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TO:	**CHAIR AND MEMBERS CIVIC WORKS COMMITTEE MEETING ON JANUARY 6, 2015**
FROM:	**JOHN BRAAM, P.ENG. MANAGING DIRECTOR, ENVIRONMENTAL & ENGINEERING SERVICES AND CITY ENGINEER**
SUBJECT:	**2015 BURBROOK TRUNK STORM SEWER PROJECT INITIATION**

RECOMMENDATION

That, on the recommendation of the Managing Director, Environmental & Engineering Services and City Engineer, the following actions **BE TAKEN** with respect to the 2015 Burbrook Trunk Storm Sewer Project Initiation:

(a) the engineering fees for Hatch Mott MacDonald **BE INCREASED** by $250,906.38, in accordance with the estimate, on file, to an upset limit of $436,434.80, including contingency, excluding H.S.T., based upon the Fee Guideline for Professional Engineering Services, 2006, recommended by the Ontario Society of Professional Engineers, and in accordance with Section 15.2 (g) of the Procurement of Goods and Services Policy;

(b) approval **BE GIVEN** to enter into negotiations with WARD & BURKE Microtunnelling to construct the project;

(c) the Civic Administration **BE DIRECTED** to report back at a future meeting of the Civic Works Committee to confirm the project, including total estimated project costs;

(d) the financing for the project **BE APPROVED** as set out in the Sources of Financing Report attached hereto as Appendix “A”;

(e) the Civic Administration **BE AUTHORIZED** to undertake all the administrative acts that are necessary in connection with this work, including that required to obtain Canadian National Railway approvals;

PREVIOUS REPORTS PERTINENT TO THIS MATTER

- Environment and Transportation Committee (ETC), August 7, 2007, Appointment of Consulting Engineer Vauxhall Sewershed Review.
- ETC, June 19, 2006, Appointment of Consulting Engineer ES3054: Burbrook Trunk Storm Sewer, Phase III (a).
- ETC, March 23, 2005, Recommendation for Settlement of Burbrook Trunk Sewer Phase III & IV Contract Dispute.
- ETC, March 21, 2005, Update for Burbrook Trunk Sewer Phase III & IV.
  Board of Control, July 30, 2003, Contract Award Burbrook Trunk Sewer Phase III & IV.

PURPOSE

This report seeks the approval of Municipal Council to retain an engineering consultant to complete the engineering design and supervision for the construction of portions of the Burbrook Trunk Storm Sewer, and to direct the Civic Administration to negotiate a single source contract for construction, in accordance with Section 14.4 (e) of the Procurement of Goods and Services Policy, being there are valid and sufficient reasons for selecting this particular contractor having special knowledge, skills, equipment, expertise or experience.

EXECUTIVE SUMMARY

An ability to take combined sewers out of service and to protect Burbrook area basements from flooding has historically, and continues to be, a high risk endeavor. This report summarizes the project history leading up to the recommendations.

The focus of risk reduction is on a critical undercrossing of multiple CN Rail tracks. The long length, critical settlement limits for active train service, high groundwater table and the soils in which tunneling must take place all make for a high risk operation. Proof is in a failed attempt to do so 10 years ago.

What is clear is that risks must be managed in this case, with all available methods. The ultimate risk management tool is avoidance – don't build the sewer, or find another lower risk way to achieve the project purposes. This has been evaluated without success; the project should be done and at this location.

Other risk management tools have been considered in making the recommendations:

- Use the best available engineering team;
- Use the best available technologies and techniques (which have improved over the last 10 years);
- Use the best available construction expertise;
- Match the engineering design to the construction technology (as opposed to whatever a low bid contractor might propose);
- Use peer review; and
- Provide comprehensive insurance.

To allow for these, a negotiated construction contract is recommended. City Policy allows for this when warranted. Subject to the approval to proceed, staff would return to the Civic Works Committee with a recommended contract under terms, conditions and prices that are advisable. The goal is also to remain within the project budget.

BACKGROUND

What and Where

The Vauxhall sewershed covers a 1,170 hectare area north of the Thames River generally contained by Adelaide and Highbury Streets. The service population for this sewershed is approximately 24,600. During the 1990's a strategy was identified to reduce basement flooding and allow for separation of storm flows from the existing combined sanitary sewers in the Burbrook subsewershed. The solution involving a new large storm sewer in phases from the South Branch of the Thames to Dundas Street, and was referred to as the Burbrook Trunk Storm Sewer Project ('the Project'). A map displaying the project area has been included as Appendix 'B'.

Project History

The first two phases were constructed in 1999 and 2000. During 2002 and 2003 the engineering design for the third phase of the Project from Pine to Dundas was undertaken. Boreholes were taken throughout the project and across the Canadian National (CN) railway and groundwater monitoring wells were installed. The options to complete a tunnel under the tracks were ground stabilization (freezing or grouting), using an earth pressure balance Tunnel Boring Machine (TBM), a closed face TBM, traditional open face mining, or a combination of the options. Due to estimated high costs and limited North American availability of the first two options, the decision was made to proceed with a closed face TBM specification.

In 2003, the third phase was constructed and composed of two main sections. The first was an open cut portion and the second section was composed of two tunnels under the CN railway tracks to be installed using a TBM in conjunction with external dewatering. The longer tunnel section started from Pine and Oak Streets and extends under the tracks to Brydges Street. The smaller tunnel section was to be under the CN spur line just north of Brydges Street. In 2004, during construction of the longer tunnel section, settlements in the ground occurred as the TBM approached the first set of tracks. Due to the risk involved with settlement of active railways, it was not feasible to continue with the contracted technology. The tunnel had to be abandoned and the project was put on hold.

In 2004 and 2005, discussions proceeded to finish the tunnel section with other available tunneling technologies. The best possible alternative proposed by the contractor was neither acceptable from the City's engineering consultant nor CN Rail. A contractual settlement was negotiated between the City and the contractor to complete the open cut portion, remove the TBM, restore the site, and terminate the remainder of the construction contract.

In 2005, the remaining project funds were not sufficient to complete a future tunnelling project and it was reported to Council that future discussions to complete the tunnel (s) should carefully assess the probability of success versus the cost. Regardless of the type of contract let by the City to complete this project, there is an associated risk with construction and especially with tunnelling. The tunnelling portion of this work required further analysis, and once revisited, would likely require alternative procurement approaches to ensure appropriate design, approval by CN Rail and successful construction.

In 2006, in a second attempt to complete this work and given the specialized nature of the work, Hatch Mott MacDonald (HMM), an engineering firm that is an international expert in tunneling, was hired to assess and design new options for the project. In terms of tunneling, they are world leaders, particularly in the area of risk assessment, geotechnical baseline reports (GBRs) and tunnel liner design.

By 2007, HMM created two leading options both using more advanced TBM's. The cost estimate for both options ranged from about $10M to $12M, with total project cost over $13 M. The design included the concept of a GBR. During construction, the GBR would be used as a best practice tool to mitigate risk and categorize extra work as either expected or unexpected, noting that the City would be responsible to cover the costs of unexpected work. Staff worked in partnership with HMM to develop an important engineering and construction strategy that also acknowledged the possibility that a negotiated contract with one contractor might be the best solution. Both options would see tendered prices depend largely on the availability of tunnel boring machines and it was recommended that we allow flexibility in the timing of construction in our contract. Ultimately, the uncontainable contract details and the estimated costs of construction were significantly more than expected and as a result, staff began to actively seek other alternatives that could be more cost effective solutions for the challenges in the sewershed.

In 2009, Dillon Consulting (Dillon) was retained to analyze the value of sewer separation continuation in the Burbrook Area versus other options to achieve the initial goals of reducing flooding and separating combined sewer flows. Options included sanitary treatment plant upgrades, rapid treatment of potential overflows, pumping or redirection of storm flows, localized mitigation solutions, or local drainage improvements. All options were evaluated noting the preferred solution was to be a balance between benefit, level of service, risk, and costs Appendix 'C' provides key questions and answers regarding the Burbrook Trunk Storm Sewer. Their final report was completed in 2012, and although other alternatives were investigated, the completion of this part of the Burbrook Trunk Storm Sewer was recommended as still being the best option.

Since 2012, a budget reserve has been building for the express purpose of completing the subject portion of the project for 2015.

Project Technology – Why and How

The main consideration is the ground conditions on this project. Generally, at the depth of proposed tunnel inverts the soils are approximately fine to medium saturated sands and gravel. A sealed shoring system to prevent the need to dewater around the shaft locations is required. This avoids surface settlement in the surrounding area. The CN track corridor is too wide to attempt any form of dewatering over the length of the tunnel noting this was a pitfall of the 2003 approach. To avoid significant track settlement and damage, the Microtunnelling technique has been proposed because it is a sealed tunnelling system, where the tunnel face stability can be controlled in all ground conditions. Microtunnelling uses sealed concrete pipes or segments that are installed directly behind a TBM. Constructing any other way would be a higher risk.

The project will involve the construction of approximately 175 metres of trunk storm sewer by microtunneling. The tunnel alignment will start at an existing storm sewer stub connection south of Brydges Street (between Swinyard Street and Egerton Street) and extend south, crossing underneath approximately 22 railway tracks to an existing storm sewer stub connection north of Pine Street (at Oak Street). The project may also involve the construction of approximately 53 metres of trunk storm sewer by open cut trenching or microtunnelling. The alignment for this portion of the work will start at an existing storm sewer stub connection south of Margaret Street and extend south, crossing under two railway tracks to an existing storm sewer stub connection north of Swinyard Street.

DISCUSSION

In the period between the failed crossing in 2003, the redesign in 2006, the review of other alternatives, and the present, there has been significant growth in the use of microtunnelling in Ontario. Key to this growth was the arrival of microtunnel contractor WARD and BURKE Microtunnelling (Ward and Burke), who have brought significant microtunnelling experience from Europe. Regarding HMM, they continue to have significant involvement with microtunnelling across North America, and was similarly instrumental in bringing this technology to Ontario. HMM designed the first direct-specified microtunnel project in Ontario, the Keswick Outfall Project, for which Ward and Burke was the microtunnel subcontractor. This project has received numerous design awards and is notable for having involved the first curved microtunnel drive completed in Canada, the first underwater reception of a microtunnel drive completed in Canada and the first spatial curve microtunnel drive completed in North America.

With this in mind, staff developed a strategy to complete this complicated and challenging project by proposing the microtunnelling technique and assembling a team of experts to manage, and reduce and design out as much risk as possible for this method. A previous attempt to construct this project failed, so staff have been taking steps since that failure to validate, mitigate risk and build this project correctly. Funds have been budgeted to complete this project in 2015. The technology and methodology has advanced since 2008 and the proposed team is at the forefront of this industry. HMM has acknowledged that Microtunnelling is now more predictable and powerful than ever before.

Project completion has been deferred over the years, noting the window to construct is now as many required neighboring infrastructure renewal projects can’t advance until this phase of the Trunk is completed.

Proposed Project Aproach

Key components of the project to support the risk reduction strategy are addressed as follows:

The Team

HMM will revisit their previous design and documents completed for the City of London and update them, including:

- site reconnaissance and development of the strategy for tunnel shafts and connections to the existing storm sewer.
- preparation of all approval applications, including CN Railway
- an updated workplan and schedule of fees.

Their lead engineer is widely considered to be the foremost expert in his field and has played a pivotal role in some of the most challenging and innovative tunneling projects in the world of the past several decades. In 2014, the Canadian Academy of Engineering announced that Brian Garrod, Deputy Practice Leader for Tunnels at HMM and a world-recognized expert on tunnels and tunnel technology, has been inducted as one of the 49 new Fellows of the Academy. The Academy is the national institution through which Canada's most distinguished and experience engineers provide strategic advice on matters of critical importance to Canada. From this background he has helped establish tunneling in North America as a cost effective, predictable and safe construction practice.

HMM will assist staff in negotiating with Ward and Burke, a specialized contractor with specialized equipment to complete this major tunneling task by microtunnelling techniques.

Ward & Burke are the best microtunnelling company in Canada at this time, and have already developed new ideas, estimates, and advice on how to complete this project efficiently and professionally. They share our goal to collaborate as a team to help design out project risks. Their operators are highly skilled and their management team is led by Professional Engineers. They speak at all major conferences in North America and are champions in their field. Most recently, in an effort to recognize the individuals and companies that have worked toward successfully completing complicated projects and advanced the industry, the North American Microtunneling Achievement Awards were created. The awards are presented annually and it was recently announced that this year's award winners include the contracting firm of Ward and Burke of Toronto, Canada, the lone Canadian company recipient.

If required, Golder Associates Ltd (Golder) could be retained to review final elements of design or support the applications required for the various CN and/or Permit to take Water (PTTW) approvals. Golder has staff specialized in tunnelling and have worked on many complex tunnel projects around the world in very difficult ground conditions over the past 20 years – both as a consultant for owners as well as for contractors in various design-bid-build, design-build, P3, second opinion (independent review), monitoring, risk analysis and management, and forensic/claims projects. Golder has offered their assistance on the project, noting they also do many of the reviews for CN of planned utility tunnels.

Project Delivery

In October of 2014, staff met with representatives of both HMM and Ward and Burke to discuss the project. At this meeting, Administration proposed an alternative form of project delivery, similar to a design-build model where HMM (as designer) and Ward and Burke (as contractor) would work together during the design to reduce the overall project risk.

Key areas where this goal of reducing risk can be achieved include:

- tailoring the design to Ward and Burke's specific microtunnelling equipment;
- coordinating the design of temporary construction works (such as the shaft design) with the design of the permanent works (such as the design of the connection chambers); and,
- jointly reviewing risks prior to construction and agreeing on mitigation measures collaboratively.

Methodology

The project involves the installation of underground trunk storm sewer using trenchless techniques required to cross under CN Rail Lines just north of Pine Street. The microtunnelling technique will be used to carry out this crossing. Specialized, robust equipment will be utilised to complete the crossing. Microtunnelling is not a new method and is preformed extensively across the world with rapid expansion every year.

Microtunnelling has been proposed because it is a sealed tunnelling system, where the tunnel face stability can be controlled in all ground conditions. There is no possibility of soil or water entering the tunnel unlike the jack and bore and other open face tunnelling systems. Therefore, surface settlements are zero and there is no need for dewatering systems. The tunnel boring machine head also has the ability to cut and break down cobbles and boulders in its path. This ensures that there are no excessive voids outside the pipe diameter. The compact construction of these systems makes them ideally suited for use in heavily built up areas.

To facilitate the sealed tunnelling system, launch and reception shafts are required. They are large, deep and are designed to resist all water loads without the requirement for dewatering to reduce risk. The launch shaft and reception shafts are designed to support the microtunnelling operation and are the lowest risk option for this location and ground conditions.

The main advantages of using the micro tunnelling system at this location have been identified as follows:

- Using a closed face pressurized tunnelling method which can tunnel through difficult ground conditions without problems and the need for dewatering.
- Reduced settlements to the surface and impact on existing utilities/ habitat.
- There is no dependence on a dewatering system.
- Increased health and safety through automated tunneling techniques
- An extremely robust design with concrete pressure pipe encased in a reinforced concrete jacking pipe
- Precision alignment control ensuring grade on the pipework

Specialized Equipment Availability

The availability of TBM's to support the microtunnelling technique is a concern and can cause limitations to a contract and constructing on schedule. This project requires larger and more equipment to facilitate the construction of the large diameter trunk storm sewer. Recently, a 2400mm machine has just been brought over to Canada from Europe and is available for use. This machine is well-matched to our project noting that guaranteeing machine availability during our optimum construction period has always been something out of our control. Ward and Burke currently are one of the only microtunnel vendors in Canada; US contractors are the competition and generally have not been able to compete with Ward and Burke rates.

Coordination with Ward and Burke, and HMM

It is proposed to involve Ward and Burke in the design process for key tasks including: the microtunnel shafts, microtunnel pipe and the connection excavations. Final design of shaft and excavation shoring is typically the responsibility of the contractor. By involving Ward and Burke in the design stage, the design of these temporary facilities can be coordinated with the design of the overall project and permanent structures. This approach will reduce risk and reduce the construction schedule by allowing what would typically be key construction shop drawing submissions to be evaluated during the design stage.

Cost estimate

If the 2400mm machine is used, the estimate is approximately $13,000/m to complete the longer tunnel section. Total construction costs on completing the longer tunnel including construction of both the launch and reception shafts would be about $6M, subject to the completion of detailed design. Regarding the shorter crossing, the costs will be lower for a second tunnel option because the equipment will already be on site. Early indications are that the proposed project approach can be achieved within available budget.

CN Rail

HMM is CN's preferred service provider for engineering review and have a strong track record of success working with CN as it relates to communication, experience obtaining crossing agreements and working through the approval process for tunnelling projects. It is noted that early submission and timely approval of permits is critical to the project schedule, given the typical long review time anticipated for these permits. Ward and Burke have worked around or under many CN crossings in the last 5 years and have had extensive exposure to railway work in Europe. Previous CN projects did not exceed settlement criteria limits for their tunnel works and have all been successful.

Risk Register

At the beginning of the design phase, HMM will conduct a one-day risk workshop with the City of London and Ward and Burke. The purpose of this workshop will be to identify and evaluate key project risks. These key project risks will be targeted by the design team as well as Ward and Burke for mitigation. Key project risks and associated mitigation measures will be documented in a risk register, which will be updated at each major design submission.

Insurance

To address the sensitivity and risks of completing tunnelling projects, staff will negotiate an Owners Controlled Insurance Policy (OCIP) to help mitigate risk and exposure to the City. The OCIP will be development and tailored to the uniqueness of this project to create the right package for the City.

Shorter Tunnel

In 2006, HMM prepared design calculations, drawings and specification for an open cut trench crossing of the CN Railway tracks between Swinyard Street and Margaret Street. This work has not been completed, pending completion of the longer tunneled portion of the work described above. HMM, and Ward and Burke will evaluate the feasibility and cost of completing this shorter crossing by microtunnelling, taking advantage of the microtunnelling TBM having been mobilized to the site. Depending on the results of that evaluation, the 2006 open cut design will be revisited or the design will be converted to a microtunnel method. Either way, the inclusion of this work will only add 20 days to the overall construction effort.

Easements

Permanent easements to facilitate construction of both the long and short tunnel have been previously secured noting detailed design may identify some locations where temporary or construction easements are required to enable construction.

Tender Review

Subject to negotiations, it is anticipated that the final contract drawings and specifications would be tendered directly to Ward and Burke for bid. HMM will evaluate the Ward and Burke bid for reasonableness/consistency of pricing based on other recent microtunnel projects in Ontario. A tender review report containing HMM's recommendation for award will be prepared.

Schedule

The project design effort will be initiated in January, 2015 and be completed in April, 2015. For this project, ideal construction period is summer. If everything is in place to proceed and subject to successful negotiations, the project will be tendered to Ward and Burke in May, 2015. Construction will be initiated in May/June, 2015 and be completed by fall 2015.

Consultant Selection

Hatch Mott MacDonald (HMM) staff are world experts in the tunnelling industry and have won many awards. They have an experienced project team, are CN's preferred service provider and have a clear understanding of the project scope, risks and requirements. They have the technical expertise to complete this project. Their work proposal represents good value for the City. With construction planned for 2015, it is necessary to commence the design and approvals components of this project immediately.

Based on their previous work in the area, HMM has completed much of the preliminary design work. In accordance with Section 15.2 (g) of the Procurement of Goods and Services Policy, staff recommends that HMM be appointed as the consulting engineering for the updated program for engineering and supervision. The continued use of HMM on this project is of financial advantage to the City due to the fact that the firm has specific knowledge of the project and has undertaken work for which duplication would be required if another firm were to be selected.

Financial Impact

Funding for engineering and construction of this project is in Capital Works Budget Account ES3054. The work has been expected and budgeted in previous years and in the submitted 2015 budget. Early indications are that the project can be completed using the recommended approach within the project budget.

CONCLUSION

The Burbrook Trunk Storm Sewer Project is required to reduce basement flooding and allow for separation of storm flows from the existing combined sanitary sewers in the large Burbrook subsewershed.

A phase of the multi-year project failed and was stopped in 2004 due to settlement under CN tracks as a result of a tunnelling operation by traditional methods. Since then, solutions have been developed and alternatives analyzed noting project estimates were in the range of $13M to complete construction as of 2008. Tunnelling technologies have developed over the last 6 years and microtunnelling for this application has been identified as the most predictable and reliable method to complete this project.

New project delivery methods and alternative procurement approaches to ensure appropriate design, approval by CN railway and successful construction were recommended for future consideration in previous reports to Council, and are documented in this report. EESD staff, with the support of the Legal Department, has developed an alternative strategy to complete this project to reduce its risks, subject to agreements, resolutions and insurances being in place.

A team of experts has been assembled comprising of HMM, and Ward and Burke to work together to strengthen specifications, methodology and design in order to construct this project. They are both world leaders and are at the forefront of the microtunnelling industry as evident from their several tunneling awards; it is critical that they work together to tailor the design of this project to specialized equipment and engineer risk to a minimum.

The specialized equipment suited for this project has just arrived in Canada and is available to use. This cohesive team will develop tunneling risk management strategies and will jointly review risks prior to construction, agreeing on mitigation measures collaboratively.

Since 2012, staff has been building a budget reserve for the express purpose of completing the project in 2015.

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Acknowledgements:

This report was prepared by a team consisting of Ugo DeCandido, P.Eng., and Doug Harron C.E.T., from the Wastewater and Drainage Engineering Division and reviewed by the City Solicitors Office.

PREPARED BY:	**SUBMITTED BY:**
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RECOMMENDED BY:	
JOHN BRAAM, P.ENG. **MANAGING DIRECTOR, ENVIRONMENTAL AND ENGINEERING SERVICES & CITY ENGINEER**	

December 22, 2014

Attach: Appendix “A” – Sources of Financing
Appendix “B” – Location Map
Appendix “C” – Key Questions – Burbrook Trunk Storm Sewer

Cc: John Freeman – Manager, Purchasing and Supply
Rick Brown
Hatch Mott MacDonald

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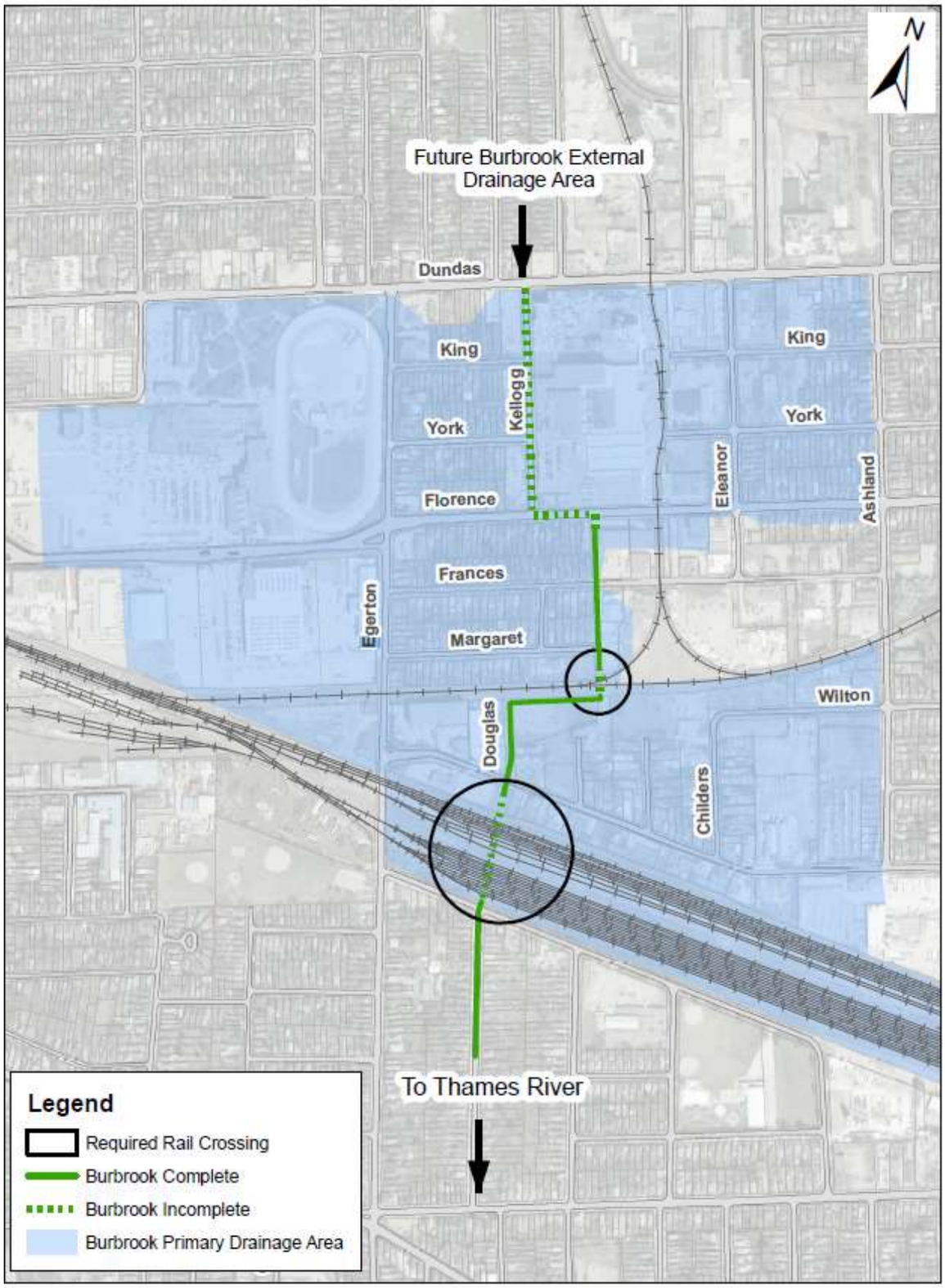
APPENDIX 'B'

LOCATION MAP



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APPENDIX 'C'

Key Questions – Burbrook Trunk Storm Sewer

Why is the Burbrook Trunk Required?

- Level of service due to undersized combined sewers to 350 properties in the Burbrook drainage area. System surcharging resulting in sewer backup and basement flooding occurs for the 1 year storm event.
- Sewer capacity further aggravated by lack of an overland flow route, resulting in street flooding.
- Not possible to separate the combined sewer system without this trunk.
- Existing area infrastructure is 100 years old and renewal is required. Having this trunk allows this work to proceed, in a systematic way along with other infrastructure upgrades 'doing it once and doing it right'. (almost all of the Group B projects are in the City's capital program between now and 2020).

Are there other, more cost effective solutions?

- Storage options were investigated; flooding is caused by local sewer capacities and poor surface drainage on streets. Centralized storage not effective and underground storage not a practical solution.
- Alternative outlets and use of the existing trunks such as the Egerton Trunk and Highbury Trunks were also investigated and are not feasible. The Highbury Trunk is already overloaded and Egerton is too small to receive any additional storm flow.
- Disconnecting homes, backflow preventers, the use of local pressure sewers were all considered, but these don't address the flooding issues, do not provide any storm sewer outlet and doesn't address the need to upgrade the 100 year old infrastructure.

What are the risks if the Burbrook Trunk is not constructed?

- Forces the City to maintain, rehabilitate or replace the Egerton Trunk, at significant cost without solving the flooding or combined sewer issues.
- Many millions have already been invested without any benefit. Without the completion of the trunk there would be lost value in the trunk downstream of the CN Mainline and the upstream section would be orphaned.
- Continued basement and surface flooding with no meaningful relief.
- System can't be separated without trunk and other infrastructure replacements would proceed without sewer upgrades, due to lack of storm outlet.
- Continued wet weather flow diversion to Carling Creek system