.70M</td>
<td>$1.73M</td>
<td>$1.97M</td>
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<tr>
<td>Tuck Creek – Upgrade Rexway Dr culvert</td>
<td>Tbd</td>
<td>$1.37M</td>
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<td>$1.37M</td>
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<tr>
<td>Falcon Creek – SWM</td>
<td>Tbd</td>
<td>$2.00M</td>
<td></td>
<td>$2.00M</td>
</tr>
<tr>
<td>Tuck Creek – Upgrade Rockwood Dr culvert</td>
<td>Tbd</td>
<td>$1.37M</td>
<td></td>
<td>$1.37M</td>
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<tr>
<td>Provisional allowance for areas still under investigation</td>
<td>Tbd</td>
<td>$4.25M</td>
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<td>$4.25M</td>
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### Subtotals

<table>
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<th>$30.12M</th>
<th>$6.01M</th>
<th>$24.11M</th>
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<tbody>
<tr>
<td>Minus funding allocated in 2016-2024 account</td>
<td></td>
<td></td>
<td>- $4.07M</td>
</tr>
<tr>
<td>SD0113 “Climate Change &amp; Flood Mitigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measures”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$20.04M</td>
</tr>
</tbody>
</table>

The 2015 Capital Budget and 2016 – 2024 Capital Budget Forecast includes $1.5M in 2015 and $1.001M in 2016 for “Climate Change & Flood Mitigation Measures”. These funds will be applied to delivering the 2015/16 program outlined above.

### Storm Water User Fee

The City has undertaken an initial assessment of establishing a storm water user fee as a mechanism to fund storm water capital and operational needs. Initially this assessment considered the viability of establishing a separate Service Based Corporation (DID-3-15) in addition to a utility rate. It is recommended that a separate Service Based Corporation not be pursued but rather a utility rate be established within the context of the existing city structure similar to the model currently employed by the Region for Water and Wastewater Charges. This would involve shifting the cost of these programs from the general property tax base where costs are apportioned on an assessed value basis to a rate that better reflects a property’s contribution to storm water runoff. The following steps are recommended:

1) Establish a stakeholders group (internal and external) to more fully assess:
   - Storm Water Program priorities for next 5-10 years
   - Desired levels of service and annual costs
   - Data to support billing for storm water fees using impervious area or other site specific data to support a rate structure
   - Appropriate bill delivery and collection system
   - Methods to educate the community on services and needs

2) A typical timeline to engage the public, work through program details, and build a rate structure and billing file is approximately 18 months.

### Other Resource Impacts

In addition to the above capital costs the following operational cost enhancements are being recommended:

- The addition of a Stormwater Management technician position to assist with grading and drainage enquires and to increase the capacity for delivery of the storm water management capital program. The cost is estimated to be $95,000. It is recommended that this position be filled initially on a contract basis to allow for timely
support to the Region’s programs this summer/fall and that the initial cost from this be funded by gapping dollars within the Capital Works Department and that the position be budgeted and filled on a permanent basis for 2016.

- It is estimated that the cost of a grant program to offset building permit fees for 2016 is in the order of $50,000 to be funded from the Tax Rate Stabilization Reserve Fund.

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**Environmental Matters:**

The City is involved in the implementation of two action plans to mitigate greenhouse gas emissions contributing to climate change, including the corporate Energy Management Plan and the Burlington Community Energy Plan. Improving the energy efficiency of buildings and transportation modes will help to reduce emissions.

Climate change adaptation recognizes that our climate is changing and having an impact on city operations and infrastructure, particularly through severe weather events. This report deals with options for the City to adapt natural and structural infrastructure to prepare for future storm events and resultant flooding potential.

With respect to creek ravines, as noted in the report, adaptation options will be influenced by the size of the stream and ravine and amount of public space verses private land, as well as creek hydrology and capacity. There may be additional work required on policy development related to the balance between a natural ecosystem approach to creek restoration and enhancement and a more engineered hardscape approach to maximize conveyance capacity. Maintenance operating procedures will also need to be reviewed in an attempt to reduce debris blockage during storm events, resulting in localized flooding. Each creek environment will need to be reviewed based on its attributes and assessed for opportunities to adapt to a changing climate.

Major creek and storm water infrastructure improvement projects identified in this report, if approved, will be subject to the Environmental Assessment process and regulatory approvals.

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**Public Engagement Matters:**

Updates are being posted about the city’s flood response activities on the city’s website at [www.burlington.ca/flood](http://www.burlington.ca/flood).

An overview of this study was provided to the City’s Sustainable Development Committee in June, following their presentation on their State of the Environment Report V to Committee, where stormwater management issues were identified.
Following the July 6, 2015 Development and Infrastructure Committee meeting, an update will be posted on the website, as well as neighbourhood meetings planned to discuss the area-specific recommendations provided in this report.

Conclusion:

The Flood Vulnerability, Prioritization and Mitigation study and staff’s flood response work have identified recommendations for creek and storm water infrastructure improvements.

Staff recommends the identified funding requirements be approved in principle, subject to approval of the 2016 budget process

Respectfully submitted,

Cary Clark, Manager of Development & Environmental Engineering
335 7600 ext. 7672

Appendices:

A. August 4, 2014 Rainfall and City Watersheds Plan
B. Long List of Preliminary Flood Mitigation Opportunities
C. Phase 2 – Flood Mitigation Project Recommendations
D. RPM’s 2015 Debris Clean-up Work Plan for $100,000 Additional Funding
E. Priority Area Maps for the Downspout Disconnection Program and the Sanitary Sewer Improvements Program

Notifications: (after Council decision)

<table>
<thead>
<tr>
<th>Name</th>
<th>Mailing or E-mail Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Harnum – Halton Region</td>
<td><a href="mailto:jim.harnum@halton.ca">jim.harnum@halton.ca</a></td>
</tr>
<tr>
<td>Kathy Menyes – Conservation Halton</td>
<td><a href="mailto:kmenyes@hrca.on.ca">kmenyes@hrca.on.ca</a></td>
</tr>
</tbody>
</table>
Approved by:

  Allan Magi, Executive Director of Capital Works
  Joan Ford, Director of Finance
  Nancy Shea Nicol, City Solicitor
  Scott Stewart, General Manager, Development & Infrastructure Division
  James Ridge, City Manager

Reviewed by:
APPENDIX “A”

August 4, 2014 Rainfall and City Watersheds Plan
APPENDIX “B”

Long List of Preliminary Flood Mitigation Opportunities

The follow table summarizes the long list of alternatives, opportunities and limitations in the priority Flood Vulnerable Areas (FVA’s) identified across the City of Burlington.

<table>
<thead>
<tr>
<th>Type</th>
<th>Alternative</th>
<th>Mechanism</th>
<th>Opportunity/Constraint</th>
</tr>
</thead>
</table>
| Stormwater Mgmt       | Online      | Riverine  | -Evaluation has focused on watersheds that contain the greatest number of priority FVAs: Tuck, Roseland and Falcon One opportunity has been analyzed in each priority watershed  
                       |             |           | -Preferred opportunities provide large available footprint area and are located downstream of a significant development area (e.g. south of Upper Middle) and upstream of priority FVAs  
                       |             |           | -Land acquisition presents the greatest constraint                                                                                                                                                                     |
| Over Control New Development | Riverine    |           | -Primary opportunity relates to greenfield development which is limited to Indian and Falcon Creek, north of CPR\(^1\)  
                       |             |           | -Secondary (minor) opportunity relates to infill development city-wide  
                       |             |           | -This alternative has not be been evaluated as part of this study                                                                                                                                                     |
| Conveyance            | Culvert Upgrades | Riverine  | -Culvert upgrades are considered the preferred FVA-specific alternative as they are: often a significant cause of both private and road flooding; currently owned by the City; have minimum construction impact on private property; can be synchronized with required transportation network upgrades; may already require replacement for structural reasons  
                       |             |           | -An assessment of culvert capacity has been complete City-wide resulting in a prioritized list of Flood Vulnerable Roads (FVRs) – this has been cross referenced with the FVA analysis  
                       |             |           | -For several priority FVAs on Tuck and Roseland Creek, the existing creek block width is narrow (10 to 20 m) limiting the maximum culvert span (without land acquisition)  
|                       | Channel Improvement | Riverine  | -Channel improvements are considered a very effective alternative, however extremely constrained by terrestrial impacts and existing narrow creek blocks (10 to 20 m)  
                       |             |           | -For several priority FVAs, the existing channel has already been improved with gabion or armourstone banks and in some cases bed (e.g. Roseland Creek downstream of Guelph Line;) within the existing creek block, thereby limiting the feasibility/benefit of further improvement;  
                       |             |           | -Considering the above, concrete rectangular channels provide the only significant conveyance improvement in several priority FVAs. These have been evaluated for the purpose of understanding the maximum potential flood mitigation without acquiring private property  
<pre><code>                   |             |           | -It is noted were this alternative considered feasible, significant resistance from Conservation Halton (CH) is expected from the aquatic/terrestrial perspectives. Feasibility will need to be determined |
</code></pre>
<table>
<thead>
<tr>
<th></th>
<th>Sewer Upgrades</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sewer Upgrades</strong></td>
<td>- Sewer upgrades are generally not an alternative that is considered in modern urban areas as storm sewers are typically isolated from residential properties (i.e. no lateral connection, or connections can be severed) and do not provide conveyance for large flood events. - Exceptions are where no major overland (surface) flow route exists; the Ingersoll Drive neighbourhood (URO3) is such an example. - Other opportunities relate to road sag points where reverse driveways make home extremely vulnerable to ponding in the right-of-way (UAP21).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Diversions</th>
<th>Channel/Pipe</th>
<th>Riverine/Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diversions</strong></td>
<td>- Riverine diversion have been screened out due to the impacts to aquatic/riparian habitat in originating system and the flooding/erosion impact on the receiving watercourse (which is likely already flood vulnerable). - Riverine diversions are also not supported by CH. - Urban (storm sewer) diversions are potentially a feasible option where the diversion directs flow out of a FVA but it remains within the original receiver (intra-watershed diversion). - This alternative has been evaluated in combination with stormwater management for URO3 (Ingersoll Drive – Phase 2 Project 5).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Flood Proofing</th>
<th>Berming/Flood Wall</th>
<th>Riverine/Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flood Proofing</strong></td>
<td>- Berming has been determined to be an extremely constrained alternative due the existing narrow creek block in most priority FVAs. - Flood walls are considered highly constrained due to the impacts on flood elevations upstream, further they are not preferred by residents (all priority FVAs are residential) as they obstruct views and access from the rear yard. - No opportunities for flood walls have been evaluated as the feasibility is considered limited; feasibility would require an additional modelling to support an impact assessment.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Building Improvement</th>
<th>Riverine/Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building Improvement</strong></td>
<td>- Flood proofing is generally considered where no other alternatives are feasible or the cost/benefit of other alternatives is not adequate.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Property Acquisition</th>
<th>Riverine/Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Property Acquisition</strong></td>
<td>- Property acquisition is considered a last resort due to the associated capital cost and social impacts. - This alternative has been evaluated in combination with channel improvements for RTK3 and RTK4 where the acquisition of a few properties benefits many.</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** 1. This alternative was evaluated as part of the Falcon Creek Hydrology & Hydraulic Study (Valdor Engineering Inc, 2012).
APPENDIX “C”
Phase 2 – Flood Mitigation Project Recommendations

Project 1 – Brant Street @ Cavendish Drive

Problem – During the August 4th, 2014 storm event, residents along Kristie Court reported flooding entering their properties overland from their rear yards and causing basement flooding. Debris is understood to have accumulated at the inlet and reduced its capacity.

Recommendations

Short Term – Re-direct flow that overtops the Cavendish inlet/ditch towards the Cavendish Drive right-of-way by way of a combination of earth fill and grading in the easement area, transitioning into a low-height wall at the southwest corner of 2400 Kirstie Court. The wall should continue along the south side of the lot beyond the home.

Long Term – Additional analysis of the Brant Street storm sewer should be completed to determine if storm sewer upgrades would be beneficial.

Project 2 – Grenallen Drive Hydro Right-of-Way

Problem – As a result of the August 4th, 2014 storm event and previous events, storm water flow has scoured the backfill around Inlet 1 creating a void on the west side of the structure that is a safety hazard. Amec staff has spoken with the residents with rear yards adjacent to the ditch inlets (2385 and 2431 Grenallen Drive) and they confirmed that surface flooding of their properties did not occur during the August 4th, 2014 storm event. The resident at 2385 Grenallen Drive did note that they had historic rear yard flooding, but that no flooding had occurred since they re-graded their yard.

Recommendations

Repair scour around Inlet 1.

Project 3 – Bennett Road Hydro Right-of-Way

Problem – During the August 4th, 2014 storm event and during other historic events, rear yard surface flooding has been experienced by 4473 Bennett Road and neighbours to the east. The surface flooding is related to a rear yard catch basin behind 4473 Bennett Road and accumulation of debris at that location.
Recommendations

The ditch inlet has sufficient capacity, however the installation of a bird-cage catch basin grate to reduce the impact of debris accumulation is recommended.

Inspect and maintain the catch basin free of debris.

Meet with the adjacent residents and discuss the potential for the catch basin to collect debris and the need/benefit of maintaining it.

A redundant catch basin could be considered, however, given the capacity of the ditch inlet and the extent of impacts limited to rear yard ponding, it is not considered to be warranted.

Project 5 – Ingersoll Drive

Problem

Ingersoll Drive is parallel to Highway 407 and is at the bottom end of a 192 ha +/- drainage area for which there is only a minor system (storm sewer) outlet. The low point on Ingersoll Drive is provided spill relief only through private property on the south side between 2261 and 2263 Ingersoll Drive. Several homes in this area have reverse graded driveways, which flood with only moderate ponding on the road.

An 1800mm diameter storm sewer runs between 2261 and 2263 Ingersoll Drive before being conveyed under Highway 407, to Ireland Drive, and ultimately to Roseland Creek. Site reconnaissance and correspondence with 407 ETR has determined that 407ETR has relined the 1800 mm smooth inside wall spiral rib steel pipe (SIWSRP) under the right-of-way with a 1350 mm High Density Polyethelene (HDPE) pipe. The two (2) pipes have similar Manning’s values and as such the lining represents a dramatic reduction in flow capacity for the system. It is understood that this relining was undertaken in 2013, prior to the August 4, 2014 storm.

Recommendations

Request 407 ETR to return the 1800mm diameter pipe to its original design diameter.

Complete the additional analysis to refine the feasibility and cost-benefit of the Sewer Upgrade. If this project is to advance, 407 ETR should be advised and replacement of the 407 ETR culvert should be based on the proposed sewer upgrade.

A SWM facility at Kinsmen Park (underground storage) was analyzed and is not recommended because of the limited benefit and the high cost of implementation.

Coordination with 407 ETR and further analysis is required in order to determine the final recommended approach.
Project 16 – Overton & Kirkburn Drive

Problem (Overton Drive)

During the August 4\textsuperscript{th}, 2014 storm event, 2483 Overton Drive experienced overland flooding. Based on discussion with city staff, it is understood that flooding was caused by overtopping/failure of the Dundas Street ditch immediately north of the property. It is at this location that a large culvert crosses Dundas Street at approximately a 90 degree angle.

A ditch inlet with a 750 mm diameter pipe is also located behind 2453 Overton Drive, for which there has been historic drainage problems. It is understood that the inlet was cleaned out and the swale that conveys major system flow to Eaglesfield Drive was re-graded in recent years.

It is noted that the major overland flow swale outlets to Eaglesfield Drive behind 2483 Overton Drive, and that this flow may have combined with the flow from Dundas Street and contributed to the flooding at this location. Although the available vertical grade between the swale and the rear yard is not significant, it appears that it should be sufficient if the ditch at Dundas Street ditch is intact.

Recommendations

Short Term – In coordination with Halton Region, re-align the Dundas Street culvert so that the outlet is located to the east side of Eaglesfield Drive, to minimize the risk of flow being conveyed towards 2483 Overton Drive. This will also provide a more efficient transitional angle into the ditch. Discuss possible scheduling of the recommended works with Halton Region staff.

Upgrade the capacity of the ditch inlet to be equal to or greater than the capacity of the downstream pipe in order to minimize the frequency of overtopping along the rear-yard major system swale.

Long Term - Further improvements to the outlet of the rear yard major system swale could be considered to increase the vertical grade between the swale and the rear yard at 2483 Overton Drive. Improvements would require adjustments to the Eaglesfield Drive road profile. This improvement is not recommended considering the high expected cost and low potential benefit.
Problem (Kirkburn Drive)

During the August 4\textsuperscript{th}, 2014 storm event, the resident at 2283 Kirkburn Drive reported overland flooding resulting in ponding depths of 1 to 2 feet on the west side of their home. Based on discussion with City staff, it is understood that storm water that caused the flooding flowed from the adjacent Eaglesfield Community Church property.

Field reconnaissance determined that the south Dundas Street ditch is only 0.3 m deep adjacent to the church soccer field, as it approaches the gravel driveway (it is 0.6 m +/- deep upstream). Based on local contours, when this ditch overtops upstream of the driveway, flow is conveyed directly to the side lot of 2283 Kirkburn Drive.

No flooding was reported at the ditch inlet located behind the rear yard of 2307 Kirkburn Drive.

Recommendations

In coordination with Halton Region, increase the capacity of the Dundas Street south ditch by berming adjacent to the soccer field, and blending into the existing gravel driveway. Localized adjustment of the driveway profile may also be required. Discuss possible scheduling of the recommended works with Halton Region staff.

Spill frequency would be reduced to the 50 year event.
**APPENDIX “D”**

**RPM’s 2015 Debris Clean-up Work Plan for $100,000 Additional Funding**

**Debris Clean-up Projects**

Debris clean-up locations being completed in 2015 are listed in the table below.

RPM staff regularly coordinates with the Conservation Halton staff to review project locations and permitting requirements. Significant debris removal projects are typically undertaken by contractors.

<table>
<thead>
<tr>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
</table>
| 239 Malvern/Penn Dr. (from lakeshore road up to the bottom of Malvern) | - Logs in creek - remove  
- Uprooted trees and woody plants lining edge of creek – remove  
- All debris transported off site |
| 2195 Walkers Line (Shoreacres Creek from Walkers Line to Millcroft Park Dr) | - Remove Uprooted trees multiple log jams in creek  
- Millcroft Park Dr. by culvert – large pile of debris located in middle of creek  
- Remove 14’ steel and wood bridge  
- This area is large enough to place woody debris 50 yards back from creek |
| 1047 Greenwood Dr. | - Two uprooted trees in creek to be removed |
| Tuck Creek between Upper Middle & Palmer Dr (behind Lester B Pearson) | - woody debris jam causing ponding and back water impacts  
- large amount of woody debris to be removed |
<p>| Tuck Creek behind 261 Lakeview | - woody debris and shale blockage |
| Tuck Creek at Harvester | - large shale build up in middle of creek |
| Tuck Creek at Fairview | - woody debris to be removed |
| Sheldon Creek behind 5354 Riverside Dr | - woody debris to be removed |
| Harvester Rd culvert east of Morris Dr | - remove debris and vegetation |
| Mainway culvert west of Heritage Rd | - clear debris |</p>
<table>
<thead>
<tr>
<th>Location</th>
<th>Details</th>
</tr>
</thead>
</table>
| 4350 South Service Rd. (Shoreacres Creek beside Ron Joyce Centre) | - exposed gas line  
- remove tree remove  
- stones |
| Walkers Line at Britannia | - tree to be removed |
| Wellington Park | - woody debris to be removed |
| Harvester Rd culvert west of Century | - remove woody debris and shale build up |
| Driftwood Park | - woody debris to be removed upstream in watercourses south of Dundas Street. |
| Pineland Park | - woody debris to be removed |

**Bi-Annual Creek Inspection Program**

Best management practices now will include regular inspection of all creeks in order to proactively identify debris and potential creek blockages. In addition to the ongoing inspections carried out by staff, Bi-annual inspections are now included in the creek maintenance program.

The objectives of this inspection program are to:

- Identify debris issues that can potentially impact the creek and increase the risk of flooding, categorized as now needs, 1 – 5 year needs, etc.
- Identify trees with a high probability of failure that may result in personal injury, property damage or a potential obstruction in the watercourse

A consultant will be retained to undertake the inspections and provide recommendations that will prioritize work programs for the following 1-2 years.

**Equipment**

The uneven topography and often tight quarters of creeks provide a challenging environment in which to respond to a flood clean-up. Additional equipment is needed to support staff in flood response.

A grapple attachment for a backhoe that will allow staff to pull out logs and other debris, and a wood chipper for a skid steer will allow staff to chip debris on site.
**Rural Ditching**

In many areas of rural Burlington, the ditches are not part of a formal maintenance program. A ditching program is now in place for 2015. Ditches will be maintained on a rotating basis.

The following provides a summary of the allocation of the $100,000 additional funding for the next 5 years.

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APPENDIX “E”
Priority Area Maps for the Downspout Disconnection Program and the Sanitary Sewer Improvements Program