COMMITTEE OF THE WHOLE MEETING  
MARCH 19, 2018

REPORT #ENG-2018-13  
BRIDGE CROSSING FEASIBILITY STUDY

RECOMMENDATION

That Report #ENG-2018-13 be received;

And further that the Bridge Crossing Feasibility Study dated, March 13, 2018, substantially in the form of Attachment No. 2 be received.

OBJECTIVE

The purpose of this report is to obtain Council's acceptance of the Bridge Crossing Feasibility Study (the Study) dated, March 13, 2018, completed by R. V. Anderson Associates Limited (RVA).

BACKGROUND

The Town's 2016 Water Master Plan identified the need to consider relocating the water transmission main off two (2) non-road bridge structures along the abandoned CNR corridor in an effort to mitigate the risk associated with the single transmission main responsible for the sole water supply to the Community of Beeton, and anticipated extension of the Alliston water supply to the Community of Tottenham.

The 2016 Municipal Structures Inventory and Inspection Report identified three (3) bridges in poor condition and requiring additional investigations. Following that report, in November 2016, Council approved Report #ENG-2016-66 to retain RVA to undertake a feasibility study for three (3) water and wastewater wooden bridge crossings identified as high priorities for further investigation due to significant deteriorations. A Location Plan for the aforementioned bridges is included as Attachment No. 1.

The purpose of the Study was to evaluate various alternatives to address the associated risks related to the watermain and forcemain infrastructure installed on the existing wooden bridges that are experiencing significant deterioration.

COMMENTS AND CONSIDERATIONS

The Study reviewed options/alternatives for the relocation of the existing sanitary forcemain and water transmission main currently located on three (3) wooden bridge structures identified as follows:

1. Beattie Bridge No. 12065 (North Bridge)
2. Bailey Bridge No. 12064 (Middle Bridge)
3. Beeton Creek Crossing No. 12063 (South Bridge)

The Study followed an Environmental Assessment evaluation like process to evaluate the feasibility of the following alternatives:

1. Do Nothing
2. Demolish the existing bridges and relocate the watermain and forcemain beneath the watercourses using trenchless construction methods.
3. Demolish the existing bridges and construct new utility bridge crossings.

The evaluation criteria examined the impact of each alternative on the natural environment, social environment, cultural environment, cultural heritage, and land use planning. A condition assessment of the existing bridge structures and geotechnical investigation were also completed as part of the Study. These reviews highlighted the following points:

1. The Archaeological Assessments completed as part of the cultural environment review identified a Stage II Archaeological Assessment is required.
2. The Condition Assessment of the structures noted the work required to rehabilitate the existing bridge structures to achieve a 20-50 year lifespan would be impractical and is not recommended.
3. The Geotechnical investigation found temporary excavations for crossing creeks through the existing soils would not be feasible. Further, construction activities requiring creek diversion would require additional regulatory approval and may be subject to scheduling restrictions. As such consideration should be given to trenchless installations.

The Study concluded the relocation of the forcemain and watermain under the rivers was the preferred solution with the demolition of the existing bridges and Horizontal Directional Drilling (HDD) as the preferred method of installation. The Study identified the following benefits of this option:

1. By relocating the utilities underground and demolishing the existing bridges, the risk posed to the Town by potential public use of the existing bridges is eliminated.
2. Less maintenance is required to operate and maintain the underground utilities compared to above ground utility crossings.
3. Underground utility installation is more secure and would be less vulnerable to vandalism, pests, and damage from weather and other environmental impacts.
4. The watermain could be twinned at this time in order to increase redundancy and reliability of the critical utilities.
5. The cost of HDD is less than a utility/pedestrian bridge at all locations.
6. Environmental impacts are manageable and may be addressed by incorporating mitigation measures that are typically used on projects of this nature, including: erosion and sedimentation controls, tree protection, and a vegetation restoration plan.
7. Construction impacts on the community can be accommodated using best management construction practices, including: traffic coordination (local and
emergency access), dust suppression, proper mufflers on equipment, appropriate working hours.

8. The resulting project would be classified as a Municipal Class Environmental Assessment Schedule A+ activity reducing engineering costs and project schedule.

As part of the design phase, the Study identified additional investigations recommended to be undertaken including:

- Stage 2 Archaeological Assessments, including test pits, are required for portions of the Beattie and Bailey Bridge sites.
- A Geotechnical Engineer and a Geomorphologist further assess the depth of bore path below the bottom of each watercourse.
- Further geotechnical investigation and deeper boreholes to further define the soil characteristics below the watercourse.
- A detailed fluvial geomorphological investigation including a scour/erosion analysis and in-water survey of the river channel, for each watercourse.
- A natural heritage/natural science assessment of the aquatic life and habitat at each watercourse.

The studies will be completed as part of the detail design phase which will be awarded through a Request for Proposal later this year. The anticipated construction timeline for the bridges are as follows: Beattie Bridge No. 12065 to begin in 2019; Bailey Bridge No. 12064 to begin in 2020; and Beeton Creek Bridge No. 12063 to begin in 2021.

It is noted that as part of unrelated works to this project, the Town's Parks, Recreation, and Culture Department have installed a pedestrian bridge at the Beeton Creek Crossing (South Bridge) as part of the Trans Canada Trail program. Further, in keeping with Council Resolution 2017-253 relating to Report #PRC-2017-33, the location of the future Trans Canada Trail will be located along Sideroad 10 for a portion of the alignment. As such, a pedestrian crossing at the Bailey Bridge (Middle Bridge) is not required. A pedestrian bridge may be required at the Beattie Bridge (North Bridge) to complete the Trans Canada Trail and this option will continue to be reviewed as part of a future trail considerations.

**FINANCIAL CONSIDERATIONS**

The Study provided the following high level cost estimate for the preferred solution, Alternative #2 - HDD and demolition of the existing bridges:

**Construction Cost Estimate for Preferred Alternative 2 (Trenchless/HDD)**

<table>
<thead>
<tr>
<th></th>
<th>BEATTIE BRIDGE (North Bridge)</th>
<th>BAILEY BRIDGE (Middle Bridge)</th>
<th>BEETON CREEK CROSSING (South Bridge)</th>
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As noted previously, the Study recommended additional investigations be undertaken as part of the detail design. A cost estimate is provided as follows:

**Technical Investigations Cost Estimate for Preferred Alternative 2 (Trenchless/HDD)**

<table>
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<th></th>
<th>BEATTIE BRIDGE (North Bridge)</th>
<th>BAILEY BRIDGE (Middle Bridge)</th>
<th>BEETON CREEK CROSSING (South Bridge)</th>
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<td>Geotechnical Investigation</td>
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<td><strong>$14,050</strong></td>
<td><strong>$17,200</strong></td>
<td><strong>$17,200</strong></td>
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</tbody>
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An award report for the detail design phase of this project will be brought forward to Council later this year.

Respectfully submitted:

Mike Ip, C.E.T.
Engineering Coordinator

Attachments:
### Approved By:

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<tr>
<th>Name</th>
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<tr>
<td>Rick Vatri, C.E.T., Director of Engineering</td>
<td>Engineering</td>
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</tr>
<tr>
<td>Mark Sirr, CPA, CMA, Treasurer/Director of Finance</td>
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<td>Approved - 15 Mar 2018</td>
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<tr>
<td>Khurram Tunio, M. Eng., P. Eng, GM of Infrastructure and Development</td>
<td>Development and Infrastructure Division</td>
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<td>Blaine Parkin, P. Eng., CAO</td>
<td>CAO</td>
<td>Approved - 15 Mar 2018</td>
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March 13, 2018

Town of New Tecumseth
Box 910, 10 Wellington Street East,
Alliston, ON
L9R 1A1

Attention: Doug Austin, Manager of Capital Projects, Engineering Department

Dear Mr. Austin:

Re: Final Report
Bridge Crossing Feasibility Study

Please find enclosed three copies and an electronic version of the Final Feasibility Study Report for the referenced project for your review.

Please do not hesitate to contact the undersigned if you have any questions.

Yours very truly,

R.V. ANDERSON ASSOCIATES LIMITED

[Signature]
Kimberly Sayers, P.Eng.
Project Manager
# Bridge Crossing Feasibility Study

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1.0 INTRODUCTION AND BACKGROUND

R.V. Anderson Associates Limited (RVA) was retained by the Town of New Tecumseth (Town) to carry out a feasibility study for the long term security, maintenance and operation of water and wastewater utilities installed on the Beeton Creek Bridge (#12063), Bailey Creek Bridge (#12064), and Beattie Bridge (#12065).

1.1 Background

Three old abandoned CNR wood trestle bridges (non-road) are used to carry critical water and wastewater infrastructure to service the community of Beeton from the community of Alliston:

- Beattie Bridge (#12065, North Bridge),
- Bailey Creek Bridge (#12064, Middle Bridge), and
- Beeton Creek Crossing (#12063, South Bridge)

A map showing the locations of each bridge is included as Figure 1.

The Town’s Municipal Structure Inventory and Inspection Reports (completed in 2010, 2013, 2015 and 2016) identified these 3 wooden bridges as high priorities for further investigations for required improvements due to significant deterioration.

The Town’s 2016 Water Master Plan identifies the need to consider relocating the water transmission main off the bridge structures to below the water courses in an effort to mitigate the risk associated with the single transmission main responsible for the sole water supply to the community of Beeton, and anticipated extension of the Alliston water supply to the community of Tottenham.

The current 20 m wide utility corridor has also been identified as a potential corridor for the Trans Canada Trail (TCT) system through New Tecumseth. The TCT has begun construction at the Beeton Creek Crossing location, and a new pedestrian bridge is currently under design to be constructed adjacent to the Beeton Creek Bridge.

1.2 Objective

The objective of this project is to determine the preferred alternative to provide long-term security and ease of operation and maintenance for the watermain and sanitary forcemains. The resulting preferred alternative is to be developed to a preliminary design.
1.3 Existing Bridges

1.3.1 Beattie Bridge (#12065, North Bridge)

The Beattie Bridge crosses the Nottawasaga River, south east of 13th Line and Tottenham Road. The north side of the bridge can be accessed through the Beattie Distillers property located at 6673 13th Line, Alliston Ontario.

Beattie Bridge is a timber structure that is approximately 40 m long and approximately 9.5 m above the Nottawasaga River. The bridge consists of 7 spans ranging from 3.0 to 13.5 m in length. The year of construction is unknown, however, the method of construction indicates that the structure was likely originally installed in the early 1900s.

In 1997, a 300 mm PVC diameter watermain, and a 300 mm diameter PVC sanitary forcemain were installed on the bridge. The watermain is the sole supply of water to the Community of Beeton. The sanitary forcemain conveys sewage from the Lilly Street Pumping Station in Beeton to the Town’s wastewater treatment plant Regional Wastewater Treatment Plant. Both pipes are enclosed in a metal protective cover and insulated with heat tracing to prevent freezing.

Various repair works have been completed over time. In 2009, trestle repairs were conducted on the Beattie Bridge. In 2010, the wastewater forcemain on Beattie Bridge was found to be damaged by a racoon infestation. To eliminate the potential for future raccoon/rodent damage, the watermain and sanitary forcemain were reinsulated with reusable aluminum faced two foot fibreglass batting and embossed aluminum cladding.

A locked chain link fence is installed around the bridge to prevent the public from gaining access.
1.3.2 Bailey Bridge (#12064, Middle Bridge)

The Bailey Creek Bridge crosses the Bailey Creek, north west of Sideroad 10 and 10\textsuperscript{th} Line. The north side of the bridge can be accessed through the WD Potato Limited property located at 3644 Sideroad 10, Beeton, ON.

Bailey Creek Bridge is a timber structure with steel girders that is approximately 27 m long and approximately 6.5 m above the creek. The bridge consists of 5 spans ranging from 2.1 to 5.0 m in length. The year of construction is unknown, however, the method of construction indicates that the structure was likely constructed in the early 1900s.

In 1997, the same 300 mm PVC diameter watermain and 300 mm diameter PVC sanitary forcemain were installed on the bridge. Both pipes are enclosed in a metal protective cover and insulated with heat tracing to prevent freezing.

1.3.3 Beeton Creek Crossing (#12063, South Bridge)

Beeton Creek Crossing crosses Beeton Creek, north of Lilly Street and Dayfoot Drive. The south side of the bridge can be accessed from the right of way north of Lily Street and the north side of the bridge can be access using the TransCanada Trail pathway.

Beeton Creek Crossing is a timber structure with steel girders that is approximately 32 m long and approximately 4.0 m above the creek. The bridge consists of 6 spans ranging from 2.3 to 5.9 m in length. The year of construction is unknown, however, the method of construction indicates that the structure was likely constructed in the early 1900s.
In 1997, the 300 mm PVC diameter sanitary forcemain was installed on the bridge. The 300 mm PVC watermain does not cross this bridge. The pipe is enclosed with a metal protective cover and insulated with heat tracing to prevent freezing.

1.4 **Natural Environment**

Typically, natural environment includes features such as groundwater, surface water and fisheries, terrestrial vegetation, wildlife and habitat.

All three locations are located on watercourses. Vegetation within the right-of-way property is largely limited to brush along the old rail bed, as the area is generally maintained to provide access for the Town’s operations staff to maintain the watermain and sanitary forcemain infrastructure.

1. **Beattie Bridge (North Bridge)** – The Nottawasaga River is a permanent watercourse considered a coldwater system regulated by the Nottawasaga Valley Conservation Authority (NVCA) for potential flooding and erosion hazards. The water course flows in a north direction towards Georgian Bay and eventually to Lake Huron. According to the NVCA, the area is classified as a low vulnerability well head protection zone (25-year groundwater travel time), and is a significant groundwater recharge area for a highly vulnerable aquifer.

2. **Bailey Bridge (Middle Bridge)** - The Nottawasaga River is a permanent watercourse considered a coldwater system regulated by the Nottawasaga Valley Conservation Authority (NVCA) for potential flooding and erosion hazards. The water course flows in a north direction towards Georgian Bay and eventually to Lake Huron. According to the NVCA, the area is classified as a significant groundwater recharge area.

3. **Beeton Creek (South Bridge)** - The Beeton Creek flows from east to the west and includes a narrow flood plain surrounded by agricultural fields to the north and
residential/school areas to the south. The water course flows in through the community of Beeton and then joins Bailey Creek, which enters Innisfil Creek.

According to the NVCA, the area is classified as a significant groundwater recharge area. Beeton Creek is a permanent warm water watercourse regulated by the Nottawasaga Valley Conservation Authority (NVCA), however, sensitive life stages of fish (e.g. spawning, rearing, feeding etc.) are unlikely to take place within the Beeton Creek Bridge vicinity.

A Natural Environment Report completed for the Trans-Canada Trail Beeton Creek Pedestrian Bridge (AECOM, 2016) noted the following:

- No significant or specialized aquatic or terrestrial habitat features were identified during the field investigations

- The vegetation communities present in the study area consist of cultural meadows that are dominated by graminoid species with a high incidence of non-native species, and a small deciduous forest which also included a high number of non-native species

- There may be some potential breeding habitat for amphibians and reptiles located within the riparian corridor of Beeton Creek. The Beeton Creek consists of non-specialized warm-water habitat for a general warm-water fish community. Limited opportunity is likely to exist for sensitive life stages of fish including: spawning, rearing, and feeding within immediate study area.

- Rare, threatened, or endangered species whose suitable habitat is present within Beeton Creek include the blanding’s turtle, snapping turtle, Little Brown Bat, and bank swallow. However, site investigations and consultations with local agencies did not identify species that fall under the Species at Risk (SAR) category at the Beeton Creek bridge area. Thus, short or long-term effects of construction on species at risk is not anticipated. It should be noted that vegetation clearing during breeding bird nesting and bat roosting seasons (i.e. April 1st to August 31st) should be avoided.
1.5 Social Environment

The Social Environment includes existing communities and recreational areas. Key considerations are the overall impacts of the project on use of and access to private property, community facilities, recreational facilities, as well as impacts on pedestrians, cyclists, noise and air quality.

The Town is currently working on converting portions of the existing railway right-of-way into the Trans Canada Trail, in the section between 4th and 9th Lines and through the communities of Tottenham and Beeton.

The social environment for each bridge location is described below:

1. Beattie Bridge (North Bridge) – This site is most easily accessed along the ROW which is located adjacent to the Beattie Distillers property and the south access is through private property containing a farming operation. Although the Town owns the ROW, the farming operation on the south side of the crossing utilizes the land for the farming operation. It is likely that both property owners would be impacted by any construction activities.

   The public does not have access to the bridge due to the security fencing. The TransCanada Trail is not currently planned to travel along the corridor towards Alliston or across this bridge. Therefore any proposed modifications to this crossing would have little impact on the general public.

2. Bailey Bridge (Middle Bridge) – Access to the North side of the Bailey Bridge and the Town’s right of way must be gained through property owned by WD Potato Limited property. The land owner would be impacted by any construction activities, as crews would need to enter the property to gain access to the right of way. Access to the South side of the Baily Bridge and Town’s right of way is gained through a locked gate at 10th Line.

   The right of way is not maintained as a public trail, and the Town plans to align the TransCanada Trail around the WD Potato property, along Town roads (10th Line and Sideroad 10), to limit public access to the private property and farming operation. Therefore any proposed modifications to this crossing would have little impact on the general public.

3. Beeton Creek (South Bridge) – Access to the South side of Beeton Creek Bridge is gained through the gravel driveway located on the right of way between the Lilly Street Sewage Pumping Station and the residential area. Access to the North side of the Beeton Creek Bridge is gained from the Town’s right of way...
trail, which currently has a locked gate at 10th Line. The local residents and the Lilly St. Pumping Station may potentially be impacted by construction activities.

The existing Beeton Creek Bridge is currently used by local residents, and the Town is in the process of constructing a pedestrian bridge crossing as part of the TransCanada Trail that will be constructed adjacent to the existing railway bridge. The use of this planned pedestrian bridge crossing would likely be impacted by construction activities.

1.6 Cultural Environment

The cultural environment refers to archaeological resources and cultural heritage in the environment. The majority of the area of the three bridge sites were previously altered by the placing of fill for the original construction of the railway and again for the construction of the watermain and sanitary forcemain.

1.6.1 Archaeological Resources

Stage 1 Archaeological Assessments were completed for all three locations:

1. Beattie Bridge (North Bridge) – A Stage 1 Archaeological Assessment (Archaeoworks Inc., November 7, 2017, Appendix 4.1) was completed for the Beattie Bridge location within the Part of Lots 6 and 7, Concession 12. The desktop study identified that some areas within the study area had elevated potential for the recovery of archaeologically significant materials. These areas include the flatter sections at either end of the study area. Further investigations in the form of a Stage 2 AA consisting of a test pit survey conducted at 5 meter transects is required.

2. Bailey Bridge (Middle Bridge) – A Stage 1 Archaeological Assessment (Archaeoworks Inc., November 7, 2017, Appendix 4.2) was completed for the Beattie Bridge location within the Part of Lot 10, Concession 10. The desktop study identified that some areas within the study area had elevated potential for the recovery of archaeologically significant materials. These areas include the bottom of the slope on the north-east and south-west sections of the ROW, and a portion of the riverbed area. Further investigations in the form of a Stage 2 AA consisting of a test pit survey conducted at 5 meter transects is required.

3. Beeton Creek (South Bridge) - A Stage 1 Archaeological Assessment (AECOM, 2016) was completed for the Beeton Creek Bridge area for the development of the TransCanada Trail. Because of the historical bridge and infrastructure developments, the majority of the study area was determined to no longer contain archaeological potential. However, it was noted that small portions of the
study area (approximately 15 meters away from the edges of the bridge, which is beyond the property line of the railway right of way) consisting of manicured lawn may retain archaeological potential and would require Stage 2 archaeological assessment if they were to be impacted by construction activities.

Stage 2 archeological assessment reports are recommended for the three sites if the identified areas in Stage 1 will be impacted from construction activities. Stage 2 Archaeological Assessments should be scheduled as part of Detailed Design, once the firm locations of the entry and exit pits and the extents of the construction activities (laydown areas, working areas, etc) are confirmed.

1.6.2 Cultural Heritage

A Cultural Heritage Evaluation Report / Heritage Impact Assessment (AECOM, 2016) was completed as part of the design of the TransCanada bridge crossing at Beeton Creek. The following key points were included in the report:

- The bridge’s cultural heritage value is mainly connected to its contextual value as part of a historic railway corridor. If the bridge is replaced it could be identified in any future interpretation or programming planned for the Trans Canada Trail at this location. Interpretation associated with the bridge should be linked to the historic nature of the abandoned railway corridor through Beeton

- Should the removal of the bridge be considered in the future, the loss of the contextual value that historically links the Beeton Creek Bridge to the abandoned railway corridor landscape may occur. As such, from a cultural heritage perspective, in situ retention of the bridge is the preferred outcome related to potential future management of the bridge. Retaining the bridge in situ would result in the conservation of the cultural heritage value of the bridge identified in this CHER/HIA. However, given the relatively low level of cultural heritage value associated with the Beeton Creek Bridge, appropriate mitigation measures should be considered if/when the bridge is removed at a later date.

- At a minimum, prior to the removal of the bridge, the structure should be documented to high graphic standards to document the existing structure for a historic and archival record. Copies of the photographic documentation should be compiled with this report and should be deposited with: New Tecumseth Public Library D.A. Jones Branch (Beeton) 42 Main Street West Beeton, ON L0G 1A0

It is likely that the two remaining bridges have similar contextual value linking the bridges to the abandoned railway corridor and would therefore require similar treatment for that recommended for Beeton Creek Crossing. However, consideration should be given to
the fact that these bridges are not designated for public access, as the TransCanada Trail will not travel across these two bridges.

### 1.7 Land Use Planning

The Ministry of Natural Resources and Forestry has reviewed the bridges and confirmed that as the bridges are not located on Crown Land.

The Town’s Official Plan establishes the goals and objectives for development within the Town and sets out policies to achieve them. The Official Plan contains the classification of land use planning for each bridge location.

1. **Beattie Bridge (North Bridge)** – The area is classified in the Town’s Official Plan as Environmental Protection 1 and identified as a valley and stream corridor, with the southern section identified as Significant Woodlands Policy 1 and 2.

2. **Bailey Bridge (Middle Bridge)** - The area is classified in the Town’s Official Plan as Environmental Protection 1, and identified as a valley and stream corridor.

3. **Beeton Creek (South Bridge)** - The area is classified in the Town’s Official Plan as Environmental Protection 1.

Permitted uses within areas classified as Environmental Protection 1 include utilities, only if it has been demonstrated to be necessary and there are no reasonable alternatives. Application for development within Environmental Protection 1 areas will require an Environmental Impact Study (EIS) to assist the Town to make an informed decision as to whether or not a proposed use will have a negative impact on the natural heritage features and related ecological functions of the Town.

Additionally, the Beattie Bridge (North Bridge) site is within the County of Simcoe Greenlands layer of the recently approved Simcoe County Official Plan. Municipal infrastructure is allowed within the Greenlands designation.

### 1.8 Condition Assessment of Existing Bridge Structures

A structural design report (AECOM, 2015) was completed to evaluate the extent of deterioration of the Beeton Creek Crossing Bridge and the potential to reuse it as a pedestrian bridge for the TransCanada Trail. Each pier pile was sampled and the section loss was recorded. 14 out of 50 piles tested had more than 50% section loss. The report noted that severely damaged piles (>50% section loss) that are adjacent to one another would need to be repaired or replaced. Rehabilitation of the existing bridge would be costly and would likely only achieve roughly a 10-15 year lifespan.
A Condition Assessment of the bridge structures was completed by RVA in December 2016 as part of this work. A copy of this Condition Assessment Technical Memorandum is included in Appendix 1. The main conclusion from the Condition Assessment was that the work required to rehabilitate the existing bridge structure to achieve a 20 to 50 year lifespan would be impractical.

1.9 Geotechnical Investigation

A topographical survey and geotechnical investigation has been completed for each of three bridge sites as part of this work.

The geotechnical investigation found that temporary excavations for crossing creeks through the cohesionless sandy/granular deposits below the prevailing groundwater tables would not be feasible. The creek diversion and construction activities within the creeks would additionally require regulatory approval and may be subject to scheduling restrictions. As such, consideration should be given to trenchless installations.

A copy of the geotechnical report is included in Appendix 2.
2.0 ALTERNATIVES

The evaluation process to identify the preferred alternative involved identifying the potential alternatives, developing evaluation criteria and undertaking an assessment of the alternatives through the application of the evaluation criteria.

The following alternatives have been identified:

1. Do nothing. Doing nothing would not resolve the maintenance and operations issues and could lead to additional watermain and forcemain breaks and service disruptions. This alternative was eliminated from further consideration.

2. Demolish the existing bridge and relocate the watermain and forcemain underneath the river using trenchless construction methods. It would be prudent to demolish the existing bridges to reduce the risk posed by the existing condition of the infrastructure and its potential for public access and ability to damage the utilities if it were to fail.

3. Demolish the existing bridge and construct a new utility bridge crossing. The existing bridges would be demolished for the reasons outlined above.

2.1 Alternative 2 – Trenchless Construction

Trenchless technologies are utilized when open cut or trenching construction would result in a significant impact to the environment. Trenchless construction would allow the watermain and forcemain to be installed underneath the watercourse and minimize the impact on the environment. There are a few different types of trenchless construction methodologies that can be used, depending on the size of the pipe and the ground conditions.

1. **Horizontal Directional Drilling** – is the most economical method of trenchless construction, provided that suitable geotechnical conditions exist. A pilot hole is drilled and then reamed to a diameter that is larger than the outside diameter of the pipe. Drilling mud is used to transport the cuttings to the drilling pit and stabilize the hole. Then a pipe is pulled back through the hole. Special measures are required to minimize the risk of “frac-out”, or leaking of drilling fluids into the surrounding environments.

   The feasibility of this method is dependent upon geotechnical conditions, such as the presence of a significant amount of cobbles and boulders that may occur randomly in glacial till, which could impede progress.

2. **Bore and Jack** – Is a proven method that has some additional flexibility to deal with poor ground conditions, and is typically used for relatively short installations
(typically less than 100 m) in soft ground conditions. A shaft is constructed at each end of the pipe installation, and the pipe is installed inside a steel casing that is jacked forward as an auger removes the soil inside the casing. This method is the most common method for constructing watermains and sewers under railways and highways. This method is not feasible if there are large boulders along the route or if significant dewatering is required, as would be required for these installations.

3. **Pipe Ramming** - Pipe is installed inside a steel casing that is rammed forward using a hydropneumatic hammer and then an auger removes the soil inside the casing. This method reduces the risk of ground subsidence, mitigates concerns with dewatering and can accommodate some small boulders but it is relatively slow, and is more costly than HDD.

4. **Tunnelling** - A tunnel can be excavated in both hard and soft ground conditions using a tunnel boring machine (TBM) or by hand mining. Several techniques have been developed to deal with poor soil conditions and groundwater. It would provide the benefit of all three pipes being installed in a single tunnel to improve access for operations and maintenance activities. However, this approach is significantly more costly and would only be used if the other approaches are not possible.

The geotechnical investigation identified that cobbles and boulders should be anticipated during drilling, especially within the gravelly sand layer found in BH5 and BH6 at the Beeton Creek Crossing (#12063, South Bridge). However, the investigation did not identify any undue problematic conditions with HDD which cannot be addressed through mitigation normally incorporated into projects of this nature. Therefore, this alternative has been carried forward in the evaluation, as it is the most cost effective method and would have the least impact on the environment during construction as there are no shafts required.

Selection of the HDD methodology, including drilling fluids and pressures for this project must consider the anticipated soil deposits to reduce the potential for frac-out, over-drilling/over-reaming and/or deviation from the planned alignment. Additionally, the HDD installation equipment should be selected by the contractor such that the pilot hole and reamers can accommodate and make their way through potential cobbles and boulders.

This alternative would also enable the watermain to be twinned now or in the future to improve reliability and redundancy of the infrastructure. If desired, the twinned installations would be recommended to be completed under the same contract at this time to improve redundancy of the crossing and save on re-mobilization costs in the future.
Table 2.1 provides some general information and conceptual level costing for this alternative. The construction costs should be reviewed and refined during detailed design.

### Table 2.1 - Alternative 2 - HDD Costing

<table>
<thead>
<tr>
<th></th>
<th>Beattie Bridge (North Bridge)</th>
<th>Bailey Bridge (Middle Bridge)</th>
<th>Beeton Creek Crossing (South Bridge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenchless crossing Length</td>
<td>130 m</td>
<td>130 m</td>
<td>130 m</td>
</tr>
<tr>
<td>HDD unit cost¹</td>
<td>$750 /m</td>
<td>$750 /m</td>
<td>$800 /m</td>
</tr>
<tr>
<td>Number of pipes to be installed</td>
<td>2 w/m</td>
<td>2 w/m</td>
<td>1 f/m</td>
</tr>
<tr>
<td>Approximate HDD Construction Cost</td>
<td>$292,500</td>
<td>$292,500</td>
<td>$104,000</td>
</tr>
<tr>
<td>Watermain/Forcemain valves, hydrants and connections</td>
<td>$130,000</td>
<td>$130,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Bridge Demolition Cost²</td>
<td>$320,000</td>
<td>$238,000</td>
<td>$280,000</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>$742,500</strong></td>
<td><strong>$660,500</strong></td>
<td><strong>$444,000</strong></td>
</tr>
<tr>
<td>Engineering (15%)</td>
<td>$111,375</td>
<td>$99,075</td>
<td>$66,600</td>
</tr>
<tr>
<td>Contingency (25%)</td>
<td>$185,625</td>
<td>$165,125</td>
<td>$111,000</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$1,039,500</strong></td>
<td><strong>$924,700</strong></td>
<td><strong>$621,600</strong></td>
</tr>
</tbody>
</table>

¹Historical HDD installations in the Town of New Tecumseth for watercourse crossings were in the range of $550 to $600/m. However, for the purposes of this report, budgetary costs to install a 300 mm diameter pipe have been estimated at $700 to $750/m, to account for the relatively short span, difficult to access installation, and additional isolation valves and flushing stations.

²A cost estimate was provided from Priestly Demolition for the removal and disposal of the bridge structure including piers and abutments for each of the three existing bridges.

Under the Municipal Class Environmental Assessment, this alternative would be considered a Schedule A+ project, requiring only that public notification be provided. Additionally, the “retirement” of any of the existing crossings would also be considered as a Schedule A+ project.

### 2.2 Alternative 3 – Construct New Bridge Crossing

A new bridge could be constructed adjacent to the existing bridge and new watermain and forcemains installed on top of the bridges. Utility bridge crossings could be designed to accommodate just the forcemain and watermain piping, or be larger to accommodate the piping and a vehicle or pedestrian traffic.
It would be recommended that the utility bridges be able to accommodate an 80 kN vehicle (standard single axle load, ex. utility van) for maintenance access for the Beattie and Bailey Bridges. At the Beeton Creek Crossing, the trail bridge that is currently being installed can accommodate a vehicle loading, therefore only a utility bridge would be required here. However, the construction at Beeton Creek would require temporary servicing costs, as a temporary forcemain would be required during construction to allow the existing bridge/forcemain to be demolished and the new bridge/forcemain installed in the same location.

For the purposes of this study, we contacted Eagle Bridge Limited, a manufacturer, supplier and installer of pre-engineered bridge structures. Costing was obtained for half-through pratt truss design bridges with underslung floor beams, constructed of weathering steel superstructure and pressure treated SPF wood deck. See Appendix 3 for information obtained from the supplier.

Table 2.2 summarizes the recommended bridge structures and costs.

<table>
<thead>
<tr>
<th></th>
<th>Beattie Bridge (North Bridge)</th>
<th>Bailey Bridge (Middle Bridge)</th>
<th>Beeton Creek Crossing (South Bridge)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Width</strong></td>
<td>5 m</td>
<td>5 m</td>
<td>3 m</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>45 m</td>
<td>30 m</td>
<td>35 m</td>
</tr>
<tr>
<td><strong>Vehicle weight</strong></td>
<td>80 kN vehicle</td>
<td>80 kN vehicle</td>
<td></td>
</tr>
<tr>
<td><strong>Bridge Supply Cost</strong></td>
<td>$210,500</td>
<td>$135,700</td>
<td>$98,700</td>
</tr>
<tr>
<td><strong>Bridge Installation Cost</strong></td>
<td>$25,000</td>
<td>$16,000</td>
<td>$12,000</td>
</tr>
<tr>
<td><strong>Bridge Abutment Cost</strong></td>
<td>$110,000</td>
<td>$110,000</td>
<td>$70,000</td>
</tr>
<tr>
<td><strong>Number of pipes to be installed</strong></td>
<td>2 w/m 1 f/m</td>
<td>2 w/m 1 f/m</td>
<td>1 f/m</td>
</tr>
<tr>
<td><strong>Watermain &amp; Forcemain Installation Cost</strong></td>
<td>$535,000</td>
<td>$400,000</td>
<td>$165,000</td>
</tr>
<tr>
<td><strong>Temporary Servicing Cost</strong></td>
<td>n/a</td>
<td>n/a</td>
<td>$100,000</td>
</tr>
<tr>
<td><strong>Bridge Demolition Cost(^2)</strong></td>
<td>$320,000</td>
<td>$238,000</td>
<td>$280,000</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td>$1,200,500</td>
<td>$899,700</td>
<td>$725,700</td>
</tr>
<tr>
<td><strong>Engineering and Schedule B Class EA (25%)</strong></td>
<td>$300,000</td>
<td>$225,000</td>
<td>$182,000</td>
</tr>
<tr>
<td><strong>Contingency (25%)</strong></td>
<td>$300,000</td>
<td>$225,000</td>
<td>$182,000</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>$1,800,500</td>
<td>$1,349,700</td>
<td>$1,089,700</td>
</tr>
</tbody>
</table>
This alternative would be considered a Schedule B project under the Municipal Class Environmental Assessment, as it is a “water crossing by a new or replacement water facility except for the use of Trenchless Technology for water crossings”, resulting in the need for a Schedule B Class EA. The “retirement” of any of the existing crossings would also be considered as a Schedule A+ project.
3.0 EVALUATION OF ALTERNATIVES

The following criterion are proposed for this evaluation:

- **Natural Environment**
  - Impact on fish & aquatic habitat, disruption to fish including spawning periods and physical changes to aquatic habitat
  - Impact on Groundwater—pumping requirements for construction purposes (PTTW)
  - Loss of vegetation
  - Impact on wildlife & wildlife habitat
- **Social / Cultural**
  - Impact on existing communities, residential areas, and neighboring land owners (e.g. noise, dust, mud)
  - Impact on cultural or heritage resources and ability to mitigate
  - Impact on agricultural resources
  - Impact on recreation and the Trans Canada Trail
- **Legal / Jurisdictional**
  - Need for property acquisition, temporary or permanent easements
  - Ease of approvals / potential for delays
  - Risk posed to the Town
- **Technical**
  - Security and reliability of watermain and forcemain
  - Ease of Operations and Maintenance
  - Constructability and flexibility of construction sequencing, potential for encountering problems.
  - Environmental Assessment Requirements
  - Ability to expand in the future
- **Cost**

For each alternative, the potential impacts under the categories listed above was assigned a score from 0 to 4, according to the following legend:

- 0 (least preferred)
- 1
- 2
- 3
- 4 (most preferred)

Each evaluation criteria category was also assigned a relative weighting for the evaluation, as shown in Table 3.1. The score for each category was then weighted based on the degree to which the category influenced the overall evaluation to determine a final overall score.
Table 3.1 – Evaluation Criteria Weighting

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Relative Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Environment</td>
<td>20%</td>
</tr>
<tr>
<td>Social / Cultural</td>
<td>15%</td>
</tr>
<tr>
<td>Legal / Jurisdictional</td>
<td>15%</td>
</tr>
<tr>
<td>Technical</td>
<td>25%</td>
</tr>
<tr>
<td>Cost</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3.2 summarizes the results of the evaluation.
<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Beattie Bridge (#12065, North Bridge)</th>
<th>Bailey Bridge (#12064, Middle Bridge)</th>
<th>Beeton Creek Crossing (#12063, South Bridge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>130 m long HDD crossing 2 – watermains 1-sewage forcemain</td>
<td>130 m long HDD crossing 2 – watermains 1-sewage forcemain</td>
<td>130 m long HDD crossing 1-sewage forcemain</td>
</tr>
<tr>
<td>Natural Environment (20%)</td>
<td>Moderate temporary disturbance to vegetated areas Moderate aquatic concerns due to undercrossing of the watercourse and demolition of existing bridge</td>
<td>Moderate temporary disturbance to vegetated areas Moderate aquatic concerns due to construction above watercourse and demolition of existing bridge</td>
<td>Moderate temporary disturbance to vegetated areas Moderate aquatic concerns due to construction above watercourse and demolition of existing bridge</td>
</tr>
<tr>
<td>Social / Cultural (15%)</td>
<td>Stage 2 archaeological assessment may be required Vehicular access to the site required during construction Annoyance to Beattie Distillery during construction</td>
<td>Stage 2 archaeological assessment may be required Vehicular access to the site required during construction Annoyance to WD Potato operations during construction</td>
<td>Stage 2 archaeological assessment may be required Vehicular access to the site required during construction Annoyance to residential neighbourhood during construction</td>
</tr>
<tr>
<td>Legal / Jurisdictional (15%)</td>
<td>Property acquisition not required “Attractive nuisance” – potential liability resulting from public access although not intended for pedestrian use</td>
<td>Property acquisition not required “Attractive nuisance” – potential liability resulting from public access although not intended for pedestrian use</td>
<td>Property acquisition not required “Attractive nuisance” – potential liability resulting from public access although not intended for pedestrian use</td>
</tr>
<tr>
<td>Technical (25%)</td>
<td>Significant utility disturbance during construction More secure installation (no aboveground access to utilities) Lower operational and maintenance costs Access for breaks requires heavy construction equipment Similar construction duration Watermain would be twinned Schedule A+ activity</td>
<td>Significant utility disturbance during construction More secure installation (no aboveground access to utilities) Lower operational and maintenance costs Access for breaks requires heavy construction equipment Similar construction duration Watermain would be twinned Schedule A+ activity</td>
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</tr>
<tr>
<td>Cost (25%)</td>
<td>$1,039,500</td>
<td>$1,802,500</td>
<td>$1,349,700</td>
</tr>
<tr>
<td>Overall Score (out of 4)</td>
<td>3.2</td>
<td>2.0</td>
<td>3.2</td>
</tr>
</tbody>
</table>

### Table 3.2 – Alternative Evaluation

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Beattie Bridge (#12065, North Bridge)</th>
<th>Bailey Bridge (#12064, Middle Bridge)</th>
<th>Beeton Creek Crossing (#12063, South Bridge)</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Natural Environment (20%)</td>
<td>Moderate temporary disturbance to vegetated areas Moderate aquatic concerns due to undercrossing of the watercourse and demolition of existing bridge</td>
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<td>Stage 2 archaeological assessment may be required Vehicular access to the site required during construction Annoyance to residential neighbourhood during construction</td>
</tr>
<tr>
<td>Legal / Jurisdictional (15%)</td>
<td>Property acquisition not required “Attractive nuisance” – potential liability resulting from public access although not intended for pedestrian use</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Cost (25%)</td>
<td>$1,039,500</td>
<td>$1,802,500</td>
<td>$1,349,700</td>
</tr>
<tr>
<td>Overall Score (out of 4)</td>
<td>3.2</td>
<td>2.0</td>
<td>3.2</td>
</tr>
</tbody>
</table>
4.0 RECOMMENDED ALTERNATIVE SOLUTION

The preferred solution for the watermain and forcemains is to relocate the utilities below the watercourse and install using HDD for the following reasons:

- By relocating the utilities underground and demolishing the existing bridges, the risk posed to the Town by potential public use of the existing bridges is eliminated.

- Less maintenance is required to operate and maintain the underground utilities compared to above ground utility crossings, and this option is preferred by the Town’s public works staff from an O&M point of view.

- The underground utility installation is more secure. It would be less vulnerable to vandalism, pests, and damage from weather and other environmental impacts. Heat tracing would not be required.

- The watermain could be twinned at this time in order to increase redundancy and reliability of the critical utilities.

- The cost of HDD is less than the utility bridge at all locations.

- Environmental impacts are manageable and may be addressed by incorporating mitigation measures that are typically used on projects of this nature, including: erosion and sedimentation controls, tree protection, controlled equipment fuelling and maintenance, dust suppression, proper mufflers on equipment, appropriate working hours, and vegetation restoration plan.

- Construction impacts on the community can be accommodated using best management construction practices, including: traffic coordination (local and emergency access), dust suppression, proper mufflers on equipment, appropriate working hours.

- The resulting project would be a Schedule A+ activity.
5.0 MITIGATION

Mitigation requirements are indicated in accordance with the three categories used in the evaluation, as follows:

- Vehicular and Pedestrian Traffic
- Social
- Environmental

5.1 Vehicular and Pedestrian Traffic

No significant vehicular traffic impacts (i.e. long-term road closures) are anticipated for the recommended alternative solution since there will not be any construction within Town or County roads.

No significant long term pedestrian impacts are anticipated for the recommended alternative solution. Where necessary and possible, the pedestrian pathway / bridge crossing at Beeton creek would be temporarily diverted around the construction areas. Excavations and machinery / equipment areas will be secured at all times with temporary chain link fencing to preclude inadvertent pedestrian access.

5.2 Social

Social impacts include the effects of dust, noise, vibration, etc., caused during construction.

It is recommended that standard construction mitigation regarding noise, dust, vibration be incorporated. Construction working hours should be restricted (8 a.m. to 5 p.m.). Utility / municipal services shut-offs (i.e. when connections are made to existing watermains) will be scheduled with the affected residents to minimize impact. These requirements will be incorporated into the construction contract.

5.3 Environmental

Construction could affect the natural environment such as vegetation, wildlife, aquatic habitat and communities.

To mitigate the potentially harmful affects that construction activities may have on the sites, the following items are recommended to be addressed through best management practices during design and construction:

- Implement erosion and sediment control measures.
• Select the final alignment of the utilities crossing the watercourses to minimize impact on trees and vegetation.

• If the detailed design reveals that minor tree loss could not be avoided, the restoration and replanting plan should include provision for planting of native trees and shrubs.

• Keep the topsoil and the subsoil layers separate during construction, and putting these layers back in the same order after installation of the watermain.

• Implement Edge Vegetation Protection measures.

• Install tree protection barriers.

• Place restrictions on equipment refuelling and maintenance.

• Place restrictions for material storage areas.

• Construction period should avoid the breeding bird and amphibian seasons.

• Restore disturbed areas as quickly as possible in accordance with restoration and replanting plan.

• Review / inspect environmental protection measures during construction and post-construction.

• Maximize the distance excavations are located from the watercourse channels.

• Maximize the depth of the watermains and forcemain below the bottom of the watercourses in accordance with the geotechnical engineer’s recommendations.

• Prepare contingency plans for potential equipment failures and for frac-out situations.

An Environmental Impact Study is planned to be completed in the spring/summer of 2018, which will identify additional mitigation measures.

The most significant environmental impact of the preferred alternative solution will be due to the watercourse crossing work. The Conservation Authority should be involved to ensure the final design meets their requirements for erosion and sediment controls, working in proximity to the watercourse, tree protection and restoration of any lands outside the right of way.
6.0 PRELIMINARY DESIGN OF PREFERRED ALTERNATIVE

As indicated in Section 4.0, the preferred solution for the watermain and forcemains is to relocate the utilities below the watercourse and install using horizontal directional drilling. The preliminary design crossing below the three watercourses is based on the following guidelines:

- Ministry of Environment and Climate Change (MOECC) Design Guidelines for Sewage Systems, 2008;
- Canadian Association of Petroleum Producers, Planning Horizontal Directional Drilling for Pipeline Construction, September 2004, reviewed 2009;

These guidelines should also be referred to during the detailed design.

6.1 Geotechnical Considerations

The overall feasibility of HDD is highly dependent upon the properties of the soil formation through which penetration will be accomplished. In general, cohesive soils, such as clays, silty clays and silty-clayey tills, are self-supporting and a bore path through these materials should be easily achievable. A bore path can often also penetrate easily through sands and clayey silts, and even cohesionless silt and sand materials provided that the appropriate drilling fluid is used to mitigate the soil surrounding the bore path from collapsing. However, medium to coarse-textured granular materials such as gravels, cobbles and boulders can give rise to a number of problems during HDD construction, including:

- Bore path instability or collapse during drilling of the pilot hole and subsequent reaming passes, that may result in the drill string becoming stuck;
- Loss of drilling fluids to the formation; and
- Release of drilling fluids to the environment.
Mitigative measures may include:

- Maintaining drilling mud in the bore hole at all times by locating the entry and exit points above the cohesionless silt-sand zones;
- Evaluating alternative drill paths that avoid or minimize exposure to the problematic soil materials;
- Casing or excavating through near surface silt, sand or coarse-textured deposits; and
- Using drilling additives to consolidate and reduce the permeability of these materials.

Strict monitoring of drilling fluid volumes, annular pressure and cutting returns will assist in ensuring that the bore path plugging and fluid losses are detected and addressed.

A Preliminary Geotechnical Investigation was undertaken by GeoPro Consulting Ltd., provided in Appendix 2. At all three locations, the investigation revealed fill / probable fill materials consisting of cohesionless soil materials such as silt, silty (fine) sand, sand, and gravelly sand. The following table identifies the locations, depths and types of the cohesionless soil materials for each crossing location:

<table>
<thead>
<tr>
<th>Watercourse Crossing Location</th>
<th>BH No. and Approx. Elevation</th>
<th>Cohesionless Soil Material Zone</th>
<th>Depth of Zone Below Existing Grade</th>
<th>Elevation of the Depth of Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beattie Bridge</td>
<td>BH1 and BH2 +/- 220.50m</td>
<td>Fill / probable fill: cohesionless silty (fine) sand and sand</td>
<td>8.6m and 4.0m respectively</td>
<td>211.90m and 216.50m respectively</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bailey Bridge</td>
<td>BH3 and BH4 +/- 219.75m</td>
<td>Fill / probable fill: cohesionless silty (fine) sand, sand and silty fine sand</td>
<td>2.4m and 4.0m respectively</td>
<td>217.35m and 215.75m respectively</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beeton Bridge</td>
<td>BH5 and BH6 +/- 222.00m</td>
<td>Fill / probable fill: cohesionless silt, sand and silt, silty sand, (fine) sand and gravelly sand Upper silt, (fine) sandy silt, fine sand and silt, (fine) sand and gravelly sand deposits</td>
<td>11.7m and 2.1m respectively</td>
<td>210.30m and 219.90m respectively</td>
</tr>
</tbody>
</table>

Note: below the cohesionless soil material is reported to be more cohesive materials ranging from fine sandy silt, silty fine sand, (fine) sand, silty sand till to clayey silt to silty clay.
In general, a ‘No Drill Zone’ can be identified that addresses geotechnical issues and concerns at the crossing locations. As typically defined by the geotechnical engineer, the ‘No Drill Zone’ is the upper limit of potential drill paths between specified entry and exist locations, intended to ensure that the bore is maintained with geological materials suitable for HDD while provide sufficient cover to mitigate inadvertent return conditions (i.e. ‘frac-outs).

The definition of a ‘No Drill Zone’ is influenced by a number of factors:

- Crossing area terrain conditions, in terms of the difference in elevation between entry and exit locations along the HDD alignment, that determine, in large part, the recommended depth of cover;
- Subsurface soil stratigraphic conditions;
- River engineering considerations, including depth of scour during the design flood event and potential for bank/meander migration; and
- The presence of active, inactive and potential landslide features, and other geotechnical ‘problem’ areas.

All potential drill paths should be design to pass outside of the ‘No Drill Zone’.

‘No Drill Zones’ have not been identified at this time. However, the actual soil conditions directly below the watercourse were not investigated nor a geomorphological investigation was undertaken and are recommended during the Detailed Design.

Regarding the soil conditions below the watercourse, information is contained within the available drawings of the original bridge construction drawings (1911, amended 1913) obtained by CN Rail as presented below:
Table 6.2 – Recorded Soil Type, Ground / Foundation Elevation, Normal Water Level and High Water Level

<table>
<thead>
<tr>
<th>Watercourse Crossing Location</th>
<th>Recorded Soil Type at Foundation Bottom Levels</th>
<th>Approx. Ground / Foundation Bottom at Abutment</th>
<th>Approx. Ground / Foundation Bottom Pier</th>
<th>Approx. Recorded Normal Water Elevation</th>
<th>Approx. Recorded High Water Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beattie Bridge</td>
<td>Soft sand and clay</td>
<td>212.88m / 212.88m</td>
<td>n/a</td>
<td>214.95m</td>
<td>216.23m</td>
</tr>
<tr>
<td>Bailey Bridge</td>
<td>Sand and clay</td>
<td>217.62m / 216.09m</td>
<td>216.63m / 215.18m*</td>
<td>217.61m</td>
<td>218.68m</td>
</tr>
<tr>
<td>Beeton Bridge</td>
<td>Soft sand and clay</td>
<td>220.17m / 218.19m</td>
<td>218.19m / 216.97m*</td>
<td>220.05m</td>
<td>221.03m</td>
</tr>
</tbody>
</table>

*It should be noted that the Bailey and Beeton Bridges were replaced following floods October 1954 (i.e. Hurricane Hazel) as per drawing records provided by CN Rail. These drawings recorded the stream bed in the vicinity of the bridge being scoured. This scouring is considered significant since the pier foundations were replaced from a mass concrete type to a steel monotube type.

Contractors often use a section of steel casing pipe that is ‘dug-in’ at the start of construction. This is commonly known in the industry as ‘conductor barrels’ and ‘washover casing pipes’ – Refer to **Figure 6.1**. The casing is intended to prevent inadvertent near-surface returns (i.e. frac-outs), and allows for easy monitoring of drilling fluid return levels. However, where cohesionless/unconsolidated deposits represent a risk of inadvertent returns on the entry side, the casing will need to be more extensive. In this case, the casing would need to be driven in with a large hydraulic hammer, a process known in the industry as ‘HDD Assist’.

---

**Figure 6.1 – Washover Casing Method**
It should be noted that due to the cohesionless soils below the water table, a fluvial / geomorphological investigation is required to be completed during detailed design. This will include a scour and erosion analysis of the watercourses which is important due to two of the three bridges (Bailey and Beeton) being washed away during Hurricane Haze in 1954 based on CNR records. The preliminary geotechnical investigation should also be upgraded to a detailed geotechnical investigation due to the boreholes at the Bailey and Beeton bridges ending in cohesionless soils (sand). HDD requires a good suitable cohesive soil layer such as clay under the watercourse. It is recommended that deeper boreholes are drilled as a minimum at these two locations to determine the depth of more competent ground and reduce the risk of a frac-out during the HDD installation.

6.2 Horizontal and Vertical Alignment of Drill Path

In addition to the subsurface soil conditions, the feasibility of HDD is dictated by the length of the bore path and the diameters of the drill rods. Existing HDD technology (i.e. rig tools and drill rods) and economic considerations are the primary factors limiting drill path length and drill rod diameter. The flexible nature of drill pipe limits the amount of pressure that can be applied to the drill rod assembly and, therefore, control of the front of the drill rod assembly decreases over longer bore lengths. The capacity of the drill rod assembly to transmit torque from the rotating surface to the down hole reamers is also a limiting factor.

It should also be noted that projects of this nature require the design path lie within a vertical plane. And the design path should avoid unnecessary bends. As such, in order to cross beneath the watercourse at each location, the design paths are based on one curve consisting of no tangents except that required at the entry and exit pits.

The design path must be consistent with the steering capability of the drill rod assembly and the allowable radius of curvature of the steel drill rods and joints. Although some soil conditions will inhibit sharp steering maneuvers, path limitations will often be based on fatigue strength considerations of the rods. A given rod may be able to withstand a single bend cycle corresponding to a relatively sharp radius of curvature, but the rotation of the rod during boring operations results in flexural cycles which will eventually cause cumulative fatigue failure. The diameter of the drill rod is an important parameter affecting its stiffness, steering capability, and the allowable bend radii. A conservative industry guideline indicated that the minimum bend radius should be approximately 1200 times the rod diameter.

The required parameters, essential in defining the bore path, are described in the following sections and as referenced in Figure 6.2 (taken from ASTM F 1962):
1. Bore Entry (Pipe Exit) – The bore entry point must be accurately specified consistent with the pipe route, equipment requirements, and topography. Bore entry angles should be in the range of 8 to 20 degrees from the ground surface, preferably 12 to 15 degrees. These angles are compatible with typical equipment capabilities.

2. Bore Exit (Pipe Entry) – The bore exit point must be accurately specified consistent with the pipe length and topography. Bore exit angles should be relatively shallow, preferably less than 10 degrees. A shallow angle will facilitate the insertion of the pipe into the bore hole while maintaining the minimum radius of curvature requirements.

3. Bore Path Profile – The design path should optimally lay within a vertical plane including the bore entry and exit points. The arcs of the bore path and straight sections (after achieving the design depth) must be defined, including radii of curvature and approximate points of tangency of curved and straight segments. The curvatures must be compatible with both steel drill rods and the HDPE pipe used. It should be noted that even larger bend radii (lower curvatures) will further reduce lateral flexural bending loads on the pipe and drill rods as they traverse the route, thereby helping avoid additional increases in tensile loads associated with their stiffness effects. Typically, the bore path should ensure a minimum depth of cover of 5m beneath the river bottom as projected over the design life of the pipe line, including allowance for scouring. This will overcome buoyance effects and help overcome the tendency for the drill head to rise toward the free surface, thereby complicating the steering operation.

4. Average Radius of Curvature – The average radius of curvature for the drill path segment (that is A-B or C-D in Figure 2) reaching to or from a depth required to
Pass beneath an obstacle, may be estimated from the bore exit or entry angle, respectively, and the depth of bore:

\[ R_{avg} = \frac{2H}{\theta^2} \]

where:

- \( R_{avg} \) = average radius of curvature along the bore path segment in metres,
- \( \theta \) = bore exit or entry angle to surface, radians, and
- \( H \) = depth of bore beneath the lowest ground surface (i.e. river bed).

The corresponding horizontal distance required to achieve the depth or rise to the surface may be estimated by:

\[ L = \frac{2H}{\theta} \]

where:

- \( L \) = horizontal transition distance in metres,

5. The depth of cover below the watercourse is dependent upon a number of factors such as subsurface soil conditions, type of drilling equipment, drill fluid pressure, the difference in elevation between the entry and exit points and the depth of bore beneath the lowest ground surface (i.e. river bed).

For the purpose of this feasibility study, 89cm (3.5") diameter x 6.1m (20’) long steel drill rods was selected to be able to perform the above calculations. Although primarily a contractor selection, the selected drill rod size is commonly used by ‘maxi-HDD’ operations with drill rigs capable of providing greater than 444.8 kN (100,000 lb) thrust / pullback.

Recommended bend radius of drill rod = 1200 x 89mm / 1000mm = 107m, say 150m.

**Table 6.3** presents the required parameters to define the bore path and the horizontal transition distance.
The resultant path will determine the stresses to be exerted upon the pipe during installation and service life. The product pipe design must therefore be analyzed based upon the final selected bore path, following the pipe design and selection procedures given in ASTM F 1962 during the detailed design phase. Refer also to Section 7.1.5.

Once the difference in elevation between the entry and exit points and the depth of bore beneath the lowest ground surface to account for scour of the river bed is determined during the detailed design, the recommended drill rod size and bore path alignment should be reviewed and revised accordingly. The depth of the bore path should be further assessed by a geotechnical engineer and a geomorphologist. It may be necessary to increase the drill length. Due to the project being situated in a former railway corridor, moving the entry and/or exit points back further from the watercourse crossing can be easily accommodated.

<table>
<thead>
<tr>
<th>Location</th>
<th>Utility</th>
<th>Bore Entry (Pipe Exit) / Bore Exit (Pipe Entry) Angle</th>
<th>Depth of Bore Beneath the Lowest Ground Surface (H)</th>
<th>Average Radius of Curvature of Bore Path to Achieve Required Depth (R)</th>
<th>Horizontal Transition Distance (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beattie Bridge</td>
<td>Watermain (bore entry on east side)</td>
<td>14 degrees</td>
<td>11.5m</td>
<td>500m</td>
<td>100m</td>
</tr>
<tr>
<td></td>
<td>Watermain (bore exit on west side)</td>
<td>10 degrees</td>
<td>11.5</td>
<td>1100m</td>
<td>140m</td>
</tr>
<tr>
<td>Beattie Bridge</td>
<td>Sanitary Forcemain (bore entry on east side)</td>
<td>14 degrees</td>
<td>11.5m</td>
<td>500m</td>
<td>100m</td>
</tr>
<tr>
<td></td>
<td>Watermain (bore exit on west side)</td>
<td>10 degrees</td>
<td>11.5m</td>
<td>1100m</td>
<td>140m</td>
</tr>
<tr>
<td>Bailey Bridge</td>
<td>Watermain (bore entry on south side)</td>
<td>14 degrees</td>
<td>8.0m</td>
<td>260m</td>
<td>65m</td>
</tr>
<tr>
<td></td>
<td>Watermain (bore exit on north side)</td>
<td>10 degrees</td>
<td>8.0m</td>
<td>580m</td>
<td>100m</td>
</tr>
<tr>
<td>Bailey Bridge</td>
<td>Sanitary Forcemain (bore entry on south side)</td>
<td>14 degrees</td>
<td>8.5m</td>
<td>280m</td>
<td>70m</td>
</tr>
<tr>
<td></td>
<td>Sanitary Forcemain (bore exit on north side)</td>
<td>10 degrees</td>
<td>8.5m</td>
<td>610m</td>
<td>100m</td>
</tr>
<tr>
<td>Beeton Bridge</td>
<td>Watermain (bore entry on north side)</td>
<td>14 degrees</td>
<td>8.0m</td>
<td>260m</td>
<td>65m</td>
</tr>
<tr>
<td></td>
<td>Watermain (bore exit on south side)</td>
<td>10 degrees</td>
<td>8.0m</td>
<td>580m</td>
<td>100m</td>
</tr>
</tbody>
</table>
6.3 Construction Access & Staging Areas

Drilling execution planning should consider that access to both sides of the drill will be required during the HDD construction process. Due to the project being situated in a former railway corridor and bridges span the watercourses, adequate access to both sides of the watercourse locations will be suitable.

Access to an adequate supply of fresh water is expected to be provided via hydrants on the existing watermain. Water will be required for the following:

- Initial drilling fluid make-up;
- Additional drilling fluid as the drilling progresses;
- Replacement fluid for drilling fluid escaping into the formation due to seepage or hydraulic fracture;
- Hydrostatic testing of the product pipe.

Access for monitoring of the drill path is expected to be a challenge due to the watercourse and may require water craft.

The selection of the bore entry and exit locations will need to consider the following:

- Terrain must be cleared, leveled and suitable for the work;
- Entry and exit locations should be of sufficient size and configuration to undertake the work safely and with consideration of the following:
  - Drill rig entry and exit points;
  - Rig size and layout requirements
  - Pipe laydown area;
  - Fabrication area;
  - Drill fluid containment pits and/or tanks;
  - Bulk storage of materials.
- Existing infrastructure and land use.

Due to the project being situated in a former railway corridor, the available area required will be sufficient. Significant tree removals are not anticipated. However, impacts to trees should be limited to removal of overhanging limbs within the railway corridor.

Due to sloped embankments and ditches within the former railway corridor, the terrain will need to be leveled and potentially shored with engineered fill and/or interlocking
concrete Jersey barriers to temporarily retain the soil. Temporary ditching and/or culverts may be required to maintain / improve drainage conditions during construction.

6.4 Risk Considerations

As with all construction techniques, a degree of risk and unpredictability is associated with the use of HDD applications. This section identifies and assesses the potential risks as well as provides guidelines to minimize the risks.

Risks can generally be divided into three types: regulatory, environmental and operational risks.

Regulatory risk can be encountered during:

- the application and approvals stage of a project; and
- construction.

During the application and approvals stage, the project may be delayed or rejected if insufficient information is submitted for regulator review. In the event that an application is approved, insufficient information may cause the regulatory agency to invoke restrictive conditions to ensure protection of the environmental resources.

During construction, an inadvertent release of drilling fluid to the environment or other contravention of an act may result in possible charges being laid by the regulatory agencies. These infractions could include:

- Section 32 of the Fisheries Act - unauthorized killing of fish
- Section 35 of the Fisheries Act - unauthorized HADD
- Section 36 of the Fisheries Act - unauthorized release of deleterious substances

In a regulatory climate in which more emphasis is being placed on self-regulation, industry can expect that any violation of the regulatory requirements may result in more rigid interpretation of the legislation. Therefore, it is imperative that all permits/approvals are obtained and applicable conditions are implemented to demonstrate that industry can be trusted to self-regulate.

Success of an HDD installation is dependent upon the ability to minimize the causes of failure. The risks associated with each crossing will vary according to many factors. These include but are not limited to:

- inadequate planning;
- lack of contingency planning;
• inexperienced field personnel;
• overestimation by the contractor in the firm’s abilities;
• insufficient quantity and size of equipment onsite; and
• inadequate knowledge of subsurface conditions.

Environmental risk on a project can be minimized by ensuring that sufficient planning is conducted and adequate investigations are carried out as part of the detailed design process. Another means of addressing risk on a project is through the type of construction contract that is used.

Table 6.4 summarizes some of the more common problems associated with HDD and identifies the environmental risks associated with each.
Table 6.4 – Environmental Risks Associated with HDD

<table>
<thead>
<tr>
<th>Potential HDD Difficulty</th>
<th>Environmental Risk</th>
<th>Scale of Risk (Occurrence / Impact)</th>
<th>Mitigation and / or Contingency Plan(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collapsed hole, stuck drill stem, lost tools</td>
<td>Failure leads to subsequent attempts and possible additional land requirements</td>
<td>Low / Medium</td>
<td>Ensure sufficient land is obtained for subsequent attempts and ensure approvals are in-place for alternative techniques.</td>
</tr>
<tr>
<td>Loss of circulation</td>
<td>Failure leads to excavation to find cause of lost circulation and possible additional land requirements</td>
<td>Low / High</td>
<td>Ensure sufficient land is obtained for excavation and ensure approvals are in-place for alternative techniques. Activate contingency plan if frac-out is occurring or suspected.</td>
</tr>
<tr>
<td>Drilling fluid seepage directly into watercourse</td>
<td>Prolonged sediment load and deposition with possible adverse affects on fish and fish habitat.</td>
<td>High / High</td>
<td>Undertake a fluvial / geomorphological investigation during detailed design including an assessment of the soil conditions below the river beds to ascertain a recommended depth below the river beds. Also undertake a natural heritage / natural science assessment of the aquatic life and habitat in the watercourses. Drill fluids to be NSF 61. Ensure a drilling fluid contingency plan is in-place.</td>
</tr>
<tr>
<td>Drilling fluid seepage onto land.</td>
<td>Sediment deposition with possible adverse affects on wildlife and vegetation.</td>
<td>Medium / Low</td>
<td>Drill fluids to be NSF 61. Ensure a drilling fluid contingency plan is in-place.</td>
</tr>
<tr>
<td>Washout of cavities and collapse of overburden (due to cohesionless soils)</td>
<td>Sink-holes on land / below watercourse</td>
<td>High / High</td>
<td>Utilize ‘conductor barrels’ / ‘washover casing pipes’ prior to pilot bore. Ensure a drilling fluid contingency plan is in-place.</td>
</tr>
</tbody>
</table>

Items with a ‘High’ Occurrence / Impact must be reviewed and addressed during detailed design. This will include, but not limited to, the following:

- a fluvial / geomorphological investigation including an assessment of the soil conditions below the river beds to ascertain a recommended depth below the river beds.
• a natural heritage / natural science assessment of the aquatic life and habitat in the watercourses.

Appendix 5 provides excerpts from the guide for Pipeline Associated Watercourse Crossing (Chapters 5 and 6) regarding environmental and habitat mitigation procedures.

The risks associated with an HDD installation during operations are generally considerably less than those of a traditional trenched crossing. In particular, the risk of the following problems is minimized or eliminated:

• maintenance of disturbed banks or stream bed;
• exposure of pipe during peak flow events or due to ice scour; and
• damage of pipe due to anchors or other third party activities.

Increased risks include:

• pipe is inaccessible for repairs due to depth of cover;
• corrosion due to undetected damage to pipe coating;
• subsidence at entry and exit points; and
• visual leak detection is not possible.

6.5 Contingency Planning

Expectations for a site-specific contingency plan must be prepared during detailed design. Contents of a contingency plan (ultimately supplied by the contractor) should address the following:

• general measures;
• equipment and personnel needs for containment and clean-up;
• emergency response procedures;
• plans for continuance of drilling or alternative plans;
• time lines of acceptable response and notification;
• clean-up methods and plans;
• regulatory and stakeholder contacts;
• monitoring plans; and
• disposal plans.

Consideration for other mitigation measures may include the following:

1. Selection of Alternatives - Alternatives that may be available to allow continued use of an HDD method following an initial failure include:
   a. Down-hole cementing to either side to seal off the problem zone for re-drilling or seal off a large portion of the existing bore hole to a point where a new drill path (generally at a lower elevation) can be attempted; note that if reaming is necessary this method may not be successful since any reaming will remove localized cementing.
   b. A new drill can be attempted at a steeper entry angle in an attempt to get below the problem area.
   c. The drill can be moved, and an attempt made to re-drill from a new location (the revised drill path should be reviewed and revised accordingly prior to drilling).
   d. The feasibility of conventional (i.e., trenched) crossing methods should be considered if the drill fails with direct consultation with regulatory authorities.

2. Containment - Several containment measures are commonly used for the uncontrolled release of inadvertent returns as indicated in Table 6.5. The measure(s) chosen to be used depend upon:
   a. the anticipated volume to be contained;
   b. existing access to the site;
   c. environmental sensitivity of the area contaminated and adjacent areas; and
   d. soil and weather conditions
### Table 6.5 – Containment of Inadvertent Returns

<table>
<thead>
<tr>
<th>Containment Measure</th>
<th>Conditions Used / Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt fencing</td>
<td>Controls migration of drilling fluid in wetlands; retains small volumes of sediment; decreases overland flow of drilling fluids; minimizes total suspended sediment quantities of surface waters through filtration; suitable for wetlands and the banks and shorelines of waterbodies</td>
</tr>
<tr>
<td>Hay or Straw Bales</td>
<td>Retains small volumes of sediment; decreases velocity of downslope runoff; suitable for vegetated wetlands, and the banks and shorelines of water bodies</td>
</tr>
<tr>
<td>Sand Bags</td>
<td>Contains high volume inadvertent returns by creating a dam; used where silt fences and bales are not effective</td>
</tr>
<tr>
<td>Floating Booms</td>
<td>Contains drilling fluid in areas with a high flood potential where drilling mud returns may be spread by water flow throughout a water body; suitable in water bodies where water level exceeds 30 cm</td>
</tr>
<tr>
<td>Plywood Sheets</td>
<td>Contains deeper pooled inadvertent returns; suitable for water bodies where clean-up of returns cannot be completed before water flow disperses the returns</td>
</tr>
<tr>
<td>Culverts</td>
<td>Large culverts can be installed vertically over an instream point source release to contain released fluids and facilitate clean-up activities</td>
</tr>
<tr>
<td>Aquadams</td>
<td>Useful in diverting streamflow from an area of release or isolating the release area</td>
</tr>
</tbody>
</table>

3. **Clean-up and Remediation** - An important decision may be required when developing plans to clean-up an inadvertent release of drilling fluid. The decision can involve determination of whether or not clean-up and reclamation of a site will incur greater adverse effects on the environment than leaving the fluid in situ and allow natural processes to reclaim the area. In some situations, a combination of minimal intervention and letting nature take its course can also be appropriate (e.g., re-establishing a channel in a blocked wetland while leaving the wetland to reclaim itself). The determination as to whether to clean-up or not must be made in conjunction with appropriate regulatory and land authorities. In many cases, this decision will be contrary to traditional practices and must be made after thorough examination of the advantages and disadvantages of each.

Notwithstanding, discussion should be made with the appropriate regulatory agencies to discuss the clean-up goals for a site subjected to an inadvertent release of drilling fluids prior to commencement of clean-up activities. If a net gain is not anticipated as a result of clean-up, alternative measures may need to be implemented. Vehicles and equipment commonly used during the clean-up of a mud release are identified in Table 6.6.
### Table 6.6 – Potential Equipment and Vehicles Used During Drilling Mud Clean-up

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backhoe</td>
<td>Executing containment pits at drill sites situated in upland Areas</td>
</tr>
<tr>
<td>Vacuum trucks</td>
<td>The immediate collection of drilling fluids for recycling or offsite disposal; Ground low-pressure tires may be placed on vacuum trucks to reduce footprint in sensitive areas</td>
</tr>
<tr>
<td>Dump trucks</td>
<td>Removal of drilling mud to disposal areas, if required</td>
</tr>
<tr>
<td>Frac tanks</td>
<td>Above ground storage of drilling fluids and to contain inadvertent returns prior to disposal; Minimizes overall disturbance to the site, since sump pits are not required</td>
</tr>
<tr>
<td>Swamp mats</td>
<td>Minimizing sedimentation caused by heavy traffic in waterways; reduces compaction and rutting by heavy equipment in areas of wet terrain during nonfrozen conditions</td>
</tr>
<tr>
<td>Plywood sheets</td>
<td>Use as walkways for crews in sensitive areas, reduces footprint to the site</td>
</tr>
<tr>
<td>Brooms, rakes, spades and shovels</td>
<td>Manual removal of fluids from vegetated areas, for use after majority of muds are cleaned-up by larger equipment</td>
</tr>
<tr>
<td>Squeegees</td>
<td>Useful in removing residual mud from vegetation, thin residual mud so that vegetation is able to break through the fluid layer</td>
</tr>
<tr>
<td>Snowshoes</td>
<td>Useful for workers to access areas with thickly pooled released drilling mud to assess final clean-up requirements where heavy machinery is not allowed; Reduces impact of foot traffic on vegetation</td>
</tr>
<tr>
<td>Water rinse</td>
<td>Softens hard or dry drilling fluid</td>
</tr>
</tbody>
</table>

### 6.6 Monitoring and Reporting

Expectations for monitoring and reporting should be reviewed during detailed design. Appendix 5 provides excerpts from the guide for Pipeline Associated Watercourse Crossing (Chapter 7) regarding monitoring crossing project performance.

### 6.7 Pipe Design and Selection Considerations

Maxi-HDD applications typically require a detailed analysis of the product pipe in relation to its intended application. Due to the large anticipated pulling loads and potentially high external pressure, a careful analysis of the HDPE pipe must be performed, subject to the confirmation of the route geometry, to verify or determine an appropriate DR (or pipe
wall thickness). The analysis should consider both the installation forces occurring during pull-back and the long-term operational loads.

Pipes made from either high density polyethylene (HDPE) are suited for directional drilling. HDPE pipe specifications include Specifications D 2447, D 2513, D 3035, and F 714. Since the pipe is provided in short segments, the individual units should be joined using a butt-fusion technique in accordance with Practice D 2657. This will allow the inherent strength of the HDPE pipe to be maintained during the placement process and when subjected to other operational stresses.

The pipes will be subject to several loads and forces during construction and operation. During detailed design, the designer must determine the design and selection of the pipe to serve the function intended and withstand operational stresses at the direction drilled section as well as at other sections along the pipe line. It should be noted that the designer must account for, but not limited to, the following as outlined in ASTM F 1962 Standard Guide:

- Operation and installation loads;
- Internal (operational) pressures;
- External (operational) hydraulic and earth loads;
- Net external pressure;
- Pipe resistance to external loads;
- Pipe deflection (ovality);
- Axial bending stress;
- Pulling forces;
- Pipe stiffness;
- Coefficient of friction;
- Hydrokinetic pressure;
- Axial tensile stress;
- Torsional stress;
- Combined loads during installation;
- Reduced HDPE collapse strength;
- Thermal effects;
- Combined loads during operation; and
- Thermal stress.

6.8 Hydraulic Design

A hydraulic analysis should be undertaken during detailed design based on the latest versions of the Ministry of Environment and Climate Change (MOECC) Design Guidelines for Drinking-Water Systems and Design Guidelines for Sewage Systems for the watermain and sanitary forcemain respectively. This will require an understanding of the maximum and minimum operating pressures and transient pressures.

6.9 Open Cut Portions

Portions of the pipes to be installed in open cut are expected to be limited to depths between two to three metres to achieve minimum cover requirements per Town standards. Where the directionally drilled pipe terminates, standard open-cut construction following OPSS will be used to connect to the existing pipes.

6.10 Tie Ins

Short duration shutdowns of the watermain may be allowed by the Town during construction of the watermain tie-ins if sufficient water storage is available in Beeton to meet water demands during the duration of the shutdown. If an extended shutdown is required, temporary works will be required during construction to divert flow during the tie-ins.

Short duration shutdowns of the forcemain may be allowed by the Town during construction of the forcemain tie-ins by pumping and hauling sewage from the Lily St SPS to the Regional Waste Water Treatment Plant. Alternatively, for longer duration shutdowns, temporary works can be installed to divert flows during the tie-in work to maintain the forcemain in operation throughout construction.

To allow the watermain and sanitary forcemain to remain in operation during the tie-in portion of the construction activities, a temporary bypass tap will be constructed on the pipe on either side of the bridge and connected together with temporary above-grade piping. A line valve insertion will be used on either side of the bridge, diverting the flow through the temporary system until the tie-ins are complete.

The contents of the pipe located in the forcemain and watermain between the line valve insertions will require proper disposal. Chlorinated water must be dechlorinated prior to discharging into a level vegetated area subject to the approval of the Conservation Authority.
6.11 Appurtenances

The detailed design should provide consideration for various permanent appurtenances such as:

- Fire hydrants (flushing or otherwise);
- Swab launchers and receiving ports;
- Air release / air vacuum valves;
- Drain valves; and
- Valving.
7.0 APPROVALS

During detailed design and prior to construction, approvals will be required from several review agencies:

- The Drinking Water Works Permit will require Form 1 – Record of Authorization of Watermain Authorized as a Future Alteration for watermains from the Ministry of the Environment and Climate Change through the Town.

- An Environmental Compliance Approval (ECA) for sewage works from the Ministry of the Environment and Climate Change.

- The Town's Official Plan requires all applications for development and/or site alteration on lands within the EP1 and EP2 designations and adjacent lands include an Environmental Impact Study.

- Permits may be required from the Nottawasaga Conservation Authority, as the areas are regulated by the conservation authority for potential flooding and erosion hazards under O. Reg. 172/06 and CA Act. Additional investigations, such as Environmental Impact Study (EIS) or Natural Heritage Evaluation investigations may be required in support of these permits.

- The Ministry of Natural Resources and Forestry has reviewed the bridges and confirmed that as the bridges are not located on Crown Land, a work permit under the Public Lands Act or the Lakes and Rivers Improvement Act is not required.
8.0 RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

During detailed design and prior to construction, further investigations will be required. The scope and type of investigations should be confirmed by the various authorities having jurisdiction. Below is a list of further investigations that have been identified during the Preliminary Design:

- Stage 2 Archaeological Assessments, including test pits, are required for portions of both the Beattie and Bailey Bridge sites, as noted in the Stage 1 Archaeological Assessments (Appendix 4.1 and 4.2). These studies should be completed once the extent of construction activities are confirmed during detailed design.

- The depth of the bore path below the bottom of each watercourse is recommended to be further assessed by a geotechnical engineer and a geomorphologist.

- Further geotechnical investigation is recommended to determine the depth of more competent (non-cohesive) soils.

- A detailed fluvial geomorphological investigation is recommended, including a scour / erosion analysis and in-water survey of the river channel, for each watercourse, especially in light of two of the three bridges (Bailey and Beeton) being washed-out during Hurricane Hazel in 1954.

- A natural heritage / natural science assessment of the aquatic life and habitat is recommended at each watercourse.
9.0 REFERENCES

“Municipal Bridge Appraisal” Forms, 2015

“Municipal Bridge Appraisal” Forms, 2016


ASTM F 1962 - 05 “Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacle, Including River Crossings”, Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, USA.


Grand Trunk Railway (now Canadian National Railway) Northern Division – 13th District, Bridge No. 277 – Mile 72.12, Bailey Creek, Structural Bridge Drawings, Chief Engineering Office, Montreal, May 1911.

Grand Trunk Railway (now Canadian National Railway) Northern Division – 13th District, Bridge No. 278 – Mile 73.75, Nottawasaga River (Beattie Bridge), Structural Bridge Drawings, Chief Engineering Office, Montreal, May 1911, amended June 27, 1913.

Grand Trunk Railway (now Canadian National Railway) Northern Division – 13th District, Bridge No. 276 – Mile 71.12, Hammell’s Creek (Beeton Bridge), Structural Bridge Drawings, Chief Engineering Office, Montreal, June 1911.

Canadian National Railways Central Region, Allandale Division – Milton Subdiv. Miles 59.9 & 61.0, Hammell’s Creek & Bailey’s Creek, Reconstruction Structural Bridge Drawings, January 14, 1954 (1955).