APPENDIX I

Conceptual Design - Salem Road and McKay Road
Trunk Watermain and Sanitary Sewer
THE CITY OF BARRIE

PROJECT NO. 15M-00594-01

CONCEPTUAL DESIGN – SALEM ROAD AND MCKAY ROAD TRUNK WATERMAIN AND SANITARY SEWER TRANSPORTATION ENVIRONMENTAL ASSESSMENTS AS PART OF THE GROWTH DEVELOPMENT PROJECTS – SALEM DEVELOPMENT AREA

TECHNICAL REPORT

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# TABLE OF CONTENTS

1 INTRODUCTION .................................................. 2
2 WATERMAIN .................................................. 3
   2.1 Watermain Sizing ............................................. 3
   2.2 Reference Design Standards ............................... 3
   2.3 Watermain Materials of Construction ..................... 3
   2.4 Pressure Rating of Watermain ............................. 3
   2.5 Concept Design Considerations ......................... 4
      2.5.1 Open Cut construction ................................. 4
      2.5.2 Trenchless Technology Considerations .............. 4
   2.6 Chambers, Valves and Appurtenances ............... 5
      2.6.1 Line Valves ............................................. 6
      2.6.2 Air and Vacuum Release Valve Chambers ............ 6
      2.6.3 Drain Chambers ....................................... 6
      2.6.4 Swab Launching and Receiving Stations ............. 6
      2.6.5 Cathodic Protection .................................. 6
3 SANITARY SEWER DESIGN ............................... 7
   3.1 Sanitary Sewer Sizing .................................... 7
   3.2 Reference Design Standards .............................. 7
   3.3 Conceptual Design Considerations ...................... 7
      3.3.1 Open Cut construction ................................ 7
      3.3.2 Trenchless Technology Considerations – Highway 400 Crossing .......................... 8
   3.4 Maintenance Holes ....................................... 8

APPENDICES

A Concept Design Plan and Profile Drawings – McKay Road: 400mm diameter Trunk Watermain, 600mm diameter Sanitary Trunk Sewer

B Concept Design Plan and Profile Drawings – Salem Road: 500mm and 750mm diameter Trunk Watermain
1 INTRODUCTION

The City of Barrie has retained WSP Canada Inc. (WSP) to provide conceptual design services with respect to watermain and sanitary trunk servicing design, as identified within the Master Planning Documents to accommodate growth forecasted within the City to 2031.

The purpose of this report is to develop a conceptual design approach for the following major infrastructure:

1. Sanitary trunk sewer along MacKay Road, with design considerations for a trenchless crossing at Highway 400.
2. Trunk watermain along MacKay Road, with design considerations for a trenchless crossing at Highway 400.
3. Trunk watermain along Salem Road, with design considerations for a trenchless crossing at Highway 400.

The recommendation made as part of this report with respect to the sanitary trunk sewers and watermains are compatible with the proposed transportation improvements project.
2 WATERMAIN

2.1 WATERMAIN SIZING

Based on the Water Distribution and Storage Master Plan (October 2013) prepared by AMEC Environmental and Infrastructure, the proposed trunk watermain distribution system required to meet the maximum day water and fire flow demands through the study area includes the following:

1. 400mm diameter watermain east-west along McKay Road within the proposed interchange limits, and crossing Highway 400.

2. 500mm diameter watermain east-west along Salem Road from Veterans Drive to the proposed Salem Reservoir and Pumping Station.

3. 750mm diameter watermain east-west along Salem Road from the proposed Salem Reservoir and Pumping Station to Saunders Road, crossing Highway 400.

2.2 REFERENCE DESIGN STANDARDS

The proposed watermain and all associated ancillary components will be designed in accordance with all applicable City standards and guidelines, which include the following:

- Approved Manufacturer’s Products for Linear Water Systems (2016).
- City of Barrie – Water Transmission and Distribution Standard Drawings.

2.3 WATERMAIN MATERIALS OF CONSTRUCTION

In accordance with the City of Barrie’s Design Guidelines, the following material materials are recommended to be considered as part of the detailed design submission stage:

- Concrete pressure pipe (CPP) in accordance with AWWA C301, or C303 for 500mm diameter pipe and C301 for diameters 600mm and greater; or
- Ductile Iron Pressure Class 53 with Tyton and/or restrained joints in accordance with Ontario Provencaal Standard Specifications, complete with cement lined fittings.

2.4 PRESSURE RATING OF WATERMAIN

It is anticipated that at the detailed design stage and construction specifications the test pressure of the trunk watermains will be 1,035 kPa (150 psi) for a duration not less than 2 hours in accordance with Ontario Provincial Standard Specifications and City of Barrie requirements.

At the detailed design stage, the design engineer and the City should confirm the operating pressure, surge pressure and test pressure of the proposed watermain system(s).
### 2.5 Concept Design Considerations

The following section briefly outlines major crossings defined as follows:

1. Salem Road at Highway 400 – 750mm diameter trunk watermain.
2. McKay Road at Highway 400 – 400mm diameter trunk watermain.

#### 2.5.1 Open Cut Construction

Watermain construction by open-cut is a common technique that involves the excavation of a trench from the surface utilizing excavators to the required depth, the watermain material type installed at the design grade, and the trench then backfilled and compacted. The use of open-cut trench construction is generally limited to excavations less than 10 m due to equipment restrictions, safety concerns, and economic feasibility. As the depth of the trench increases, the excavation is temporarily supported either using trench boxes or sheeting to prevent collapse of the trench walls.

In addition, when construction is within urbanized areas, consideration must be given to the protection and support of existing underground utilities that may be impacted by the excavation.

For open-cut excavations, the soil and groundwater conditions are important factors in determining what preparatory work is required. For example, if there is a high ground water table combined with sands, silts, or gravels, the ground requires stabilizing prior to excavation. The typical method for removing groundwater is the installation of a groundwater dewatering system.

Open cut construction for the proposed 400mm, 500mm and 750mm diameter watermains along both McKay Road and Salem Road is expected to be constructed by open-cut methods. The sections of watermain at the Highway 400 crossings, which will be recommended to be constructed by tunnelling.

#### 2.5.2 Trenchless Technology Considerations

The methods outlined below are presented at the concept design stage for consideration, only. It is recommended that an extensive geotechnical investigation be completed during the preliminary and detailed design stage to select the appropriate methods for required trenchless crossings.

The Highway 400 crossing will be required to be trenchless. At the detailed design stage, it is recommended that an extensive review of available technologies be undertaken which include horizontal directional drilling (HDD), microtunneling with the use of a Tunnel Boring Machine, pipe ramming, or Auger Jack and Bore dependent on the size of water main proposed, as well as geotechnical and groundwater conditions.

**Horizontal Directional Drilling (HDD)** is guided boring of a bore using a drill rig. A pilot bore is first drilled along the bore path. The bore is then enlarged through reaming. Following reaming, the product pipe is pulled through the final bore.

**Microtunnelling** is an underground method of constructing a passage using a microtunnel boring machine (MTBM) which is steered remotely from the surface.

**Pipe Ramming** is a method for installing steel casings utilizing the energy from a percussion hammer to advance a steel casing with a cutting shoe attached at the front end of the casing.
**Auger Jack & Bore** is a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking ahead and rotating a cutter head, followed by removal of material from inside the bore by using an auger.

Careful attention will need to be paid to selecting the optimum trenchless construction method based on soil conditions. The Highway 400 crossings will include installation of a standard steel liner within the Ontario Ministry of Transportation (MTO) right-of-way (ROW) along with settlement monitoring, in order to conform to MTO requirements. All trenchless construction methodologies will be required to be reviewed along with the geotechnical and hydrogeological data developed for the project in conjunction with the MTO.

Based on the depth of the trunk water mains, and the length of tunnel to be constructed, as well as risk considerations given the critical nature of Highway 400 as a major continuous transportation infrastructure components, the use of a Tunnel Boring Machine (TBM), or micro-tunnel machine, is preliminarily recommended for construction of the proposed 400mm diameter water main along McKay Road crossing Highway 400 as well as the 750mm diameter trunk water main crossing along Salem Road crossing Highway 400 sanitary sewer.

The conventional TBM includes a front face that comprises of the cutting discs and teeth depending on the material being mined. Within the TBM casing is the motors and machinery that turn the cutting head and propel the machine forward. Generally, as the TBM moves forward, a primary liner is constructed, typically with a system of expanded steel ribs and hardwood timber lagging. This provides for the initial stabilized tunnel as the machine excavates forward. Once the tunnel mining is complete, a final liner of either cast-in-place concrete or pre-cast sewer pipe is placed in the tunnel. This is referred to as the secondary liner and will function as the trunk sanitary sewer.

This method of tunnelling cannot deal with excessive amounts of groundwater. If groundwater is a concern then advance dewatering will be necessary.

Preliminary shaft locations and watermain routes have been identified on the concept design drawings provided in Appendix A and B.

The proposed route for the 750mm diameter trunk water main along Salem Road crossed Highway 400 has been selected south of the future bridge in order to avoid conflicts with the structures and its associated footings / foundations. Given the Highway 400 will be widened in the future to 10 lanes at this location, appropriate offsets and proposed launch and receiving shafts have been strategically located to avoid any potential conflicts and comply with the Ontario Ministry of Transportation (MTO) requirements.

The proposed route for the 400mm diameter trunk water main along McKay Road crossing Highway 400 has also been selected south of the proposed interchange in order to comply with MTO offsets and requirements. There is also an archaeological site located within the northeast quadrant. Subsequently, it was determined that this selected route was the most feasible given the project constraints.

### 2.6 CHAMBERS, VALVES AND APPURTEANCES

There are a number of chambers proposed along each conceptual watermain route which include line chambers, air and vacuum release chambers, drain chambers, as well as swab launch and retrieval chambers. The exact locations and details of each chamber will be dependent on road and intersection design, as well as phasing of each development area. The appended plan and profile concept drawings for the proposed chamber locations have been based on available information to date.

With respect to distribution system connections, it is recommended that all distribution system connections and detailed be determined at the detailed design stage.
With respect to water services and hydrants, it is anticipated that all water services and hydrants will be located within local distributions system and not directly connected to the trunk watermains.

### 2.6.1 LINE VALVES

In accordance with the City’s Water Transmission and Distribution Policies and Design Guidelines (2015), Line Valves (Isolation Valves) are required to be installed at maximum intervals of 305 m. A minimum of three valves are required to be located at each intersection. As many as four valves may be required if isolation is determined to be critical.

All valves are required to be resilient seated gate valves, complete with an at-grade accessible valve box on all watermains up to and including 600mm diameter. Valves greater than 600mm diameter are required to be butterfly valves, unless otherwise specified.

### 2.6.2 AIR AND VACUUM RELEASE VALVE CHAMBERS

Air and vacuum release valve chambers have been located along the proposed conceptual design alignment route at high points. These strategic locations allow for air to be removed and prevent a vacuum from developing within the watermain.

The final locations and details associated with each of the drain chambers are recommended to be determine at the detailed design stage.

### 2.6.3 DRAIN CHAMBERS

Drain chambers have been located along the proposed conceptual design alignment route at low points for the proposed trunk watermain(s).

The final locations and details associated with each of the drain chambers are recommended to be determine at the detailed design stage.

### 2.6.4 SWAB LAUNCHING AND RECEIVING STATIONS

Swab launching and receiving stations will be incorporated into the final design of the trunk watermains proposed. Dedicated maintenance chambers, complete with riser pipes, will be integrated into the final design and completed in accordance with the City of Barrie Design Guidelines.

The final locations and detailed of the maintenance chambers are recommended to be determined at the detailed design stage.

### 2.6.5 CATHODIC PROTECTION

Cathodic protection is recommended to be incorporated into the final design of the trunk watermain(s). The design of the cathodic protection system will be contusive to the final pipe material selected and will be in compliance with the City’s design guidelines. The final geotechnical investigation to be completed at the detailed design stage should consider the corrosively of the soils conditions.
3 SANITARY SEWER DESIGN

3.1 SANITARY SEWER SIZING

Based on the Wastewater Collection Master Plan (2013) prepared by AMEX Environment and Infrastructure, the proposed trunk sanitary sewer improvements for the Salem Road to be completed as part of this study is a 600mm diameter sanitary trunk sewer along MacKay Road within the proposed interchange limits, with considerations for a trenchless crossing at Highway 400.

3.2 REFERENCE DESIGN STANDARDS

The sanitary trunk sewer and all system appurtenance will be design in accordance with the following standards:

- Ontario Provincial Standard Specifications and Drawings.

3.3 CONCEPTUAL DESIGN CONSIDERATIONS

Conceptual plan and profile design drawings have been prepared and are included in Appendix B. The concept drawings illustrate the topographic elevations, proposed sewer depth, existing utilities (to be confirmed), and surface features including buildings, roadway, and property lines. The ultimate sewer sizing is dependent on final development types and future locations of roads, entranceways, easements, etc. and should be further development during the design stages of this project.

To establish the ground profile along the proposed trunk sanitary sewer route and to evaluate alternative designs and construction techniques, a topographical survey will have to be completed along the preferred alignment at the detailed design stage. It was determined that the trunk sanitary sewer depth ranged from a few meters to more than 10m in depth. The plan and profile of the sanitary trunk sewer along McKay Road is presented in the Appendix B, which illustrates the ground surface and trunk sanitary sewer elevation.

An important factor in evaluating construction techniques and methodologies is to understand the soil conditions that the trunk sanitary sewer will be constructed in. A detailed geotechnical evaluation is required at the detailed design stage along the preferred alignment route.

3.3.1 OPEN CUT CONSTRUCTION

Sanitary sewer construction by open-cut is a common technique that involves the excavation of a trench from the surface utilizing excavators to the required depth, the trunk sanitary sewer pipe installed at the design grade, and the trench then backfilled and compacted. The use of open-cut trench construction is generally limited to excavations less than 10 m due to equipment restrictions, safety concerns, and economic feasibility. As the depth of the trench increases, the excavation is temporarily supported either using trench boxes or sheeting to prevent collapse of the trench walls.
In addition, when construction is within urbanized areas, consideration must be given to the protection and support of existing underground utilities that may be impacted by the excavation.

For open-cut excavations, the soil and groundwater conditions are important factors in determining what preparatory work is required. For example, if there is a high ground water table combined with sands, silts, or gravels, the ground requires stabilizing prior to excavation. The typical method for removing groundwater is the installation of a groundwater dewatering system.

Open cut construction for the proposed 600mm diameter sanitary sewer is expected to be constructed by open-cut with the exception of the section of trunk sanitary sewer to be constructed at the Highway 400 crossing, which will be recommended to be constructed by tunnelling.

3.3.2 TRENCHLESS TECHNOLOGY CONSIDERATIONS – HIGHWAY 400 CROSSING

The construction of deep gravity sanitary sewers by conventional tunnelling methods is recommended for the trenchless crossing at Highway 400. There are a number of tunnelling techniques that are used depending on the size of the pipe, material that the tunnel will be mined through and whether groundwater is a consideration. Based on the depth of the trunk sanitary sewer, and the length of tunnel to be constructed, as well as risk considerations given the critical natural of Highway 400 as a major continuous transportation infrastructure components, the use of a Tunnel Boring Machine (TBM), or micro-tunnel machine, is preliminarily recommended for construction of the propose 600mm diameter sanitary sewer.

The conventional TBM includes a front face that comprises of the cutting discs and teeth depending on the material being mined. Within the TBM casing is the motors and machinery that turn the cutting head and propel the machine forward. Generally, as the TBM moves forward, a primary liner is constructed, typically with a system of expanded steel ribs and hardwood timber lagging. This provides for the initial stabilized tunnel as the machine excavates forward. Once the tunnel mining is complete, a final liner of either cast-in-place concrete or pre-cast sewer pipe is placed in the tunnel. This is referred to as the secondary liner and will function as the trunk sanitary sewer.

This method of tunnelling cannot deal with excessive amounts of groundwater. If groundwater is a concern then advance dewatering will be necessary.

Preliminary shaft locations have been identified on the concept design drawings provided in Appendix B.

The proposed route for the 600mm diameter trunk sewer along McKay Road crossing Highway 400 has been selected south of the proposed interchange in order to comply with MTO offsets and requirements. There is also an archaeological site located within the northeast quadrant. Subsequently, it was determined that this selected route was the most feasible given the project constraints.

3.4 MAINTENANCE HOLES

Municipal sanitary sewer systems typically have a maximum spacing of maintenance holes of approximately 100 m, or at locations where there was a change in direction of the sanitary sewer. The reason for adhering to the required spacing for maintenance holes is to facilitate limitations in equipment used to inspect and/or facilitate cleaning or repairing of the sanitary sewers. This requirement is still used in open-cut construction projects; however, where projects are completed in tunnel the distances between manholes are less rigid. Sanitary sewer inspection technologies have improved significantly and no longer is a controlling factor in determining manhole spacing. In
tunnel projects, the maintenance locations are controlled more by the locations of connections, or construction shafts. During the detailed design, the spacing between maintenance holes and the size of the maintenance holes will have to follow the City of Barrie Design Guidelines.
APPENDIX A

CONCEPT DESIGN PLAN AND PROFILE DRAWINGS – MCKAY ROAD: 400MM DIAMETER TRUNK WATERMAIN AND 600MM DIAMETER SANITARY TRUNK SEWER
APPENDIX B

CONCEPT DESIGN PLAN AND PROFILE DRAWINGS – SALEM ROAD: 500MM AND 750MM DIAMETER TRUNK WATERMAIN