# REPORT TO COMMON COUNCIL

The City of Saint John

M & C 2011- 149

June 13, 2011

His Worship Mayor Ivan Court
And Members of Common Council

Your Worship and Members of Council:

**SUBJECT:**

**Glen Falls Flooding and Residential Relocation**

**BACKGROUND**

Council commissioned development of a Stormwater Management Strategy in June 2006 after a particularly heavy rainstorm caused serious flooding in a number of areas of Saint John, including new subdivisions, as well as Marsh Creek and Glen Falls. Terrain consulting engineers (now Genivar) was engaged by Council to develop the Strategy, in which Marsh Creek was again a primary focus of attention and study.

Key findings and recommendations on the Marsh Creek system were included in the Stormwater Management Strategy report presented and adopted by Council in December 2008. Terrain found that the flood risk area for Glen Falls in a 1:100 return period storm event closely approximates the flood risk area outlined in the City's Flood Risk By-law that was adopted in 1980. The latter is based on aerial photos following a severe flooding event in November 1975, and on study work performed over 30 years ago by consulting engineers Proctor and Redfern Limited. Terrain's main recommendation to reduce flooding in heavy rainfall events in Glen Falls and the Marsh Creek Drainage Basin was to divert excess runoff from tributary streams in the upper reaches of the basin into Drury Cove via a closed pipe system. The initial estimate for diversion was expensive ($18M) but the proposal held the potential to finally "solve" the periodic flooding that has been affecting Glen Falls residents and neighbouring businesses. Accordingly, Terrain was engaged to do preliminary design and a cost benefit analysis for the proposed diversion.

The preliminary design and cost benefit analysis report was tabled in December 2009. The updated cost estimate for construction of the proposed piped diversion was $51,660,000. This, plus less than universal public support for the project and the potential for storm surge related flooding in the basin, halted further work on the diversion proposal. An idea was then put forward to consider relocation of residents from areas of the flood zone most at risk of future

flooding, and restoration of the vacated areas as natural wetlands. This suggestion was raised at a public meeting for residents of Glen Falls held on Thursday July 15, 2010 at Exhibition Park. The Mayor, members of Council, and City staff were present to provide an overview of the Stormwater Management Strategy and the status of the Preliminary Design and Cost Benefit Analysis for the piped diversion. Residents were encouraged to provide their opinions, thoughts and feedback on the potential for relocation.

While citizens were not universally supportive, interest was expressed in the idea, and in what the details of such a plan might be. Forty three property owners subsequently indicated an interest, one way or another, about the idea of selling and relocating – forty one saying yes they would sell, one saying no, and another expressing interest. Since the meeting two more property owners have indicated their interest in pursuing such an option.

Subsequent to the meeting at Exhibition Park the matter was considered by Council in Committee (land matter) with a staff report suggesting relocation be considered within the context of a comprehensive overall plan to address flooding in the area. Council adopted this position and the purpose of this report is to update Council, review the current situation and propose a comprehensive plan of actions for Council's consideration and direction.

## ANALYSIS

### Why Does Periodic Flooding Continue to Occur in Glen Falls?

Glen Falls, and much of the surrounding area is built upon a natural flood plain, the same as parts of Fredericton, Maugerville, Oromocto and other communities are built upon the natural flood plain of the Saint John River. In severe rainstorms there is more runoff generated and directed into Marsh Creek than the channels can carry (i.e. the channels are not large enough to handle the volumes of runoff generated).

Insufficient channel capacity, in places reduced further by obstructions, will cause water levels to rise in the upper channels of the Marsh Creek system. As water levels rise above storm sewer outfalls, runoff from streets and private properties cannot drain away as freely and water begins to collect in the pipe systems and to pool around street catch basins and other system inlets. Ponds grow wider and deeper as runoff collects and moves towards lower lying ground. In more severe storms, the channel banks themselves may be overtopped by water, which then flows overland via the path of least resistance.

A more formal summary of contributing factors is reprised below from the Proctor and Redfern engineering reports of 1974 and 1976. Some of the individual issues noted in the points below have been addressed since then, but the basic principles are still applicable.

#### Causes of Flooding

1. The effect of the Tide on Discharge to the Sea – during high tide when stream flow cannot be discharged from Marsh Creek into the sea, serious flooding can occur when the volume of water

in the system is greater than the storage volume available within the channel and undeveloped flood plain areas (e.g. forebay; Glen Falls Floodway)

2. Hydraulic Inadequacy of Bridges and Culverts – many bridges and culverts along the Creek did not have adequate capacity to transmit peak flows which occur during heavy rain – this causes a rise in water levels above or behind the structure (backwater effect) – the most significant structures in this regard are the Marsh Creek Bridge ***(since replaced with a clear span by NBDOT in 1982)***, the Strescon plant on Ashburn Road, and the Rothesay Avenue crossing near McAllister Drive ***( since upgraded by NBDOT in 2001)***
3. Inadequate Channel Capacity – *(the already inadequate capacity of the channels)* to carry flows from heavy rains have been reduced by siltation, overgrown vegetation, debris, and encroachment of building construction.
4. Development Within the Natural Floodplain – buildings erected within the natural floodplain are subjected to periodic inundation and consequent damages when stream flows exceed the channel capacity.

In addition to being on a natural flood plain for Marsh Creek, much of Glen Falls and surrounding area was once a tidal flood plain – before the introduction of aboideaux (tide gates) prevented the tide of the Bay of Fundy from flowing inland over low lying salt marshes. Some points in Glen Falls are actually lower than the level of the high tide in the Bay of Fundy, which is now held back by the Courtenay Causeway and flood gates under the Causeway.

**Past Engineering Studies and Remedial Measures**

A series of increasingly more severe and damaging flooding events occurred over a period of 10-15 years in the sixties and seventies – April 1962, February 1970, December 1974, November 1975, January 1976. These led to the commissioning of a series of engineering studies by both the Municipal and Provincial governments, beginning in 1974 by Proctor and Redfern Limited, consulting engineers (P&R 1974; P&R 1976; P&R 1984).

These studies produced an abundance of information on the performance of the Marsh Creek system and tributary streams, primary causes and extent of flooding and flood risk areas, and recommendations to mitigate the effects of flooding. The excerpt above on "**Causes of Flooding**" is one example. Growing out of these studies was a series of recommendations for improvement that included both physical works (structural measures like dykes and dams) and non-structural measures like flood plain management. In fact, one non-structural measure recommended in the 1976 P&R Report was "evacuation" of residents from flood prone areas of Glen Falls – this was not acted on at that time because of the severity of flooding then extant and affecting not only property owners in Glen Falls but elsewhere in the flood risk area as well.

A program of remedial physical works and non-structural measures like the Flood Risk By-law that were of benefit to all affected property owners was chosen over the "evacuation" option. The adopted program was carried out, as far as possible, from 1978-1982 via tri-level government funding agreements (**An Agreement on Flood Damage Reduction For Marsh Creek Watershed**) overseen by a tri-level committee (**The Marsh Creek Flood Damage Reduction Committee**). Physical works like the Upper Glen Falls Reservoir (Dam), maintenance clearing

of channels and ditches, construction of the Marco Polo Bridge were completed or supported with funding from the "Agreement on Flood Damage Reduction For Marsh Creek" under the auspices of the Committee. A number of other improvements were also made by other parties (eg construction of dyke for Floodway #3; replacement of crossings including train trestles with culverts and clear span bridges).

**Upper Glen Falls Reservoir (Dam)**

A list of physical works completed over the years (plus past recommendations not yet acted upon) is attached to this report. Given the work that has been accomplished, the question might well be why does flooding yet occur, and why haven't past efforts been effective in reducing the flood plain footprint and eliminating flooding? The short answer is that not all of the works proposed in the earlier studies (for 1:100 year return protection and 1:25 year return protection) have been able to be carried out for the reasons noted below.

It might appear that the situation essentially remains unchanged given that the flood risk area in the Stormwater Management Strategy mirrors the Flood Risk By-law. However, the November 1975 storm that caused the most serious flooding to date and established the By-law flood risk areas is considered the equivalent of a 1:70 year return event. The flood risk area in the Stormwater Management Strategy reflects a 1:100 year return storm. Similar to the piped diversion recommended by Terrain, low benefit/cost ratios for some of the works recommended by Proctor and Redfern rendered them impractical, and the full 1:100 suite of recommendations was not acted upon. In fact not all of the 1:25 year recommendations could be acted upon, because one essential storage component of the whole system – the forebay area behind Courtenay Causeway - could not be secured for storage purposes.

The flooding situation in the Marsh Creek Drainage system has improved in terms of incidence, severity, and duration. However, periodic flooding has not been eliminated and, realistically, is not likely to be in the future, given the costs involved and other constraints on the system.

For residents, the fact that periodic flooding still affects the Glen is evidence the situation hasn't improved, the problem hasn't been "fixed". Besides the more general flooding episodes there are also local drainage issues in the Glen, the same as in other areas, that can influence perceptions and opinions. Examples of this include runoff in extremely intense rainfall events running from high ground down and through private lots toward the street or creek channel and causing localized flooding conditions, or surcharging storm systems.

The reason that more general flooding still occurs periodically is the same as outlined in the previous section – in particularly heavy rainfall events there is too much runoff generated for the Creek channels to handle (i.e. the natural channels are too small for the amount of water trying to flow through them).

**Current Conditions**

Discussions about drainage and flooding issues often include descriptions of the size or severity (volume/duration) of rainfall events in terms of a return period e.g. a 1:100 year return period or 1:10 year return period storm. Flood risk and/or flood protection levels may also be expressed as a 1:100 year level of protection, 1:25 year, etc. What exactly do these terms mean and how are they determined?

These terms are simply a way of categorizing any rainfall event by comparison with past rainfall records for a specific area like Saint John, and describing the probability that a certain sized storm, or larger, will happen. Small rainfall events happen more often, larger events less frequently. A 1:100 year return storm is a large storm that has a 1% chance (1/100) of occurring (or being exceeded) in any one year. A 1:20 year return storm is a smaller storm with a 5% chance (1/20) of occurring (or being exceeded) in any one year and a 1:5 year storm is smaller still with a 20% chance (1/5) of occurring in any one year. This doesn't mean that a 1:5 year size storm will occur once in a five year period, or only once, just that the probability of this size of storm or larger occurring is about once in five years - two could actually occur in the same week.

Categorizing rainfall events in this way allows engineers to assess, or design, drainage systems in terms of how much rainfall (and resulting drainage runoff) a system can handle. In this field, engineering assessment is much less precise than, for example, design of a bridge or building, where the strength of materials used and loads to be carried is much more accurately known and calculated.

Volumes of drainage runoff generated are based on assumptions and observations of the nature of the terrain as well as direct flow measurements and computer modeling. Actual storm events are related to "design" storms, although each storm event has unique aspects (in terms of intensity and duration). Run-off generated can also be affected by existing ground conditions (e.g. saturated vs. dry), height of ground water table and the like. In addition to these factors, the amount of flooding that may take place within the Marsh Creek flood plain in any particular event may also be influenced by other variables– e.g. how much storage exists within the system prior to the event (is it full or empty?); functionality of flood control structures – e.g. tide gates;

reservoir outlets (e.g. Lawlor Lake); localized flooding as noted above; presence of beaver dams (West Branch Marsh Creek); point in the tide cycle.

Actual storms may be classified against the design storm criteria to indicate severity. Engineering design size of drainage infrastructure is based on being able to handle certain return period "design" storms. In the Stormwater Management Strategy adopted by Council in December 2008 the principle of a dual system design of both a "minor" component (ditches/pipes) local drainage system and "major" overland component is a requirement for all new developments. The minor system is to be sized to handle a 1:5 year return event, while the major system must be able to handle a 1:100 year return event.

While this dual system design was not a requirement prior to 2008, the recommended programs of individual structural measures to remediate flooding issues in the Marsh Creek drainage system were first targeted to 1:25 year return (1974), then 1:100 year return (1976), and finally 1:25 year return (1979) as benefit/cost ratio and unavailability of land rendered a full program impractical. Individual projects like the Upper Glen Falls Reservoir were designed to detain a 1:100 year return storm to provide protection from downstream flooding, but not all elements of the recommended program were constructed and so the level of flood protection achieved for the Glen and other areas in the flood risk area remains much less.

A key flood protection component of the Marsh Creek drainage system is the downstream storage area (the forebay) that was created behind the Courtenay Causeway when construction was completed in 1963. Without this area for storage and the effective functioning of the tidal gate structure, water levels in the lower Creek are much higher, and flooding more severe all along the system. A staff report in 1990 indicated that flood protection was lower than a 1:5 year return storm when the tide gates were damaged and unable to prevent passage of seawater into the forebay area. The forebay (and tidal gate structure) is a critical feature which will be addressed later in this report.

In 1984 the New Brunswick Department of Environment commissioned Proctor and Redfern to do a "Marsh Creek Project Review" to assess the level of flood protection that had been achieved to that point. The idiosyncracies of the Marsh Creek system made a definitive calculation difficult, but the authors estimated that protection was "in the range of 15-25 years." They also noted that "culvert blockages, ice, and other local conditions may significantly affect the capacity of existing drainage facilities."

Despite further improvements in the system since 1984 (e.g. culverts at Simpson Drive and Rothesay Avenue; Glen Falls Floodway) the modeling done by Terrain in 2008 indicates there are a number of properties at risk in a 1:5 year return event, others at risk in a 1:10 year event and so on up to the 1:100 year event. There are also a large number of residential properties in Glen Falls out of the 1:100 flood risk area but also subject to occasional inconvenience caused by periodic flooding of streets.

**Courtenay Causeway and Forebay Storage**

The causeway across Courtenay Bay was conceived in the 1940's not only to alleviate growing vehicle traffic volumes between the City and Parish of Simonds but also as a means of providing greater downstream storage of flows from Marsh Creek during high tide in the Bay of Fundy. Floods affecting developed areas on the "Great Marsh" stretching from the Haymarket Square to Glen Falls were increasing, as development occurred on the marsh area and uplands around it. In 1948, consulting engineer D.O. Turnbull of Saint John confirmed the feasibility of a causeway in an engineering report to the commissioners of the "Great Marsh Commission". The location he suggested was very nearly the same as the current causeway and he provided preliminary design features (including a tide gate structure) and an associated cost estimate of $700,000.

Construction of the original (two-lane) Courtenay Causeway was completed in 1963 under a tri-party agreement between the Province of New Brunswick, City of Saint John, and Irving Oil Limited. In exchange for ownership of the reclaimed lands in Courtenay Bay (behind the Causeway), the Irving interests agreed to construct the base for the causeway and government provided the roads and associated amenities. A six culvert tide gate structure was included near the west side of Courtenay Bay. The Causeway was upgraded in the mid-seventies to four lanes with improved access at both ends (Union Street on the west and Bayside Drive on the east).

Porous fill materials in sections of the base allow passage of some seawater into the forebay area behind the Causeway, but with tide gates operating as designed, the Causeway provides a reasonable barrier against the high tides of the Bay of Fundy. This in turn provides a large, and extremely critical, storage area for runoff from Marsh Creek during periods of time when the tide is high. Before the Causeway was built, tide gates were located at the Marsh Bridge road crossing (Rothesay Avenue) east of Haymarket Square. The additional storage space for runoff made available by Courtenay Causeway alleviates flooding issues all along the Marsh Creek system, including Glen Falls. Without the influence of tidewater, normal water levels in the creek are lower and there is more initial storage capacity within the creek channels to handle runoff from heavy rainfall events. The tide gates allow for significant discharge of waters stored in the forebay during low tide, and for continuous downstream flow in Marsh Creek from the upper reaches of the system over the high tide cycle.

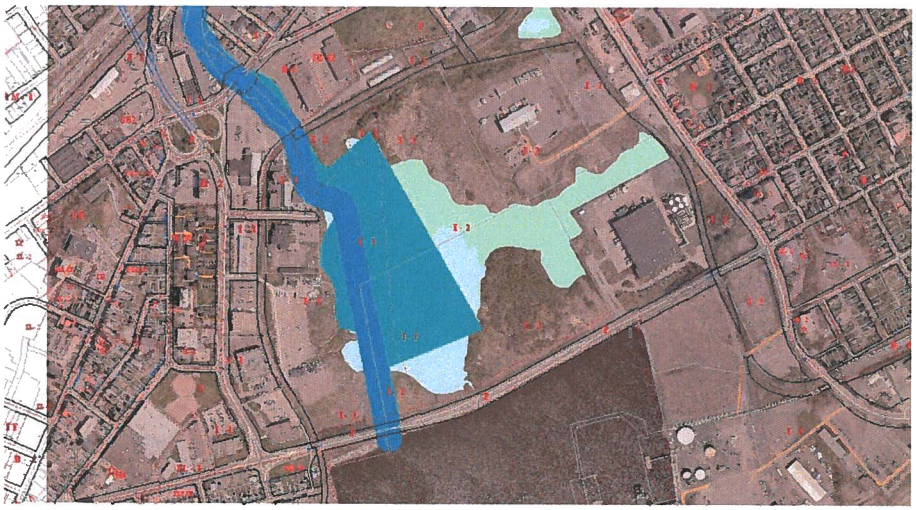
While forebay storage is a critical moderating influence on the severity (depth) and duration of upstream flooding that occurs, it is important to also understand that increasing the amount of storage capacity available at this location (e.g. excavation; installation of a pumping station or high capacity operable sluice gates) can further improve but not "eliminate" upstream flooding. Glen Falls will continue to flood when runoff from heavy rainfall events is too great for the narrow channels to handle, causing stream levels to rise and local storm sewers to surcharge.

Notwithstanding the fact that improvements to forebay storage cannot eliminate upstream flooding, increased storage capacity in this part of the system has consistently been recommended in engineering studies. In the 2008 Stormwater Management Strategy, recommendations to increase storage capacity at the forebay included installation of a pumping station (estimated at $11M) or high capacity operable sluice gates (estimated at $5M), but only

after the upstream piped diversion project was completed. The 1976 Proctor and Redfern report recommended acquisition and excavation of a 57 acre parcel of the forebay for flood storage to meet the objective of a 1:100 year return level of flood protection. This was later reduced to 26.6 acres as a 1:25 year return objective was adopted when the overall remedial program was modified in 1978-79 because of "low economic efficiencies" (i.e. the benefit cost ratio of some component projects were deemed not to warrant the expenditure).

When negotiations failed to secure the necessary lands, expropriation proceedings were initiated in 1982 by the City on behalf of the tri-level government partnership sponsoring the flood reduction program. That process did not acquire the necessary lands. With the inability to secure forebay lands, tri-level agreements expired and the City has worked essentially on its' own since then (with Provincial assistance for replacement of roadway culverts at Rothesay Avenue and Simpson Drive) to maintain the Creek system, and to fund various capital improvement projects as noted on the attachment. It appears that lower lying areas of the forebay providing storage space for runoff waters has not appreciably changed. Elevation data of the Marsh Creek drainage basin was acquired in the Stormwater Management Study using Lidar technology, so the amount of storage space available may be able to be determined without a land survey.

A 26.6 acre portion of the forebay is included in a flood risk area in the Flood Risk By-law as illustrated on the orthophoto below. Infilling of this area would require a permit and off-setting excavation elsewhere in the flood plain. Future use of the forebay is uncertain and clarification should be sought as part of a comprehensive plan to deal with flooding in the Marsh Creek Drainage Basin.



**Courtenay Bay Causeway and Forebay – Flood Risk Area in Light Blue**

## Relocation and Risk Mitigation Strategies

For the purposes of this report, the Glen Falls neighbourhood is that within the area bounded by Rothesay Avenue, Golden Grove Road, Broadway Avenue from Rothesay Avenue to Glen Road, Glen Road to Belgian Road, Belgian Road to John T. McMillan Avenue, John T. McMillan

Avenue to Golden Grove Road and all the homes from Belgian Road out to the dead end of Glen Road. Only the residential homes/properties lying within or touched by the flood plain identified as the "Glen Falls Flood Risk Area" within City BY-LAW NUMBER CP-11 THE FLOOD RISK AREA BY-LAW OF THE CITY OF SAINT JOHN" are considered in the numbers that are referenced in this report.

There are forty five property owners in Glen Falls who have indicated an interest in relocation, either at the public meeting of July 15, 2010 at Exhibition Park, or with City officials following the meeting.

Of these interested property owners, fourteen (14 ) have lots located in areas that could be affected by a return storm of 1:5 years – the total assessed value of these properties is $1,206,800. However, staff noted there are a total of 63 properties with a 1:5 year flood risk within the Glen Falls area as noted. At an average conservative assessment of $85,000 per unit, the total assessed value of residential properties within this risk group is $5,355,000.

Twelve (12) property owners with lots located within the 1:10 year return storm risk area indicated an interest in relocation, including one where the owner is not interested in selling and relocating. The total assessed value of these twelve is $999,300, less $115,800 for the person not interested. Overall, there are a total of 92 more properties in the 1:10 year flood risk category over and above the 63 properties in the 1:5 year flood risk area. At an average of $85,000 in assessed value the total value of these properties would be $7,820,000, in addition to $5,335,000 estimated for those with a 1:5 flood risk.

Five (5) more property owners that could be affected in a 1:25 year return storm, or smaller risk, expressed interest in relocation and these properties are assessed at $457,800. Of the other owners expressing interest in relocation, five (5) have properties within a 1:50 year return storm ($482,300), four (4) have properties within the 1:100 year return storm flood risk area ($426,400) and five (5) more ($517,100) are outside the designated flood plain.

An approach to relocation might be to consider the cost benefit for interested property owners most often affected (ie 1:5 year return period). Of course the potential financial implications of extending such an offer to all in the same flood risk zone has to be understood.

This is not the first time that re-location of affected residents from Glen Falls has been considered. In the Proctor and Redfern Report of 1975-76, "evacuation" of residents was one of five "non-structural" measures considered. In that report it was noted that "of the non-structural measures, residential evacuation presents the possibility of satisfying many of the objectives" (outlined at the beginning of the report). While not feasible at the time, relocation of some number of residents could possibly now be considered as part of an overall solution to flooding in the area.

Appealing though the idea may seem at first, there are certain realities. Higher risk properties are not all located in the same area – because of the relatively flat terrain even small variations in elevation can significantly alter risk categories. Properties at the highest risk of flooding may be

located across the street from those that are out of the flood zone altogether. Logistics of relocation would be complex and the cost of such a program high. Not all residents are in favour of relocating and wonder about the negative effects on their neighbourhood such a program could have. The Glen Falls neighbourhood has many appealing qualities, including proximity to the major commercial district, and it occupies a niche in the market.

Staff updated the 40+ residents who expressed interest in relocation via newsletter in April. More recently in May, staff and Ward 4 Councillors met with members of the "Glen Falls Community Committee" - their objectives include to "improve the quality of life of our residents and to preserve our neighbourhood for our neighbours and for future generations" and "protecting the future of Glen Falls so that it continues to be a vibrant long standing community". They wish to "work with the City of Saint John to help find economical solutions to the flood water problem with minimal cost to the City and the least effect on the environment." Of interest is that of those property owners who originally expressed interest in a relocation option, three are represented on the Committee. A program of improvements to public and private properties, similar to initiatives undertaken in other jurisdictions like New Orleans, may be a more practical and manageable proposal as opposed to full scale relocation (see below).

In addition to the above considerations there has been a considerable investment in public infrastructure in Glen Falls – in water and sewer services, storm drainage, streets, curbs and sidewalks. Residents of Glen Falls are one part of the equation. Taxpayers in general are another. Affordability and sustainability of solutions for all stakeholders will be a key to whether relocation would be a large or small component of an overall approach and plan to deal with the flooding issue.

**Future Steps**

As noted above, relocation of Glen Falls residents must be considered as a possible part of a comprehensive review and plan to address flooding that affects the Marsh Creek Drainage Basin. The piped diversion system proposed by Terrain cannot be justified based on the analysis of benefits to costs, similar to some other physical remedial works that were proposed in earlier engineering studies. However, other works could yield some incremental benefits for current flooding conditions. The most notable of these for Glen Falls flooding are upstream reservoirs at Mystery Lake and Kelly Lake to detain peak flows from entering the Marsh Creek system through Cold Brook. Similarly, an outlet control structure at Ashburn Lake could help reduce flows into the West Branch of Marsh Creek, while providing some benefit to the YMCA property located there.

Reconstruction/replacement of the Mystery Lake Dam with a new outlet control structure is being pursued, preliminary design and a wetland functional assessment and rare species survey has been undertaken, and an Environmental Impact Assessment (EIA) is planned in the 2012 Capital Program. Detention capacity is limited at Mystery Lake while Kelly Lake has more potential detention benefit. Preliminary actions were undertaken for Kelly Lake (lands acquired) and design initiated but not carried through when residents of the area approached Council of the day (1993) requesting that the project not proceed because periodically elevated water levels would negatively impact their properties. Of interest is that recent complaints of wet grounds were received from a property owner upstream of Mystery Lake and attributed to work to restore the structure, even though no work has been undertaken and the stop logs in the spillway have been removed for many years.

The attachment to this correspondence summarizes all remediation measures, proposed and executed, under five broad categories, - 1) detention/diversion, 2) channel efficiency, 3) downstream storage, 4) storage/efficiency, and 5) non-structural measures.

While remediation measures have been the focus of attention to try and improve conditions, continued maintenance of existing channels has always been a concern to prevent matters from worsening. To this end a comprehensive ongoing maintenance program is important, but is hampered by the fact that most of the creek system runs through privately owned lands. Another factor is increasing environmental regulation which prohibits, or complicates, traditional maintenance practices and approaches. The question of who is ultimately responsible for the creek system and its performance is a legal one which should be reviewed by legal staff and a determination made. Notwithstanding, extensive maintenance of the system of ditches in and around Glen Falls leading to Marsh Creek was recently undertaken and completed by City forces. More maintenance effort and resources (funding) in future will be required to maintain this drainage system infrastructure and assets in a restructured program.

Staff has made initial contacts with Provincial Emergency Measures officials seeking information on any flood assistance or relief programs that may be available or accessible to help address situations such as Glen Falls. At present there are no programs specifically dedicated to reducing flood risks but the Federal Government in conjunction with Territorial and Provincial

Governments launched "Canada's National Disaster Mitigation Strategy" in January 2008. There is no funding directly associated to this initiative, but eligible or approved mitigation measures could be supported through the Build Canada Fund. This is an avenue that could be pursued for designated mitigation projects. A tri-level approach for funding support should again be part of the plan on a go forward basis.

## CONCLUSIONS

The findings of the Stormwater Management Strategy, and Preliminary Design and Cost Benefits Analysis for the proposed piped diversion, leaves little doubt of the inevitability of continued flooding along Marsh Creek, without diversion or without a trend to lower amounts of precipitation and less severe storm events. The level of flood protection currently in place as expressed by "return storm" varies for Glen Falls residents, depending on the ground elevation of their property – some residents are affected by storms of less than 1:5 year return period, others 1:10 year return and upward, and still others are out of the flood risk zone altogether.

Weather appears to be trending to greater precipitation amounts and an increase in the frequency of severe rainfall events. Calculations for "design" storms may have to be revised as years pass and more data is collected. Design storms at best approximate actual rainfall events, but flooding conditions on the ground in the Marsh Creek Drainage Basin reflect other factors as well such as existing ground conditions and pre existing amount of storage available in stream channels and storage areas.

Physical works to provide flood level protection against 1:100 year return storms in this area are uneconomic on a benefit to cost consideration. The inability to secure forebay lands as a component of a 1:25 year protection program makes achievement of higher levels of protection even more remote.

Sea level rise is a factor to consider for low lying areas like Glen Falls and the Marsh Creek Drainage Basin. Flooding conditions will not improve as the sea becomes higher in relation to the Great Marsh area. Indeed the 2008 Stormwater Management Strategy Report identified a real flood risk to the area from storm surge in the Bay of Fundy, in combination with other factors.

Potential mitigation measures (physical works) other than diversion (e.g. construction of a control structure at Mystery Lake, detention at Kelly Lake and Ashburn Lakes, provision of more floodway space and the like) may all yield some incremental improvement to the frequency, severity, and duration of flooding that takes place, but the basic problem would remain for Glen Falls . At times there will be simply too much runoff from upland regions entering channels that are too narrow, shallow, and flat to carry all of the water directed into them, and flooding of Glen Falls and other low lying areas in the Marsh Creek flood plain will continue occur.

The Stormwater Management Strategy clearly indicates that proposed improvements in the lower basin (e.g. CNR culverts, Causeway sluiceway or forebay pumping) will not effectively change (improve) flooding conditions in Glen Falls, on their own. This is consistent with previous study

findings. The outline of the 1:100 flood plain determined by Terrain is almost identical to the Glen Falls and Lower Marsh Creek Flood Risk areas that were established in the Flood Risk By-law, based on earlier work by Proctor and Redfern.

Under the circumstances, relocation of homes and residents away from the most impacted areas has been raised as the only viable and sure way to reduce the impacts of flooding on citizens. Dialogue on this possibility has been opened with residents of the area and feedback received. The purpose of this report is to place the relocation proposal within the context of an overall plan and approach to the negative impacts of continuing periodic episodes of flooding.

There will be costs associated with any mitigation measure. The question will be how much, and then to determine a fair allocation among participating parties. Three levels of government were initially engaged in partnership to deal with the effects of flooding in the Glen Falls area. It would follow that an attempt to implement a plan to "finalize" dealings with flooding on this flood plain and mitigate damages should also involve the three government levels.

Finally the question of forebay storage should be addressed again in some manner, in order to properly consider all other parts of a comprehensive plan to deal with flooding in the Marsh Creek Drainage Basin.

**RECOMMENDATIONS**

It is recommended that the Common Council:

1. Recognizes that periodic flooding will continue to occur on the Marsh Creek Flood Plain.
2. Continues the process regarding design and reconstruction of a new outlet control structure for Mystery Lake.
3. Reviews the Flood Risk By-law as it may be applied to the flood risk area identified in the forebay; reviews By-law for changes to prevent further residential construction in the flood risk areas; revises flood risk areas based on Stormwater Management Strategy model.
4. Follows up to determine the current storage space available in the forebay area.
5. Prepares a comprehensive program of inspection and maintenance for Marsh Creek Drainage system.
6. Updates a flood response contingency plan in the event of flooding with warnings and public communications for severe events – through Saint John EMO
7. Engages the services of a consultant to determine the benefit and feasibility of constructing detention reservoirs on Kelly Lake and Ashburn Lake and models the performance of Majors Brook.
8. Consults with the YMCA (owners) concerning Ashburn Lake to determine interest in possibly re-building an outlet control structure for the dual purposes of the recreation facility and flood water storage.
9. Consults with appropriate staff of other government levels (eg NBEMO) regarding flood assistance and other programs that may be pertinent to this situation.

10. Consults with owners of the forebay lands to determine current status.
11. Develops a feasible assistance program for private property owners based on an appropriate cost sharing model and pursue tri-level government support.
12. Directs the City Solicitor to review the legal ownership of the creek system and physical structures and responsibilities arising therefrom for maintenance and efficiency performance in carrying flows.

Respectfully submitted,

J.M. Paul Groody P.Eng
Commissioner,
Municipal Operations and Engineering

J. Patrick Woods CGA
City Manager

| CATEGORY | Project |
|---|---|
| **Detention/Diversion** | Upper Glen Falls Reservoir |
| | Lower Marsh Creek Floodway(#3 - below Strescon) |
| | Lawlor Lake Outlet |
| | Forest Hills Dam |
| | Mystery Lake Dam |
| | Kelly Lake Reservoir |
| | Ashburn Lake Reservoir |
| | Dry pond/wetland enhance Majors Brook |
| | West Branch Marsh Creek to Drury Cove |
| | Mystery Lake to Cruickshank Lake (Blackall) & Little R. |
| | Piped Diversion - Drury Cove |
| **Channel Efficiency** | Clean channel; debris and vegetation |
| | Maintenance Program |
| | Add Culvert CNR (Below Marsh Bridge) |
| | Replace Culverts Clear Span CNR Below Marsh Bridge |
| | Replace CNR Trestle @ One Mile |
| | Marsh Bridge Add culvert |
| | Marco Polo Bridge |
| | Replace Ashburn Lake Road Bridge |
| | Replace Private Crossing - Strescon |
| | Remove Trestle Bridge MacKay Lumber |
| | Replace Culvert Rothesay Avenue |
| | Replace Culvert Simpson Drive |
| | Replace Culvert Glen Road |
| | Replace Culvert Connaught Ave. |
| **Downstream Storage** | Construct Courtenay Causeway c/w tide gates |
| | Forebay Storage (57 Ac) |
| | Forebay Pumps |
| | Cold Brook Floodway (#1)Excav 15 ac + 15 ac |
| | Majors Brook Floodway (#2) Excav 20 ac + 10 ac |
| | Local Diking/Flood Walls & Pumping- Glen Falls |
| | Local Diking/Flood Walls & Pumping- Majors Brook |
| | Forebay Storage (26 Ac) |
| | Forebay Pumps |
| | Courtenay Bay Storage |
| | Repair/replace tide gates |
| | Glen Falls Floodway |
| | Replace tide gates; install sluice gates or forebay pumps |
| | Study of Causeway; earth dam; higher levee |
| **Storage/Efficiency** | Enlarge/re-align narrow channels |

Re-alignment Ashburn Creek to Lower Marsh Creek
Enlarge Channel from Glen Road to CNR Crossing
Enlarge channel from Forebay to Strescon

**Non Structural Measures**

Residential Evacuation & Relocation Glen Falls
Floodplain Management - Flood Zones By-Law
Flood Warning & Emergency Evacuation
Flood Proofing
Flood Insurance
By-Law Amendments - no new residential until risk reduced
Study Forebay to establish storage volume & maintain
Benefits Cost to increase protection evaluated
Policy of 1:100 protection set
Buy/expropraite all lands along watercourses -
Initiate Negotiations with IOL - gain control of floodway
Zoning By-law - amended -floodway zone along watercourses
Consult NBDOT - replace tide gates with pump station
Storm Drainage Design Criteria Manual
Increase Controls Over Future Development on Floodplain

**P&R 76** - Water Management Study Marsh Creek Watershed - 1976 Proctor and Redfern Limited
**GFLR 87** - Glen Falls Flood Risk 1987 - Planning and Development
**FAP 90** - Marsh Creek Flood Risk Abatement Program - 1990 - Building and Technical Services
**ACRES/IOL 82**- Forebay Storage Options presented during forebay expropriation process - 1982
**SMS 08** - Stormwater Management Strategy - Terrain - 2008
**ENG** - Engineering Initiated Projects
**GEMTEC 09** - Mystery Lake Flood Control System 2009-2011
**TERR 09** - Preliminary Design and Cost Benefit Analysis 2009
**CADILLAC/AMEC** - McAllister Mall Flood Protection Project 2009-2010
**Turnbull 48** - Report to Great Marsh Commission on Feasibility of a Causeway across Courtenay Bay 1948

| Source | Status | Comments |
|---|---|---|
| P&R 76 | Complete '79 | |
| P&R 76 | Complete '79 | |
| P&R 76; Terr 09 | Repl. '79; '10 | |
| Eng | Complete '80 | |
| P&R 76; FAP 90 GEMTEC 09 | Prelim Design & EIA | |
| P&R 76; FAP 90 | Not pursued 1993; Kelly Lake Res | |
| Terr 09 | Further review req'd | |
| | | |
| Cadillac/AMEC | Private initiative - pending | |
| P&R 76 | N/R | |
| P&R 76 | N/R | |
| | | |
| SMS 08 | Suspended '10 during EIA | |
| | | |
| P&R 76 | Complete 78-79 City Forces | |
| P&R 76; GFLR '87 | Ongoing | |
| P&R 76 | Complete 78-79 CNR | |
| FAP 90; SMS 08 | Pending | |
| | Complete - clear span CNR | |
| P&R 76 | Decided on Clear Span | |
| Modified '77-78 | Complete '82 NBDOT | |
| | Complete NBDOT | |
| | Complete Strescon Ltd. | |
| | Removed | |
| FAP 90 | Replaced ' NBDOT | |
| FAP 90 | Replaced ' NBDOT | |
| Eng '08 | Replaced ' 09 CSJ | |
| Eng '08 | Replaced ' 10 CSJ | |
| | | |
| D. Turnbull '48 | Complete '63 | |
| P&R 76 & Modified | Dropped to 26 ac '78-79 | |
| P&R 76 | N/R | |
| P&R 76 | Not pursued | |
| P&R 76 | Not pursued | |
| P&R 76 | N/R | |
| P&R 76 | N/R | |
| Modified | Expropriation Unsuccessful '82 | |
| Acres '82 IOL | Offered to IOL to build; not pursued | |
| Acres '82 IOL | Dropped; Expense | |
| FAP '90 | | |
| Eng 99 | Constructed '99 & '01 | |
| SMS 08 | Pending upstream diversion | |
| SMS 08 | Expense; pending upstream diversion | |
| | | |
| P&R 76; | Not pursued - land acquisition & encroachment of structures | |

| | |
|---|---|
| P&R 76; | Not pursued |
| FAP '90 | Not pursued - land acquisition & encroachment of structures |
| FAP'90 | Not pursued - land acquisition & encroachment of structures |
| | |
| P&R 76; Eng 11 | N/R originally; reconsideration '11 |
| P&R 76 | PNB Legislation& Flood Risk By-law '80 |
| P&R 76 | Normal Operting Procedures |
| P&R 76 | Some work done by private owners |
| P&R 76 | N/R or Followed up |
| GFLR 87 | ? |
| GFLR 87 | Not pursued |
| GFLR 87 | |
| FAP '90 | |
| FAP '90 | |
| FAP '90 | |
| FAP '90 | |
| FAP '90 | |
| SMS 08 | Adopted '08 |
| SMS 08 | |