Winnipeg

FINAL REPORT

Newton Force Main Red River Crossing

Preliminary Design Report

November 2021

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Associated Engineering

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KGS GROUP

EGE Engineering Ltd.

EXECUTIVE SUMMARY

The Newton Force Main crosses the Red River and was built by the City of Winnipeg in two stages. The first was built in 1960 which is a 350 mm diameter steel force main and conveys flows from the Linden Combined Sewer District. The second was built in 1978 and is a 350 mm diameter high density polyethylene pipe which conveys flows from the Hawthorne Combined Sewer District. The two lines are cross connected between two chambers within Fraser's Grove Park which allow the force mains to operate together.

The Newton Force Main underwent modifications as part of the High Risk River Crossing Condition Assessment Program to allow inspections and assessments. The steel line was inspected in the first phase where it was found that minimal degradation and wall loss had occurred since being put into service. The high density polyethylene (HDPE) was inspected using sonar technology in the second phase, and it was found to have a circumferential split near the downstream end, have a small leak through a low head leakage test, and be deformed with low resistance to cracking. The split was repaired using a trenchless point repair to prevent leaking until the force main can be replaced.

The City of Winnipeg retained Associated Engineering to conduct a concept study that recommends the most suitable strategy to replace the existing sanitary force main through the development of the various options and providing recommendations for a permanent replacement. The HDPE force main is not suitable for rehabilitation therefore, no rehabilitation options were explored.

This concept study included the development of potential options to replace the high-density polyethylene via trenchless methods which were Horizontal Directional Drilling and Microtunnelling. These options were:

- **Option 1** – Microtunnel from Rowandale Crescent to Scotia Street
- **Option 2** – HDD from Rowandale Crescent to Scotia Street
- **Option 3 –** HDD from Fraser's Grove Park to Kildonan Park
- **Option 4 –** Microtunnel from Fraser's Grove Park to Kildonan Park
- **Option 5 –** Microtunnel from Rowandale Crescent to Kildonan Park
- **Option 6 –** HDD from Rowandale Crescent to Kildonan Park
- **Option 7 –** Microtunnel from Fraser's Grove Park to Louis Greenburgh Plaza
- **Option 8 –** HDD from Fraser's Grove Park to Louis Greenburgh Plaza.

These options were presented and discussed in two workshops held with City of Winnipeg representatives from the Engineering and Wastewater Services divisions within the Water and Waste Department. Options were evaluated using the Analytical Hierarchy Process and each was ranked based on the set of criteria developed and weighted by the workshop group. These were:

- Social Impact
- Environmental Impact
- Constructability
- New Infrastructure
- Geotechnical Considerations
- Impacts to Private Property

Each option was compared to the others and scored based on the criterion and project objective. A weighted score for each option was achieved by multiplying the assessed score with the weight of the determined evaluation criteria and then ranked. Value Ratios (cost to benefit ratio) were determined for each option by dividing the weighted score by the options estimated cost. The option with the highest value ratio is the one perceived to be the best valued and best suited in meeting the project objectives.

The option with the highest value ratio was Option 3 - HDD from Fraser's Grove Park to Kildonan Park followed by Option 6 – HDD from Rowandale Crescent to Kildonan Park. Option 4 – MT from Fraser's Grove Park to Kildonan Park scored highest in the total weighted score followed by Option 3 – HDD from Fraser's Grove Park to Kildonan Park. Option 3 scored well because of its limited impact to private property, increased constructability, and benefits realised by the improvements to new infrastructure.

A geotechnical investigation completed along the proposed alignment confirmed that HDD installation is feasible and the bedrock in the area is good quality. A conceptual design of the proposed borepath was completed in **Figure 10-1**, which considers the geometric and geotechnical constraints onsite.

Associated Engineering recommends moving forward with the preliminary design for the replacement of the Newton Force Main Red River Crossing based on **Option 3 - HDD from Fraser's Grove Park to Kildonan Park**.

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1 INTRODUCTION

1.1 Newton Force Main

The Newton Force Main Red River Crossing is a dual crossing of the Red River between Fraser's Grove Park and Newton Avenue. The twin crossing consists of a 350 mm diameter steel force main from the Linden Combined Sewer District (CSD) constructed in 1960, and a 350 mm diameter high density polyethylene (HDPE) force main from the Hawthorne CSD constructed in 1978. The crossing carries combined sewage flows from the Linden and Hawthorne Districts to a secondary sewer on the west side of the Red River near the intersection of Scotia Street and Newton Avenue. The wastewater flows by gravity from there to the Main Street Interceptor and is then conveyed to the North End Pollution Control Centre.

Originally flows from both the Linden and Hawthorne pump stations were serviced by the 350 mm steel force main. In 1978 the second HDPE force main was added on a parallel alignment across the Red River. Hydraulic modelling has indicated that flows from both the Linden and Hawthorne pump stations could be served by a single force main during peak dry weather flows. The system continues to be operated as separate force mains.

The Newton Force Mains were inspected as part of the High Risk River Crossing Program. The steel force main was inspected during Phase 1 of the program, in 2014, and was found to be in good condition with virtually no wall loss due to corrosion. The assessment determined this force main to have over 100 years of serviceable life remaining with some minor work required on the banks to prevent future erosion at the crossing location.

The HDPE force main was inspected during Phase 2 of the program in 2018 and was found to have leaks and evidence of excessive deformations. The investigation found the HDPE pipe to have very low resistance to Slow Crack Growth (SCG), which can make the pipe susceptible to brittle failure in response to long-term exposure to either sustained pressure or intermittent short-term over-pressure. A low head leakage test identified an apparent leak of over 800 l/hr, and CCTV inspection identified a circumferential split in the HDPE pipe immediately adjacent to the downstream end of the siphon. The leaks in the force main were repaired and the force main was flagged for replacement in the near future. No evidence of global slope instabilities was observed but armoring of the lower riverbanks was recommended to address erosion issues.

Based on the Phase 2 work, it was recommended that the Newton Avenue Force Main be replaced by horizontal directional drilling, as the current condition of the HDPE pipe was not considered conducive for cured in place pipe rehabilitation. Although the existing steel force main is in relatively good condition, replacement of both force mains will be considered depending on the installation method and alignment.

1.2 Objectives and Scope

The purpose of this project was for Associated Engineering to conduct the conceptual engineering required to create and evaluate options for the rehabilitation or replacement of the Newton Force Main. During the project kick off meeting it was agreed that the options would focus on the replacement as the City had already conducted independent reviews and concluded that rehabilitation was not feasible and that the focus to be on the replacement of the HDPE force main. Within the concept identification and study portion of the work, Associated Engineering's responsibility was to perform an assessment of the various strategies available, and to develop a minimum of four different concepts using two different construction methodologies. Each concept was to be developed providing the following:

- Material, alignment, approach, geotechnical considerations
- Constructability, and the need for specialized contractors
- Schedule
- Maintenance and operations
- Sustainability
- Cost estimates to AACE Class 5 category including engineering and construction
- Risks and opportunities
- Infrastructure security
- Regulations, permitting and environmental considerations

A two-part Preliminary Design Workshop was held by Associated Engineering on June 16, 2021, and June 21, 2021. The workshops included representatives from several City divisions and branches from the Water and Waste Department as stakeholders based on the Analytical Hierarchy Process (AHP). The final objectives of the project are for Associated Engineering to develop a technical Conceptual Design Report summarizing the option development, workshop process and decisions, and provide a final recommendation on the steps forward for the replacement of the force main.

This report summarizes the process taken to create options, identify evaluation criteria and their weight, option ranking, and conduct the value ratio in order to determine the most suitable option to advance into preliminary design.

Following the Preliminary Design Workshop, geotechnical investigation was completed along the proposed alignment and a conceptual plan and profile of the borepath was developed.

2 BACKGROUND AND INFORMATION REVIEW

This section outlines the background information that was reviewed, the discussions which occurred during the project kick off meeting, and steps taken to develop the options for the Concept Evaluation Workshop.

2.1 Background Information

Information on the force main provided to Associated Engineering included:

As-Built Drawings

As-built drawings were provided for the existing Newton Force Mains, the Newton pump station, Kildonan Park, Newton Avenue, and Scotia Street. GIS information was provided for all utilities in the area and franchise utility information was obtained from Manitoba Hydro. The as-built information outlines the alignment and the connection of the existing force mains and identifies potential utility conflicts, which may impact alignment selection.

Geotechnical Information

Geotechnical reports were provided from the City as well as **KGS Group**. These reports include information and assessments of the areas within the Kildonan Park on the west side of the river as well as along the river in private residencies along the east side the river.

2.2 Site Constraints

Utilities

The existing force mains tie-in to the existing system on the Newton Avenue Pump Station lot. In addition to the existing force mains, the lot also contains a combined sewer outfall, the pump station and wet well, overhead power lines, and lot services. Crossing at the same location is not considered feasible and alternative crossing locations will be considered to avoid extensive utility relocations.

River Bank Stability

KGS Group conducted a desktop review of the available information in the vicinity of the crossing location. KGS is aware of existing slope instabilities on the west bank of the river near Kildonan Park. Crossing alignments will incorporate suitable setback distances to ensure the new force main crossing is not within unstable zones. A more detailed geotechnical review is included in **Section 4**.

Environmental and Regulatory

EGE Engineering Ltd. reviewed the local, provincial and federal regulations regarding new force main crossings of the Red River. The level of effort for permitting and approvals is anticipated to be the same for any crossing alignment in the area using Horizontal Directional Drilling (HDD) or Microtunnelling (MT) installation. Further regulatory requirements are discussed later in **Section 6**.

Residential Impact

The existing force main crossings pass through the Newton Flood Pumping Station lot, which is situated on a residential street. Flows are then directed northwest on Newton Avenue - another residential street. Alternative crossing alignments will be considered to minimize the impact to the residents in this area, however the secondary sewer on Newton Avenue is a convenient route to carry sewage flows to the Main Street Interceptor; therefore, it is likely some construction will be required at the Newton Avenue and Scotia Street intersection regardless of the crossing alignment. Residents near the Newton Avenue and Scotia Street intersection may be subject to construction noise, dust, traffic and road and /or driveway closures depending on the crossing alignment and construction methodology.

Recreation and Parks

The Fraser's Grove Valve Chamber is located in Fraser's Grove Park, which runs along the east bank of the Red River in the vicinity of the existing crossings. Work in the park will be required to decommission the existing force main crossing and the new force main will cross through the park since the park extends both east and west of the valve chamber. On the west side of the river, Kildonan Park and Louis Greenburgh Plaza are located near the river and may provide good alternative crossing locations. Construction within parks may result in noise, dust, traffic, tree clearing and trail closures however work in parks may be preferable to working in close vicinity to residents.

2.3 Installation Methodologies

Horizontal directional drilling and microtunnelling were considered for the Newton Force Main Red River Crossing. The construction methodologies are described in the following sections. Both construction methodologies were developed considering that a dual encasement solution would be required.

2.3.1 Horizontal Directional Drilling

Horizontal directional drilling is a surface to surface installation method widely used for river crossings of similar scope. Installation by horizontal directional drilling involves drilling of the pilot bore, pre-ream, and product pullback.

During the installation process, the drill rig provides the thrust, pullback and rotational torque required to maneuver the drill string and product pipe during the installation. For all three phases of the installation, a drilling fluid is utilized that assists with stabilizing the borehole, transporting soil cuttings out of the borehole, and reducing friction within the borehole during product pullback. Once the casing pipe is pulled in, the carrier pipe would be pulled inside and connected to the force main system.

Based on input from EGE Engineering Ltd., dual encasement is not required for trenchless installation within bedrock. Therefore, the horizontal directional drilling option would likely consist of a 450 mm nominal (350 mm ID) diameter HDPE force main. During this stage of the assessment Associated Engineering is assuming a size for size replacement. If dual encasement is required, a 900 mm nominal diameter HDPE casing pipe will be installed first and the 450 mm pipe will be pulled inside. The two HDPE pipes will act as a dual encasement system.

Advantages

- Requires a smaller diameters casing pipe (if required) than compared to the microtunnelling option.
- Minimal excavation for tie-in would be required, also tie-ins would be completed at a shallower excavation depth when compared to the microtunnelling option.
- Shorter construction schedule compared to microtunnelling.
- Generally lower cost.

Disadvantages

- Large setbacks from the river required for drilling geometry restrictions, extends the length of the installation compared to microtunnelling.
- Large diameter entry casing required to stabilize ground entry prior to borepath entering the bedrock.
- Reduced capability to adjust to change in conditions.

2.3.2 Microtunnelling

Microtunnelling is a term used to describe a family of horizontal earth boring installation methods that also do not require personnel to enter the pipe during its installation. It is guided, steerable, and capable of installing pipes with tight tolerances on line and grade. Traditional methods utilize a microtunnel boring machine (MTBM) to excavate the tunnel along the alignment. A jacking frame is set within the launch shaft on the proposed line and grade of the installation and used to first launch the MTBM into the ground, and then continue to advance it by pushing pieces of sectional jacking pipe behind the trailing unit. The jacking pipe is specifically designed and manufactured to withstand the jacking forces developed during the installation process. Once the jacking pipe is installed the carrier pipe would be installed and connected to the force main system through the shafts.

The microtunnelling option would likely entail the installation of a minimum 1500 mm diameter concrete jacking casing pipe containing a 450 mm nominal (350 mm ID) diameter HDPE force main. During this stage of the assessment Associated Engineering is assuming a size for size replacement. Provincial requirements necessitate river crossings have two sealed systems meant to act as “dual containment”. The concrete jacking pipe and HDPE force main act as a dual encasement system for the microtunnelling method.

Advantages

- With launch shafts the installation is shorter and may be closer to the river.
- Lower slurry operating pressure and flow required during the installation reducing the risk of hydrofracture into the river.
- Greater ability to adapt to changes in geotechnical conditions than horizontal directional drilling.
- Ability to replace both force mains within the same tunnel and accommodate upsizing if required.

Disadvantages

- Larger construction equipment and footprint required to contain support equipment required at launch/retrieval shafts.
- Installation requires the installation of a larger diameter casing to house the force main.
- Requires large deep shafts to install the casing pipe within the bedrock beneath the river,
- Results in complicated work required within the shaft to connect to the force main which includes 90 degree bends and cleanout fittings.
- Longer construction schedule than the horizontal directional drilling option.
- Generally more expensive.

3 CONCEPT DEVELOPMENT

The purpose of this study was to develop potential options to replace the Newton Force Main Red River Crossings. The options primarily focus on replacement of the HDPE force main however the cost savings and benefits of replacing the steel force main were also considered.

These options are:

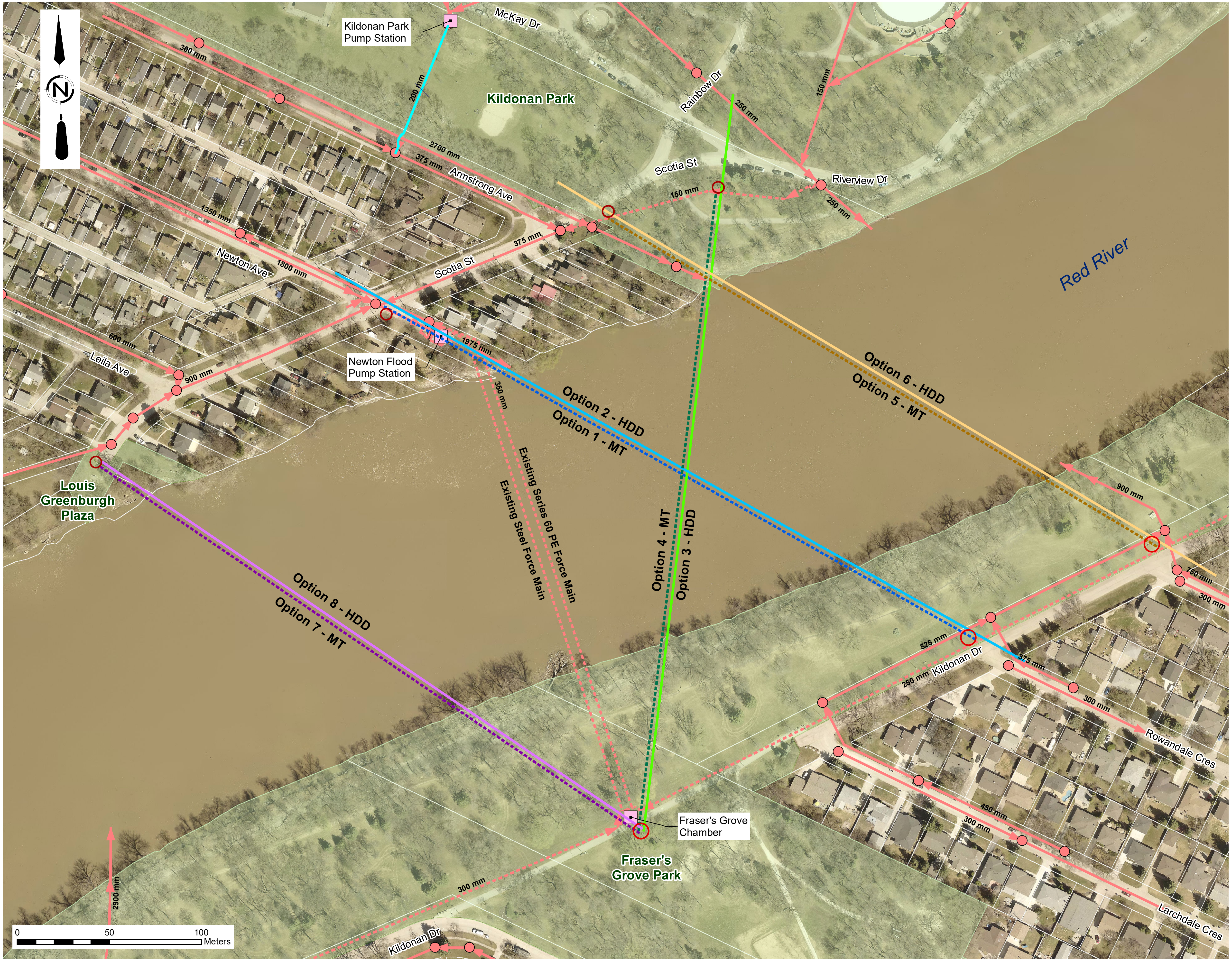
1. **Option 1** – Microtunnel from Rowandale Crescent to Scotia Street
2. **Option 2** – HDD from Rowandale Crescent to Scotia Street
3. **Option 3 –** HDD from Fraser's Grove Park to Kildonan Park
4. **Option 4 –** Microtunnel from Fraser's Grove Park to Kildonan Park
5. **Option 5 –** Microtunnel from Rowandale Crescent to Kildonan Park
6. **Option 6 –** HDD from Rowandale Crescent to Kildonan Park
7. **Option 7 –** Microtunnel from Fraser's Grove Park to Louis Greenburgh Plaza
8. **Option 8 –** HDD from Fraser's Grove Park to Louis Greenburgh Plaza

Figure 3-1 shows the various options and their methodologies.

A workshop package was provided to the attendees which included a project summary, option descriptions, as well as a permitting and approval review. The workshop booklet has been included in **Appendix A**.

3.1 Constructability Assessment

A constructability assessment was completed on the eight proposed alignments using Associated Engineering's past experience with trenchless crossings of the Red River. Associated Engineering has provided trenchless feasibility and design services for two crossings within 1.5 km of the potential crossing locations considered for the Newton Force Main crossings; one was constructed using horizontal directional drilling and the other by microtunnelling. **Table 3-1** outlines the constructability of each option based on the known site conditions, the geometry of the crossing and the trenchless methodology requirements.



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LEGEND:

- ┅ Option 1, MT
- ━ Option 2, HDD
- ━ Option 3, HDD
- ┅ Option 4, MT
- ┅ Option 5, MT
- ━ Option 6, HDD
- ┅ Option 7, MT
- ━ Option 8, HDD
- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main

Winnipeg

FIGURE 3-1

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT OPTIONS

AE PROJECT No.	2021-4589
SCALE	1:2,000
APPROVED	
DATE	2021JUN14
REV	
DESCRIPTION	ISSUED FOR DRAFT

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25 mm
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Table 3-1
Constructability Assessment

Alignment	Installation Method	Length (m)	Pipe Material	Constructability Discussion
Option 1: Rowandale Crescent to Scotia Street	Microtunnel	370	Concrete Jacking Pipe Casing, HDPE Carrier	The east side is open, accessible, and would serve as a suitable staging area. The west side is congested with a number of ariel and subsurface utilities and limited area for shaft excavation and cranes needed to construct the work. Microtunnelling within the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible with significant utility relocation.
***Option 2:** Rowandale Crescent to Scotia Street	Horizontal Directional Drilling	430	HDPE Casing, HDPE/PVC/Liner Carrier	It is estimated that the entry and exit pits must be located at least 100 m from the river's edge based on experience in the area. To meet these setback distances the entry and exit pits will be located on residential streets near homes on Newton Avenue and Rowandale Crescent. The residential streets do not provide the required working area for construction. This alignment is further complicated by the existing utilities at the Newton Avenue Lift Station and at the intersection of Scotia Street and Newton Avenue. To avoid utility conflicts on the pump station site, the new force main will need to be installed beneath the pump station and require a large casing installation under several existing utilities in Scotia Street. This alignment will also result in the installation of the force main under the sidewalk on Newton Avenue. Challenges exist on the east side with the proximity to homes and utilities as well but not as significant as on Scotia Street. This alignment is not considered feasible.
Option 3: Fraser's Grove Park to Kildonan Park	Horizontal Directional Drilling	405	HDPE Casing, HDPE/PVC/Liner Carrier	Entry and exit pits require around a 100 m set back from the rivers edge. The east side Fraser's Grove Park is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable entry area. Kildonan Park on the west is also large and open but does have some utilities which require consideration for the placement of the exit area. The Park is suitable to stage the pipe string out for pullback. Horizontal directional drilling is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 4: Fraser's Grove Park to Kildonan Park	Microtunnel	350	Concrete Jacking Pipe Casing, HDPE Carrier	Fraser's Grove Park on the east side is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable working area and launch shaft. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and reception shaft but is suitable for the work. Microtunnelling within the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 5: Rowandale Crescent to Kildonan Park	Microtunnel	350	Concrete Jacking Pipe Casing, HDPE Carrier	The green space along the river valley parallel to Kildonan Drive near Rowandale Crescent is open with minimal utility conflicts, good site access and would serve well as a launch shaft and working area. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and reception shaft but is suitable for the work. Microtunnelling within the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 6: Rowandale Crescent to Kildonan Park	Horizontal Directional Drilling	415	HDPE Casing, HDPE/PVC/Liner Carrier	The needed setback of 100 m would place the entry area along Rowandale Crescent in front of resident's homes. Installation of a large diameter entry casing is challenging but feasible. The green space along the river valley parallel to Kildonan Drive near Rowandale Crescent is open with minimal utility conflicts, good site access and would serve well as a working area. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and pipe string out but is suitable for the work. HDD is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 7: Fraser's Grove Park to Louis Greenburgh Plaza	Microtunnel	355	Concrete Jacking Pipe Casing, HDPE Carrier	The east side Fraser's Grove Park is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable working area and launch shaft. Louis Greenburgh Plaza is a small green space with limited utility conflicts and moderate access. This location is suitable for a working area and reception shaft. Microtunnelling within the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
***Option 8:** Fraser's Grove Park to Louis Greenburgh Plaza	Horizontal Directional Drilling	355	HDPE Casing, HDPE/PVC/Liner Carrier	The required setback of 100 m is feasible on the east side with workspace available within the Fraser's Grove Park. Louis Greenburgh Plaza is a small green space on the west side of the river with little more than 40 – 50 m of workspace from the edge of riverbank. There is insufficient setback for the use of horizontal directional drilling in this location. Horizontal directional drilling is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is not considered feasible.

***Indicates options that will not be considered further as they are not considered feasible.**

3.2 Overview of Alignments

The following sections provide detailed information on the construction methodology, advantages, disadvantages, risks, and key issues of each proposed crossing alignment. As identified in **Table 3-1,** Options 2 and 8 are not considered feasible due to constructability concerns; as such, detailed descriptions of these options are not provided.

3.2.1 Option 1 - Microtunnel from Rowandale Crescent to Scotia Street

Option 1 involves the use of microtunnelling to install a new force main beneath the Red River. This includes the installation of a casing pipe from a jacking shaft in the green space west of Kildonan Drive and Rowandale Crescent to a reception shaft near the intersection of Scotia Street and Newton Avenue. A carrier pipe would be installed in the casing pipe and then grouted in place before being connected to the existing system. The existing HDPE force main pipe would then be abandoned in place or removed from the river bottom.

Scope is shown in **Figure 3-2.** Construction sequence is as follows:

1. Relocate above ground utilities to allow space for construction of the retrieval shaft.
2. Construction of a 25 m deep launch shaft in the green space along Rowandale Crescent.
3. Construction of a 25 m deep retrieval shaft near the intersection of Scotia Street and Newton Avenue.
4. Microtunnel 370 m of 1500 mm diameter concrete jacking pipe between the two shafts from east to west.
5. Installation of the carrier pipe within the concrete jacking pipe and the force main risers within the shafts.
6. Connection to the existing force main on Kildonan Drive and Newton Avenue.
7. Commission new crossing and decommission and abandon the existing HDPE force main pipe crossing.

Advantages

- Overall decreased length of force main.
- Provides flexibility to install additional infrastructure beneath the river inside the casing pipe if desired.

Disadvantages

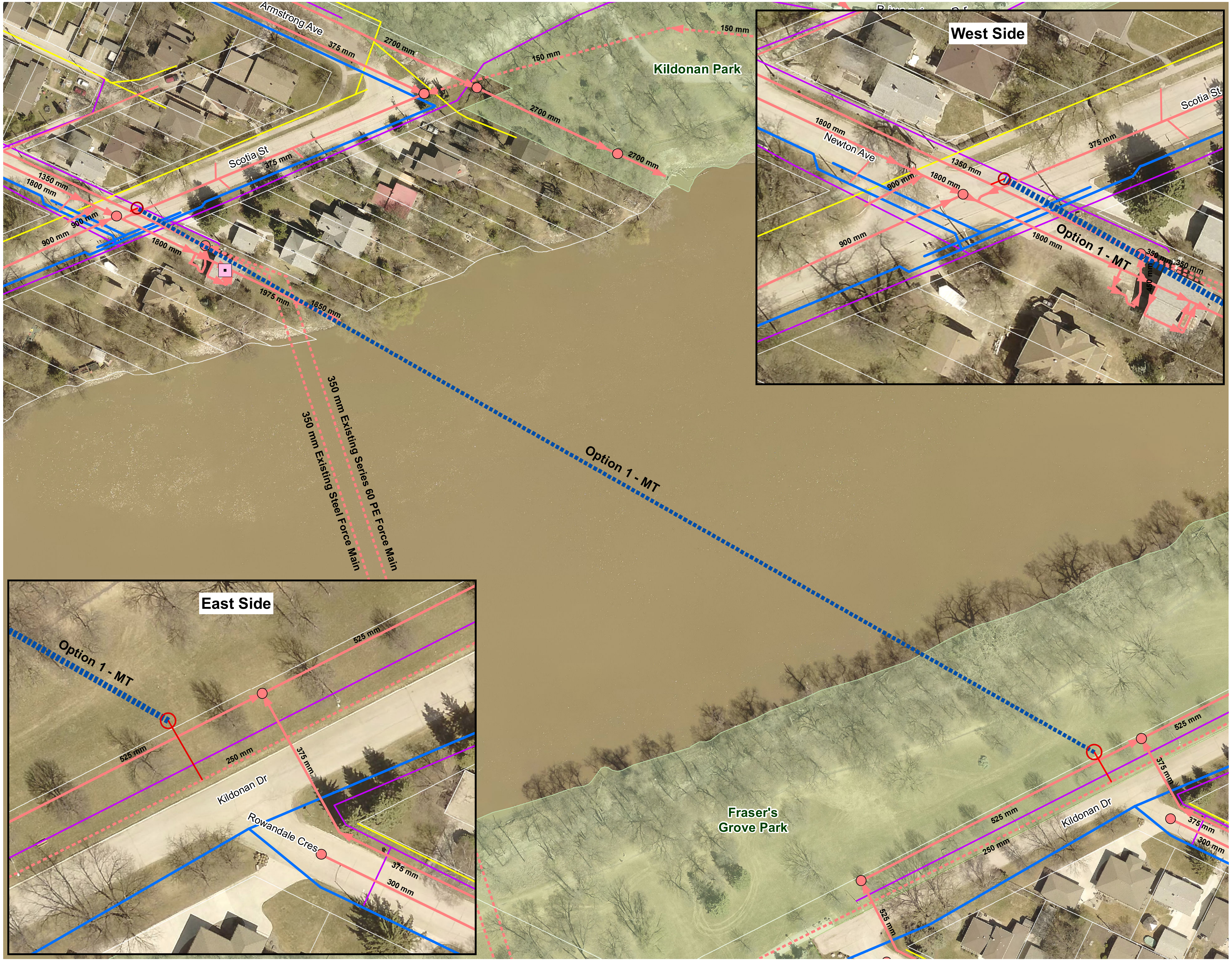
- Above ground power and telecommunication utility relocations required to space for allow work to occur including shaft construction.
- Working in close proximity to private residences along Scotia Street and Newton Avenue.
- Road right of ways on the west side only available work space which is relatively small and congested.

Risks

- Installation crosses beneath the existing Newton Flood Pumping Station and existing storm, combined, and water utilities in the intersection of Scotia Street and Newton Avenue.

Key Issues

- Congested area along Scotia Street with limited space to construct a shaft with sufficient space to house equipment.
- Possible vibration and noise disturbance to surrounding residents.
- Utility relocation delay risks.
- Secondary connection requirements to Fraser’s Grove Park chamber to be confirmed.



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LEGEND:

- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- Connection
- ● Sewer Manhole
- Sewer Main
- Force Main
- Waterline
- Electric Line
- Gas Line

FIGURE 3-2

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 1

AE PROJECT No.	2021-4589
SCALE	1:1,200
APPROVED	
DATE	2021JUL19
REV	
DESCRIPTION	ISSUED FOR DRAFT

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3.2.2 Option 3 - HDD from Fraser's Grove Park to Kildonan Park

Option 3 involved the use of horizontal directional drilling to install a new force main beneath the Red River. This includes casing pipe from the entry area within Fraser's Grove Park across to the Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. Entry and exit casing would likely be needed at both ends of the installation. A carrier pipe would be pulled through the casing pipe and then connected to the existing system. The existing HDPE force main pipe crossing would then be abandoned in place or removed from the river bottom.

Scope is shown in Figure 3-3. Construction sequence is as follows:

1. Mobilize and setup drill rig in the east side within the Fraser's Grove Park.
2. Drill pilot bore approximately 405 m in length across the river at a sufficient depth to prevent hydro-fracture.
3. Pre-ream the borehole to expand the pilot bore.
4. String out the casing and carrier pipe within the Kildonan Park along McKay Drive.
5. Pull and install the 900 mm diameter casing pipe.
6. Pull and install the 450 mm diameter carrier pipe inside the casing pipe.
7. Excavate and connect to the force main and Fraser's Grove Chamber.
8. Excavate and install new force main or gravity pipe along Scotia Street and connect to the sanitary main along Newton Avenue.
9. Commission new crossing and decommission the existing HDPE force main pipe crossing.
10. Backfill and restore surrounding area.

Advantages

- Minimal impacts to the riverbank - minimal excavation required.
- Minimal relocations expected within Kildonan Park or along Scotia Street.
- Large open workspaces on both sides of the river within parks.

Disadvantages

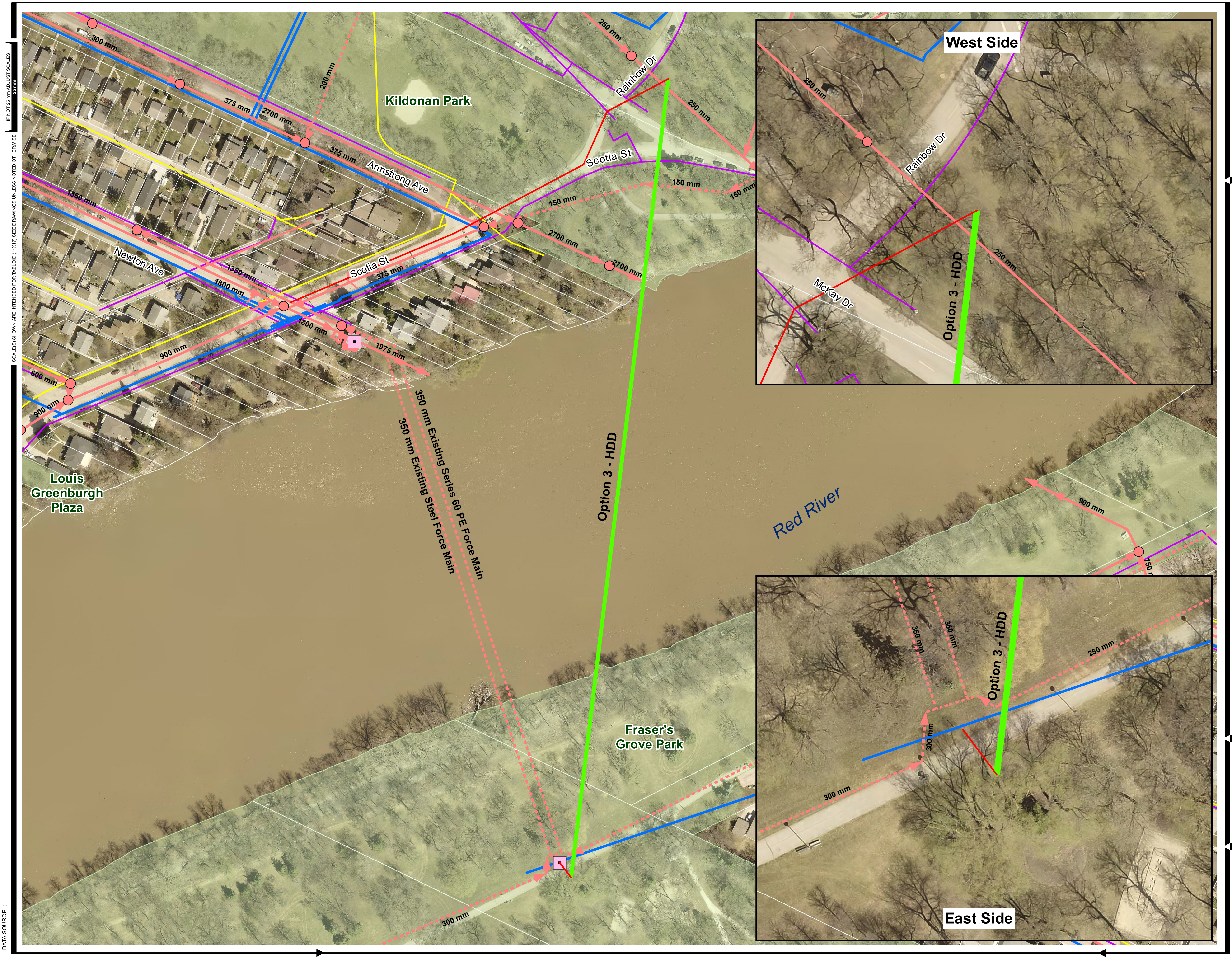
- Increased total overall length of force main of approximately 240 m (including open cut connection).
- Open trench impacting private residents along Scotia Street and within Kildonan Park.
- Working within park space impacting park users.

Risks

- Trenchless and open trench crossing large diameter storm sewer outfall that runs along Armstrong Avenue.
- Trenchless crossing of previously unstable riverbank within Kildonan Park.

Key Issues

- Force main and gravity connection pipe size requirements along Scotia Street to be confirmed.



LEGEND:

- Connection
- ● Sewer Manhole
- Sewer Main
- Force Main
- Waterline
- Electric Line
- Gas Line

FIGURE 3-3

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 3

AE PROJECT No.	2021-4589
SCALE	1:1,800
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3.2.3 Option 4 - Microtunnel from Fraser's Grove Park to Kildonan Park

Option 4 involves the use of microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area within Fraser's Grove Park across to a receiving shaft within Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The existing HDPE force main pipe would then be abandoned in place or removed from the river bottom.

Scope is shown in **Figure 3-4.** Construction sequence is as follows:

1. Construction of a 25 m deep launch shaft within Fraser's Grove Park.
2. Construction of a 25 m deep retrieval shaft within Kildonan Park.
3. Microtunnel 350 m of 1500 mm diameter concrete jacking pipe between the two shafts from east to west.
4. Installation of the carrier pipe within the concrete jacking pipe and the force main risers within the shafts.
5. Excavate and connect to the force main and Fraser's Grove Chamber.
6. Excavate and install new force main or gravity pipe along Scotia Street and connect to the sanitary main along Newton Avenue.
7. Commission new crossing and decommission and abandon the existing HDPE force main pipe crossing.

Advantages

- Provides potential to install additional infrastructure beneath the river inside the casing pipe if desired.
- Large open workspaces on both sides of the river within parks.

Disadvantages

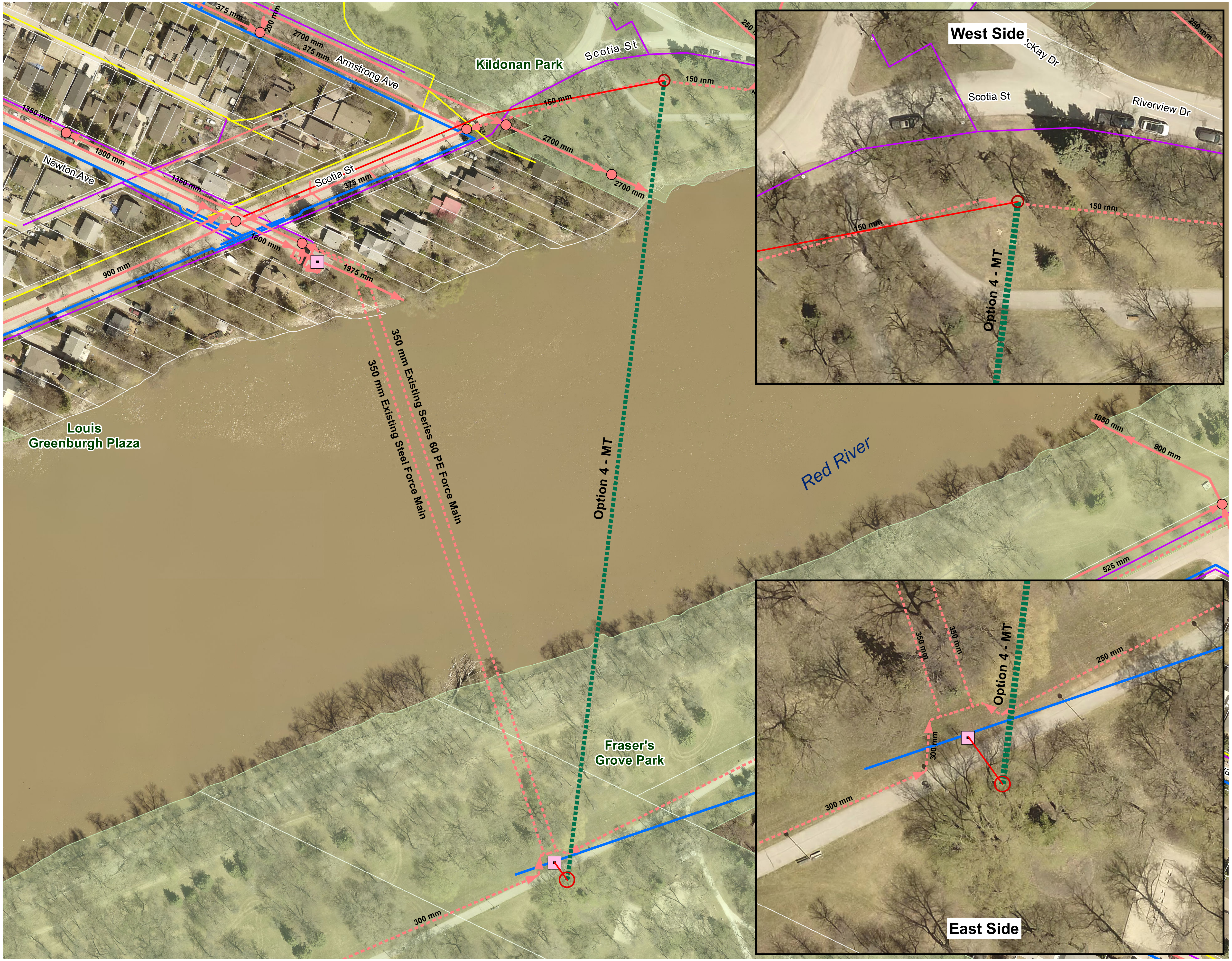
- Increased total overall length of force main of approximately 180 m (including open cut connection).
- Working within park space impacting park users.

Risks

- Trenchless and open trench crossing large diameter storm sewer outfall that runs along Armstrong Avenue.
- Trenchless crossing of previously unstable riverbank within Kildonan Park.

Key Issues

- Connection pipe size requirements along Scotia Street to be confirmed.



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Platinum member

Winnipeg

LEGEND:

- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- — Connection
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main
- — Waterline
- — Electric Line
- — Gas Line

N

0 25 50
m

FIGURE 3-4

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 4

AE PROJECT No.	2021-4589
SCALE	1:1,600
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3.2.4 Option 5 - Microtunnel from Rowandale Crescent to Kildonan Park

Option 5 involves the use of microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area just west of the intersection of Kildonan Drive and Rowandale Crescent across to a receiving shaft within Kildonan Park near the intersection of Scotia Street and Armstrong Avenue. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The existing HDPE force main pipe would then be abandoned in place or removed from the river bottom.

Scope is shown in **Figure 3-5.** Construction sequence is as follows:

1. Relocate above ground utilities to allow space for construction of the retrieval shaft.
2. Construction of a 25 m deep launch shaft in the green space Rowandale Crescent.
3. Construction of a 25 m deep retrieval shaft in Kildonan.
4. Microtunnel 350 m of 1500 mm diameter concrete jacking pipe between the two shafts from east to west.
5. Installation of the carrier pipe within the concrete jacking pipe and the force main riser within the shafts.
6. Excavate and install new force main along Scotia Street and connect to the sanitary main along Newton Avenue.
7. Connection to the existing force main on Kildonan Drive.
8. Commission new crossing and decommission and abandon the existing HDPE force main pipe crossing.

Advantages

- Provides flexibility to install additional infrastructure beneath the river inside the casing pipe if desired.
- Large open workspaces on both sides of the river within parks.
- Decreased overall length of force main of approximately 200 m (including open cut and rerouting from Rowandale Crescent).

Disadvantages

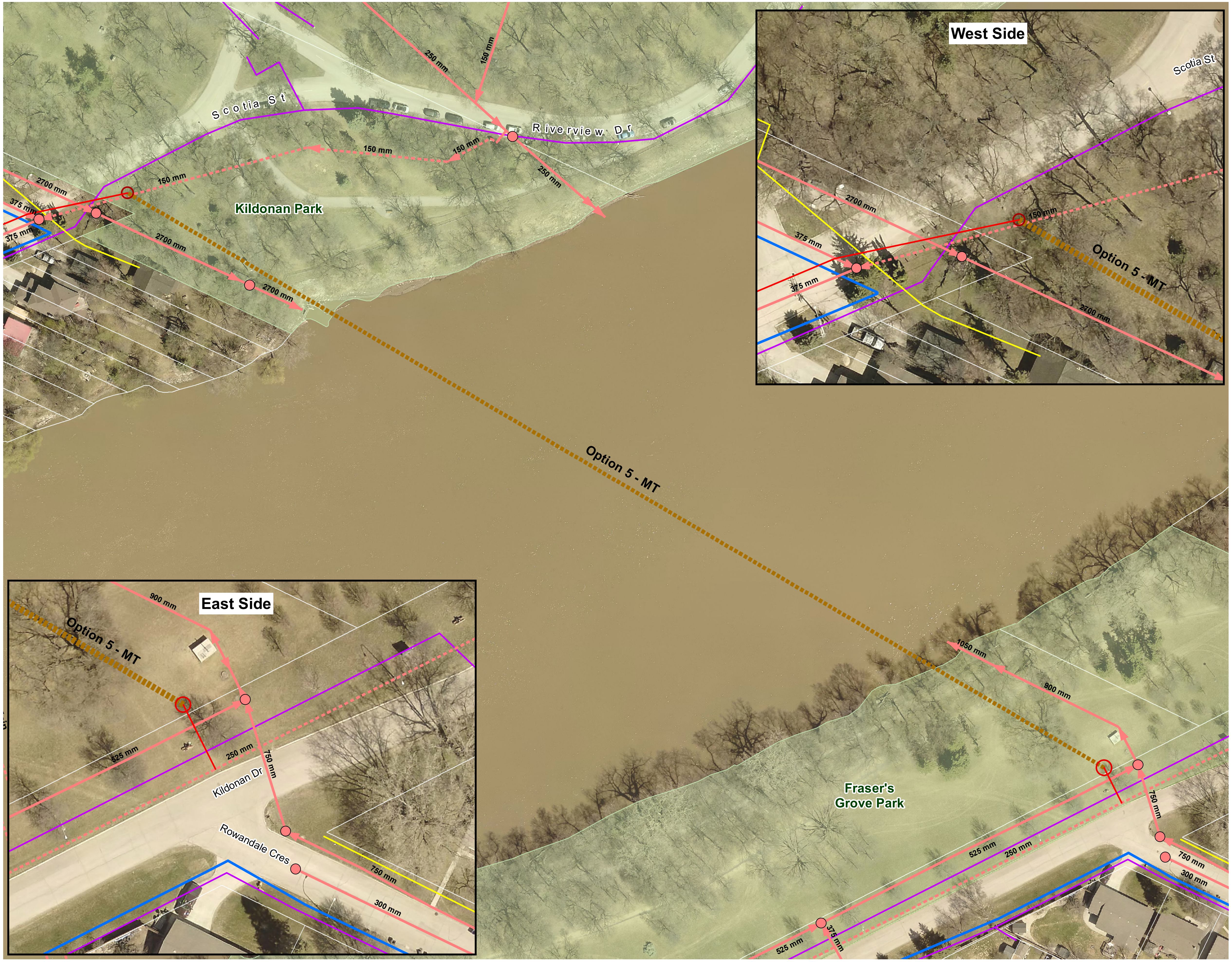
- Working in close proximity to private residences.
- Working within park space impacting park users.

Risks

- Trenchless crossing of previously unstable riverbank within Kildonan Park.
- Trenchless and open trench crossing large diameter storm sewer outfall that runs along Armstrong Avenue.
- Excavation of deep shafts required within potentially compromised bedrock potentially connected to the rivers water table.

Key Issues

- Connection pipe size requirements along Scotia Street to be confirmed.
- Secondary connection requirements to Fraser’s Grove Park chamber to be confirmed.



LEGEND:

○	5 m ø Reception Shaft
○	8 m ø Working Shaft
—	Connection
●	Sewer Manhole
→	Sewer Main
- - →	Force Main
—	Waterline
—	Electric Line
—	Gas Line

N

0 25 50 m

FIGURE 3-5

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 5

AE PROJECT No.	2021-4589
SCALE	1:1,100
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3.2.5 Option 6 - HDD from Rowandale Crescent to Kildonan Park

Use of horizontal directional drilling to install a casing pipe from the entry area within Fraser's Grove Park across to the Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. Entry and exit casing would be needed at both ends of the installation. A carrier pipe would be pulled in the casing pipe and then connected to the existing system. The existing HDPE force main pipe would then be abandoned in place or removed from the river bottom.

Scope is shown in Figure 3-6. Construction sequence is as follows:

1. Mobilize and setup drill rig in the east side within the Fraser's Grove Park.
2. Drill pilot bore approximately 415 m in length across the river at a sufficient depth to prevent hydro-fracture.
3. Pre-ream the borehole to expand the pilot bore.
4. String out the casing and carrier pipe within the Kildonan Park along McKay Drive.
5. Pull and install the casing pipe.
6. Pull and install the carrier pipe.
7. Excavate and connect to the force main and Fraser's Grove Chamber.
8. Excavate and install new force main along Scotia Street and connect to the sanitary main along Newton Avenue.
9. Commission new crossing and decommission the existing HDPE force main pipe crossing.
10. Backfill and restore surrounding area.

Advantages

- Large open workspaces on both sides of the river within parks or greens spaces.
- Decreased overall length of force main of approximately 135 m (including open cut and rerouting from Rowandale Crescent).

Disadvantages

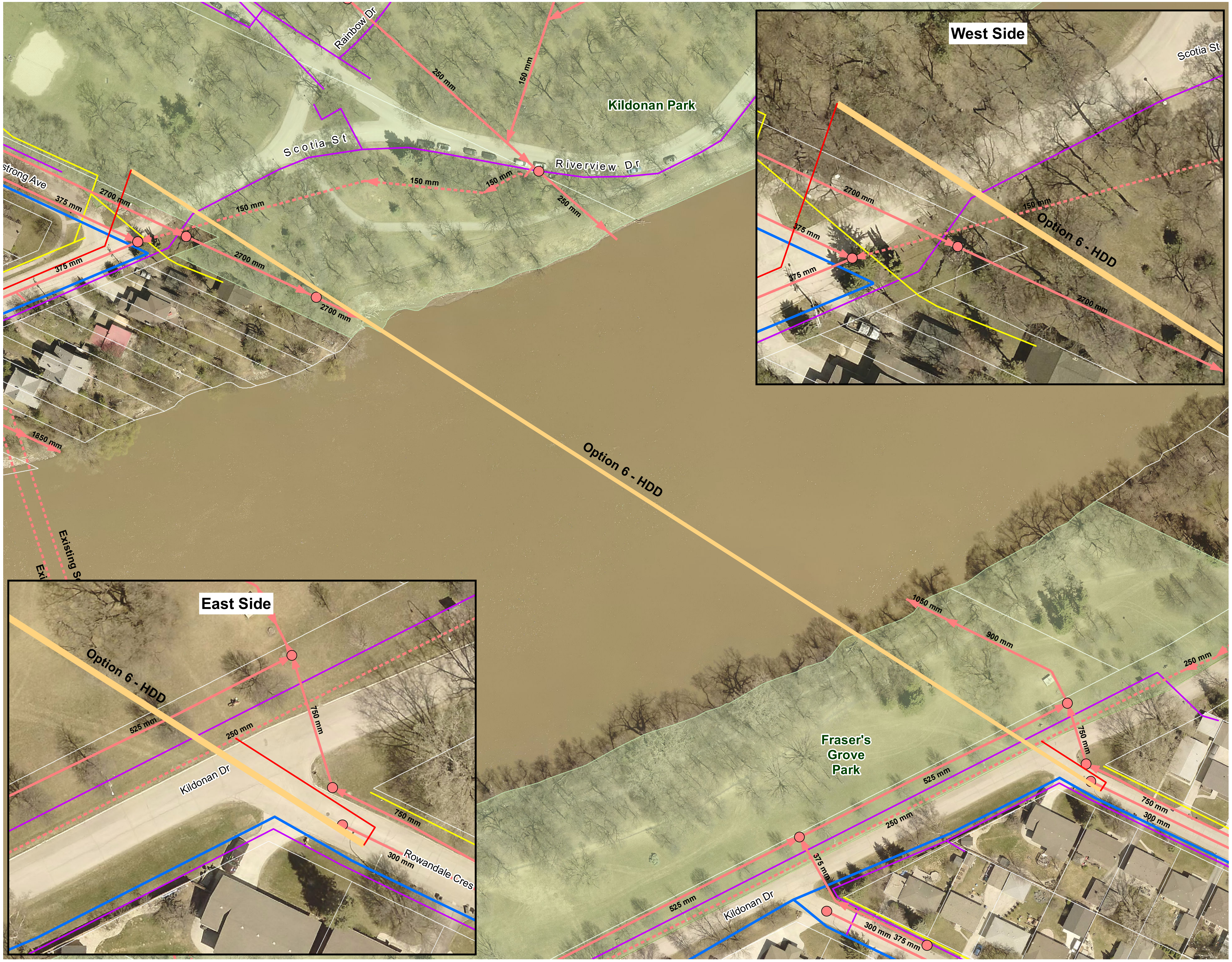
- Working in close proximity to private residences.
- Working within park space impacting park users.

Risks

- Trenchless and open trench crossing large diameter storm sewer outfall that runs along Armstrong Avenue.
- Trenchless crossing of previously unstable riverbank within Kildonan Park.
- Possible vibration impact to surrounding infrastructure and private residents.

Key Issues

- Connection pipe size requirements along Scotia Street to be confirmed.
- Secondary connection requirements to Fraser's Grove Park chamber to be confirmed.



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Winnipeg

LEGEND:

- Connection
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main
- Waterline
- Electric Line
- Gas Line

N

0 25 50
m

FIGURE 3-6

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 6

AE PROJECT No.	2021-4589
SCALE	1:1,300
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DATE	2021JUL19
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3.2.6 Option 7 - Microtunnel from Fraser's Grove Park to Louis Greenburgh Plaza

Option 7 involves the use of microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area in Fraser's Grove Park across to a receiving shaft within Louis Greenburgh Plaza. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The existing HDPE force main pipe would then be abandoned in place or removed from the river bottom.

Scope is shown in **Figure 3-7.** Construction sequence is as follows:

1. Relocate above ground utilities to allow space for construction of the retrieval shaft.
2. Construction of a 25 m deep launch shaft in Fraser's Grove Park.
3. Construction of a 25 m deep retrieval shaft in Louis Greenburgh Plaza.
4. Microtunnel 355 m of 1500 mm diameter concrete jacking pipe between the two shafts from east to west.
5. Installation of the carrier pipe within the concrete jacking pipe and the force main risers within the shafts.
6. Excavate and install new force main or gravity pipe along Scotia Street and connect to the sanitary main along Newton Avenue.
7. Connection to the existing force main.
8. Commission new crossing and decommission and abandon the existing HDPE force main pipe crossing.

Advantages

- Provides flexibility to install additional infrastructure beneath the river inside the casing pipe if desired.

Disadvantages

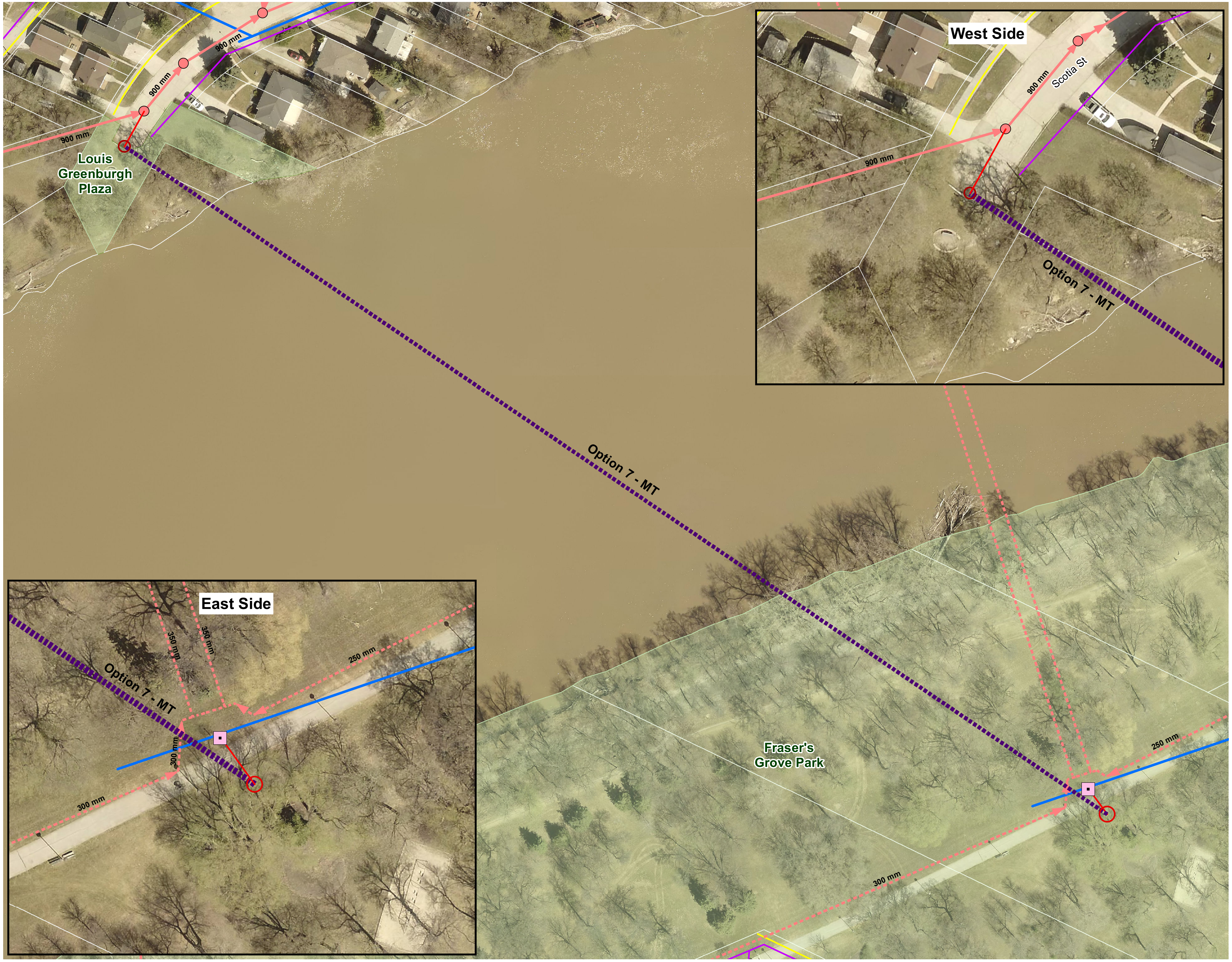
- Working in close proximity to private residences in Louis Greenburgh Plaza.
- Limited construction vehicle access to Louis Greenburgh Plaza.
- Increased overall length of force main of approximately 180 m (including open cut).
- Working within park space impacting park users.

Risks

- Reduced setback from the riverbank and potential slope instabilities.
- Trenchless and open trench crossing large diameter storm sewer outfall that runs along Armstrong Avenue.

Key Issues

- Small workspace within Louis Greenburgh Plaza.
- Connection pipe size requirements along Scotia Street to be confirmed.



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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

Winnipeg

LEGEND:

- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- — Connection
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main
- — Waterline
- — Electric Line
- — Gas Line

N

0 25 50
m

FIGURE 3-7

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 7

AE PROJECT No.	2021-4589
SCALE	1:1,100
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4 DESKTOP GEOTECHNICAL REVIEW

Geotechnical conditions play a large part in the constructability of trenchless methods. A number of trenchless projects have been done within 1500 m of the Newton Force Main and the proposed alignments. The North Kildonan Feedermain was completed by horizontal directional drilling and the Northeast Interceptor Sewer was completed by microtunnelling with both projects completing detailed geotechnical investigations, by TREK Geotechnical Inc. and AECOM respectively. Both microtunnelling and horizontal directional drilling use slurry to move the cuttings from the excavation face back to the entry location. The level of fractures found within the bedrock impact a methods ability to be effective at removing the cuttings and allowing the installation to continue. Higher rock quality equates to increased containment of slurry and reduced risk to the installation.

The discussion below draws on geotechnical information from the North Kildonan Feedermain Replacement, the Northeast Interceptor Sewer, and the Kildonan Park projects.

4.1 Subsurface Conditions

Boreholes within the previously mentioned project reports note alternating layers of sandy silt, silty clay, sand, and silt till overlying limestone bedrock. Information available on the east side indicates silt clay over lacustrine clay over clay till. Information within the Kildonan Park area on both sides do not identify bedrock but refusal due of the coring rig. Our understanding of the bedrock in the area is based on the investigations completed for the North Kildonan Feedermain and Northeast Interceptor investigations and both identified the bedrock at depth of roughly 18 - 20 m or an elevation of 210 m. The Northeast Interceptor Sewer report prepared by AECOM notes the Rock Quality Designation to be vary from 0 to 100% with an average of 64% and unconfined compressive strength to vary between 11-149 MPa. The top portions of the bedrock are generally weathered.

4.2 River Bank Stability and Proposed River Crossings

Slopes along the Red River are known for their instabilities. Within the background geotechnical report are reports noting existing slope instabilities along the west bank within Kildonan Park. Design and construction consideration must include suitable setback distances to keep new infrastructure outside of potential movement zones along the riverbanks.

After the preferred option is identified, **KGS Group** will conduct a geotechnical investigation including slope stability analysis based on their experience in the area. They will provide guidance on the needed setback distances. Due to the larger setback needed for horizontal directional drilling installation, it is unlikely this setback distance will impact horizontal directional drilling design. Microtunnelling shafts will likely need to consider the minimum setback distances.

4.3 Option Assessments

The options considered are based on microtunnelling and horizontal directional drilling. The discussion below is based on the methodology which can be applied to the specific option.

Horizontal Directional Drilling

- Design to include detailed hydrofracture analysis to ensure the drilling pressure and flow used by a contractor following good industry practices matches the expected depth of the installation.
- Selection of a higher Rock Quality Designation horizon to install the casing pipe to help contain the slurry and mitigate loss while drilling.

- Entry / Exit casing depth and requirements to ensure the design geometry includes consideration for the depth of the bedrock and the needed steering tolerance for a successful installation.

Microtunnelling

- Hydrofracture and slurry pressure considerations to install the casing pipe to help contain the slurry and mitigate loss while tunnelling.
- Shafts to be installed beyond the slope stability requirements to reduce the short-term risk of construction and long term risk to critical infrastructure.
- Temporary shoring may be affected by direct connectivity to the Red River once near the rivers' water level. These levels will vary based on the season and year to year. This can impact the contractor during construction by slowing progress and causing unexpected ground movements.

5 COST ESTIMATES

Conceptual level cost estimates were developed for each option to an AACE Class 5 level and include 50% for contingency and 15% for engineering design. Costs were developed based on recently tendered projects in Western Canada. A detailed breakdown of each estimate including unit rates has been attached in **Appendix B**. Estimates are also summarized below in **Table 5-1.**

Table 5-1
Estimated Construction Costs

Option	Estimated Cost
Option 1 - MT from Rowandale Crescent to Scotia Street	$ 15,617,250
Option 3 - HDD from Fraser's Grove Park to Kildonan Park - Single Pipe	$ 5,040,750
Option 4 - MT from Fraser's Grove Park to Kildonan Park	$ 15,800,400
Option 5 - MT from Rowandale Crescent to Kildonan Park	$ 15,607,350
Option 6 - HDD from Rowandale Crescent to Kildonan Park - Single Pipe	$ 4,826,250
Option 7 - MT from Fraser's Grove Park to Louis Greenburgh Plaza	$ 15,345,000

Options 3a and 3b were developed to determine the impact of twinning the pipe and installing a single upsized pipe to replace both the steel and HDPE force mains at the same time. At this time, it is assumed that the cost of microtunnelling is similar for the three alternatives as the tunnel will be the same size regardless of how many pipes are installed inside the tunnel.

Table 5-2
Estimated Construction Costs - Alternates

Option	Estimated Cost
Option 3a - HDD from Fraser's Grove Park to Kildonan Park - Dual Pipe	$ 9,083,250
Option 3b - HDD from Fraser's Grove Park to Kildonan Park - Single Upsized Pipe	$ 6,917,625

6 ENVIRONMENTAL AND REGULATORY REQUIREMENTS

EGE Engineering Ltd. was tasked with reviewing the environmental legislation and regulatory approval processes associated with the developed options. The scope of the assignment included the review of the following agencies and departments:

- Canadian Environmental Assessment Agency
- Department of Fisheries and Oceans Canada Fisheries Protection Program
- Transport Canada Navigation Protection Program
- Manitoba Sustainable Development
- Environmental Approvals Branch of Manitoba.

Direct communication and consultation with the above-mentioned agencies were not completed. The assessment was completed based on the existing knowledge and experience with the agencies on similarly scoped projects (i.e., sanitary sewer river crossings) in Winnipeg. The full report prepared by EGE Engineering Ltd. has been included in **Appendix C**.

Based on the current preliminary development of the options, all alignments have the same environmental approvals process and there is no difference in the level of effort required to comply with the legislation. Table 6-1 summarizes the notifications and approvals required for each installation method.

Table 6-1
Notification and Approval Requirements

Legislation	Microtunnelling	Directional Drilling
Manitoba Environment Act	Existing License - Submit Plans	Existing License - Submit Plans
Manitoba Public Health Act	Does not apply	Does not apply
CEAA 2012	Does not apply	Does not apply
Fisheries Act	Applies (Request for Review)	Applies (Request for Review)
Navigation and Protection Act	Does not apply	Does not apply
Species at Risk	Applies (general)	Applies (general)
Migratory Birds Convention Act	Applies (general)	Applies (general)

A ranking of the options in order of preference (from least likely to most likely to have an adverse environmental effect) is as follows:

1. Option 3 – HDD Fraser's Grove Park to Kildonan Park
2. Option 4 – MT Fraser's Grove Park to Kildonan Park
3. Option 6 – HDD Rowandale Crescent to Kildonan Park
4. Option 5 – MT Rowandale Crescent to Kildonan Park
5. Option 7 – MT Fraser's Grove Park to Louis Greenburgh Plaza
6. Option 1 – MT Rowandale Crescent to Scotia Street

7 CONCEPT EVALUATION

This section summarizes the evaluation and ranking of the options developed to replace the Newton Force Main. The evaluation and ranking process was completed based on the project stakeholder defined evaluation criteria developed during the Analytical Hierarchy Process workshop.

7.1 Overview

The decision support design workshop was broken down into two parts which were held on June 16, 2021, and June 21, 2021, virtually via Microsoft Teams with representatives from the City, Associated Engineering and KGS Group. Workshop Attendees are listed in **Appendix D**.

The workshop agenda and process progressed as follows:

Day 1 – June 16, 2021

1. **Project Background** - All workshop participants were provided an overview of the project objectives and purpose including a history of the force main.
2. **Discussion of Potential Options** - Several options were developed prior to the workshop which were then presented to the attendees. Each was developed to discuss the potential construction methodology, alignment, feasibility, environmental impacts, advantages/disadvantages, and key issues. Input included discussion from KGS Group on each option and its potential geotechnical risk including installation and slope stability. EGE Engineering Ltd. provided input regarding the expected permitting and approval requirements for each option.
3. **Development of Evaluation Criteria** - Examples of potential criteria were provided to the workshop attendees to demonstrate potential options and encourage the development of project specific criteria. Attendees developed the project specific definitions based on the project objective and scope.

Day 2 – June 21, 2021

4. **Evaluation and Ranking of Options** - Attendees jointly evaluated and scored each option in comparison to one another based on the evaluation criteria creating an evaluated weighted score and ranking.
5. **Value Ranking** - The value ranking is determined by dividing the evaluated weighted score by the options' estimated cost. This determines the greatest cost benefit ratio.

7.2 Evaluation Criteria

In the first workshop, attendees developed specific evaluation criteria and their definitions, based on the scope and requirements of the project assess each option. Attendees represented a variety of divisions within the City of Winnipeg to ensure a comprehensive set of opinions and views. Divisions included Wastewater Services and Engineering Services. In the second workshop each option was compared to these criteria resulting in a ranking of suitability in meeting the project goals. Developing criteria matching the scope is critical to ensure the ranking of options reflect the intent of the project.

The criteria summarized below were utilized in the option evaluation:

Social Impact: This criterion evaluates the level of impact to residents and greenspace users due to construction. Depending on the option selected, various levels of impact are expected in terms of trail and green space closures due to construction. Options with high social impacts are anticipated to trigger resident complaints and council involvement.

Environmental Impact: This criterion includes tree clearing requirements within the City parks. Varying amounts of tree clearing will be required depending on the alignment selected. As all options involve crossing the river in the bedrock, no other significant differences in environmental impacts are anticipated.

Constructability: This criterion evaluates the space available for construction and laydown, site access, the risk to existing infrastructure and the ability to maintain existing infrastructure.

New Infrastructure: This criterion includes consideration of additional sewer needs to accommodate the new force main at the proposed crossing location. Several proposed alignments require replacing or upsizing sewers on Scotia Street and other alignments may require additional infrastructure to maintain the interconnection of the two force mains.

Geotechnical Considerations: This criterion considers riverbank stability and ground conditions along the proposed alignments. Ground conditions may determine the construction methodology selected however, it is anticipated that both microtunnelling and horizontal directional drilling are feasible.

Impacts to Private Property: This criterion evaluates the impact of construction on nearby residents and their property. Many of the alignments are near private property and will result in temporary loss of access to properties, noise, dust, and increased risk of damage to property.

7.3 Criteria Weighting

Using a pairwise evaluation matrix, the evaluation criteria developed by the workshop attendees were compared to one another to determine the relative importance to each other according to the principles of the analytical hierarchy process. This process allows for the assignment of weights to each criterion and compares their relative importance in an objective manner. Table 7-1 outlines the criteria weighting utilized in the option evaluation.

Table 7-1
Evaluation Criteria Weightings

Evaluation Criteria	Weight
Constructability	31
Geotechnical Considerations	26
Impact to Private Property	24
New Infrastructure	15
Environmental Impact	3
Social Impact	0

With input from all workshop attendees, **constructability** received the highest weighting of 31. Constructability was determined to be the most important criteria because constructability can impact the risks during construction, the service life of the infrastructure, the project schedule and the project budget.

Geotechnical considerations ranked second with a score of 26 as there are known slope stability issues in the area. Geotechnical issues can make the crossing challenging and significantly increase the cost of the crossing. Geotechnical issues can also impact the stability and life span of the completed force main. The stakeholders agreed that prioritizing geotechnical considerations reduces the overall project risk.

Impact to private property was the next highest ranked criteria, with a score of 24, as many of the proposed crossing options start or end near private property. Trenchless installation near homes increases the risk of the project due to vibrations and moving equipment.

New infrastructure received a score of 15 because all the crossing options involve varying degrees of new infrastructure to connect the new force main to the existing system. These include additional lengths of force main and new connections. New infrastructure was ranked below constructability, geotechnical considerations, and impact to private property because the cost of the new infrastructure is included in the cost estimates and will impact the selection through the value ratio analysis.

Environmental impact was ranked second lowest with a score of 3 because the extents of the tree clearing are not anticipated to be significant, and the impacted trees are not part of the natural environment.

Social impact received the lowest score of 0 because the impacts due to construction were considered temporary and short in duration. The project would be administered to limit the impact to parks and near residential properties.

7.4 Option Evaluation

To determine the most suitable option, the workshop attendees scored each option based on the evaluation criteria on a scale of 1 to 9, with 9 being the most favorable. Each option's score was selected and finalized by group consensus following discussions amongst group attendees guided by the evaluation criteria definition. This rating was then multiplied by the criteria score for each option to create a total weighted criteria score. The option with the highest weighted criteria score is considered the best option based on the evaluated criteria developed by the workshop attendees. Results of the evaluation are summarized in **Table 7-2**.

Option 8 was considered not viable in the feasibility discussions above because land acquisition will be required to design a feasible crossing. Option 8 was included in the option evaluation to determine if it ranked well. If Option 8 was determined to be favorable, land acquisition may be considered.

Table 7-2
Option Evaluation

Evaluation Criteria	Weight	Option 1 - MT from Rowandale Crescent to Scotia Street	Option 3 - HDD from Fraser's Grove Park to Kildonan Park	Option 4 - MT from Fraser's Grove Park to Kildonan Park	Option 5 - MT from Rowandale Crescent to Kildonan Park	Option 6 - HDD from Rowandale Crescent to Kildonan Park	Option 7 - MT from Fraser's Grove Park to Louis Greenburgh Plaza	Option 8 - HDD from Fraser's Grove Park to Louis Greenburgh Plaza
Environmental Impact	3	8	4	5	7	6	6	5
New Infrastructure	15	8	6	6	3	5	5	5
Constructability	31	1	7	7	8	5	2	1
Geotechnical Considerations	26	7	7	7	7	7	3	7
Impact to Private Property	24	2	8	8	7	4	6	2
Social Impact	0	2	5	5	5	5	6	6
Total Weighted Criteria Score		**405**	**693**	**696**	**664**	**526**	**377**	**351**

The highest ranked option is **Option 4 - MT from Fraser's Grove Park to Kildonan Park** at a score of 696, with **Option 3 - HDD from Fraser's Grove Park to Kildonan Park** only three points lower at 693. Options 3 and 4 follow the same alignment, which indicates that this crossing location is preferred regardless of construction methodology.

Option 5 - MT from Rowandale Crescent to Kildonan Park and **Option 6 - HDD from Rowandale Crescent to Kildonan Park** were the next highest ranked options with scores of 664 and 526, respectively. Once again Options 5 and 6 follow the same alignment, indicating that this alignment is the second best regardless of construction methodology.

The ranking of the options in order of preference according to their total weighted score is as follows:

1. Option 4 - MT from Fraser's Grove Park to Kildonan Park
2. Option 3 - HDD from Fraser's Grove Park to Kildonan Park
3. Option 5 - MT from Rowandale Crescent to Kildonan Park
4. Option 6 - HDD from Rowandale Crescent to Kildonan Park
5. Option 1 - MT from Rowandale Crescent to Scotia Street
6. Option 7 - MT from Fraser's Grove Park to Louis Greenburgh Plaza
7. Option 8 - HDD from Fraser's Grove Park to Louis Greenburgh Plaza

As **Option 8** ranked the lowest, it is not considered a desirable option, therefore land acquisition to make this alignment feasible will not be pursued.

The following discussion provides the rational for the scores for each criterion provided by the attendees of the preliminary design workshop.

7.4.1 Environmental Impact Discussion

This criterion evaluated the tree clearing impacts of each option. **Options 3 and 4** were deemed to have the highest environmental impact / lowest scores as the alignment requires tree clearing on both sides of the river. The workshop participants decided to score horizontal directional drilling alignments one point below their microtunnelling counterparts as horizontal directional drilling may result in more tree loss due to pipe string out and heavy equipment moving in vicinity of trees.

Options 7 and 8 had the next lowest scores as they also impact parks on both sides of the river. It was determined that the impact to Louis Greenburgh Plaza from Options 7 and 8 was lower than the impact to Kildonan Park from Options 3 and 4 as there are few trees in Louis Greenburgh Plaza. **Options 5 and 6** were ranked second highest as there are few trees in Fraser's Grove Park near the crossing location. The highest ranked option was **Option 1** as the alignment avoids parks altogether.

7.4.2 New Infrastructure Discussion

This criterion evaluated the extent of the new infrastructure required to connect the new force main to the existing system. **Option 1** was the highest ranked as the existing force main may be used to connect the new force main to the system, which would result in no new infrastructure beyond connection of the new force main. If a new connection is required between the Fraser's Grove Chamber and the crossing location, construction on Kildonan Drive is anticipated to be easier than construction on Scotia Street.

Options 3 and 4 were the second highest ranked as they both require a new or upsized sewer on Scotia Street. **Options 7 and 8** also require a new or upsized sewer on Scotia Street but were ranked slightly lower than Options 3 and 4 with a score of 7, as there is less room in the Scotia Street right of way west of Newton Avenue due to larger existing infrastructure. Option 6 was also given a score of 7 because the alignment does not require new infrastructure on the east side of the river if only the HDPE force main is replaced. The new force main would carry flows from the Hawthorne district and the steel force main would continue to carry flows from Linden. However, if both force mains are to be replaced, new infrastructure is required on the east side to transport flows from Linden to the new crossing.

Option 5 was the lowest ranked as it requires new infrastructure on both sides of the river. A new or upsized sewer is required on Scotia Street to carry flows back to Newton Avenue and work is required on the east side to maintain the interconnection of the Linden and Hawthorne force mains.

7.4.3 Constructability Discussion

This criterion evaluated the site access and laydown and the impact on existing infrastructure. **Option 5** was ranked the highest with a score of 8 as there is good access to the site and the alignment can be shifted to avoid crossing any major existing infrastructure.

Options 3 and 4 were ranked second highest with a score of 7. Both options have good site access and avoid most major infrastructure. The only constructability concern with this alignment is crossing the large diameter storm outfall in Kildonan Park however, the risk of this crossing can be mitigated during detailed design. **Option 6** was the next highest ranked because pipe string out would impact homes on Rowandale Crescent and casing installation on the east side of the river may be difficult due to existing utilities in Kildonan Drive. **Option 7** was given a score of 2 due to limited site access and laydown.

Options 1 and 8 ranked the lowest with a score of 1. Option 1 poses constructability concerns due to crossing the existing siphons, drilling under the Newton Pump Station, existing utilities at the intersection of Newton Avenue and Scotia Street, and the requirement for road closures. Option 8 was ranked low due to the need to acquire additional land, limited site access, and proximity to the river and private property.

7.4.4 Geotechnical Considerations Discussion

This criterion evaluates the river bank stability and ground conditions along the alignment. All options except for Option 8 allow for sufficient set back from the river. **Option 8** was ranked the lowest at a score of 3 due to riverbank stability concerns. All other alignments were given a score of 7 as they are outside of the areas of concern.

7.4.5 Impact to Private Property Discussion

This criterion evaluates the impacts of construction on nearby residents and their property. **Options 3 and 4** ranked the highest in Impact to Private Property as both ends of the alignment are within public parks and the working areas are not near to private properties. **Option 5** was the next highest ranked option with a score of 7. Both ends of the alignment are closer to private properties than Options 3 and 4. Since this option uses microtunnelling, no impact to private property is anticipated as working areas can be restricted to the park spaces.

Option 7 was the fourth highest ranked with a score of 6 as the west end of the alignment is near private properties. Additionally, construction equipment will need to travel on several residential roads to access the west end of the alignment. Residents in the area will be impacted by construction noise, dust and equipment. Option 6 was ranked fifth with a score of 4 as private properties along Rowandale Crescent will be impacted by the drill setup and driveway access may be restricted.

Options 1 and 8 were ranked the lowest with a score of 2. Option 1 will have significant impacts on residents on the west side of the river. Road closures will be required on Newton Avenue and Scotia Street for equipment set up and material laydown. Residents in the area will be impacted by construction noise, dust and equipment traffic. Option 8 requires acquisition of private property to be considered feasible. If the required land is acquired, the west end of the alignment will still be near private property.

7.4.6 Social Impact Discussion

This criterion evaluated the impact of construction on residents and river valley users. The highest ranked options were **Options 7 and 8** with a score of 6 as the west end of the alignment is in Louis Greenburgh Plaza, which is less frequently used than Kildonan Park.

Options 3, 4, 5 and 6 were next highest ranked with a score of 5 as all options impact Fraser's Grove Park on the east side and Kildonan Park on the west side. These alignments were ranked lower than Options 7 and 8 as Kildonan Park is more heavily trafficked than Louis Greenburgh Plaza.

Option 1 was the lowest ranked option with a score of 2 as there are impacts to Fraser's Grove Park on the east side of the river and road closures are required on the west side of the river.

7.5 Value Ratio Analysis

The workshop attendees ranked each alternative based on the set of criteria specifically developed for the scope and context of the project. To determine the option with the highest perceived benefit cost, we divide the option's Total Weighted Criteria score by the estimated cost. The resultant number is the Value Ratio. The option with the highest Value Ratio is the one that is perceived to have the highest Benefit Cost Ratio. Table 7-3 summarizes the Value Ratio scores from the highest to lowest value ratio.

Table 7-3
Value Ratio

Option	Total Weighted Criteria Score	Estimated Cost (Millions)	Value Ratio (Criteria / Cost)
Option 3 - HDD from Fraser's Grove Park to Kildonan Park	693	$5.0	139
Option 6 - HDD from Rowandale Crescent to Kildonan Park	526	$4.8	110
Option 8 - HDD from Fraser's Grove Park to Louis Greenburgh Plaza	351	$5.2	68
Option 4 - MT from Fraser's Grove Park to Kildonan Park	696	$15.8	44
Option 5 - MT from Rowandale Crescent to Kildonan Park	664	$15.6	43
Option 1 - MT from Rowandale Crescent to Scotia Street	405	$15.6	26
Option 7 - MT from Fraser's Grove Park to Louis Greenburgh Plaza	377	$15.3	25

Option 3 - HDD from Fraser's Grove Park to Kildonan Park is the highest ranked option overall with a Value Ratio of 139. Based on criteria score alone, Option 3 - HDD was ranked second behind Option 4 - MT from Fraser's Grove Park to Kildonan Park, which follows the same alignment. The value ratio and weighted criteria score both indicate that the alignment for Options 3 and 4 is the best option.

If horizontal directional drilling is not possible due to ground conditions, microtunnelling installation may be required. Microtunnelling installation is anticipated to cost significantly more than horizontal directional drilling installation. As such, the highest ranked microtunnelling options has a lower value ratio than the lowest ranked horizontal directional drilling option. **Option 4 - MT from Fraser's Grove Park to Kildonan Park** and **Option 5 - MT from Rowandale Crescent to Kildonan Park** are the highest ranked microtunnelling options with value ratios of 44 and 43, respectively. Option 4 was the highest ranked option based on criteria alone however due to the increased cost of microtunnelling, Option 4 is ranked fourth in terms of value ratio. Additional consideration may be required to select an alignment between Options 4 and 5. Considerations may include whether the crossing will be a dual crossing or a single upsized pipe, and operation implications of the crossing location on the east side of the river.

7.6 Summary

The highest ranked option was **Option 4 - MT from Fraser's Grove Park to Kildonan Park** followed closely by **Option 3 - HDD from Fraser's Grove Park to Kildonan Park**. Options 3 and 4 follow the same alignment, which indicates that this crossing location is preferred regardless of construction methodology.

A Value Ratio Analysis was completed by dividing the total weighted score by the options capital (construction) cost which provides the option best suited to meet the project objectives for the least cost. The option with the highest value ratio was **Option 3 - HDD from Fraser's Grove Park to Kildonan Park** followed by **Option 6 – HDD from Rowandale Crescent to Kildonan Park.** Due to the increased cost of Microtunnelling installation, all microtunnelling options scored lower than the lowest horizontal directional drilling option. If microtunnelling installation is required due to ground conditions, **Option 4 - MT from Fraser's Grove Park to Kildonan Park** and **Option 5 - MT from Rowandale Crescent to Kildonan Park** are the highest ranked microtunnelling options.

Based on the Analytical Hierarchy Process, **Option 3 - HDD from Fraser's Grove Park to Kildonan Park** is the most suitable option for the replacement of the Newton Force Main provided ground conditions are conducive to horizontal directional drilling installation. If microtunnelling installation is required, **Option 4 - MT from Fraser's Grove Park to Kildonan Park** is the most suitable option.

8 GEOTECHNICAL INVESTIGATION

KGS Group provided the geotechnical engineering support for the preliminary design of the Red River force main crossing. The findings of the geotechnical investigations are presented in a separate report and included in **Appendix E**. A summary of the geotechnical investigation and results are outlined below.

8.1 Borehole Drilling and Sampling Program

A total of four (4) test holes were advanced into bedrock to investigate the subsurface stratigraphic conditions and evaluate the suitability of the bedrock for horizontal directional drilling and microtunnelling. The locations of the test holes are shown on **Figure 8-1**.The drilling was completed between August 4th and 12th, 2021.

Figure 8-1
Test Hole and Seismic Refraction Survey Locations

8.1.1 Borehole Drilling and Sampling Program

Laboratory testing is being performed on select soil and bedrock samples for use in the characterization of the subsurface. The results of the laboratory testing have been completed and are included in the report. Laboratory testing on the bedrock samples has been completed to determine the following parameters:

- Shear Modulus (G)
- Unconfined Compressive Strength
- Youngs Modulus (E)

These mechanical properties of the bedrock are required to adequately evaluate potential construction risks, tooling, and costs for horizontal directional drilling and microtunnelling options.

8.2 Seismic Refraction Survey

KGS Group retained the services of Frontier Geoscience Inc. to complete seismic refraction surveys along the two preferred alignments on August 10 and 11, 2021. The primary objective of the geophysical survey was to obtain estimates of the depths to till and bedrock along the preferred alignments. The locations of the seismic lines are shown on **Figure 8-1**.

8.3 Field Investigation Results

In general, the stratigraphy consists of alluvium soil over lacustrine clay, glacial silt till and limestone bedrock. The following sections describe the soil and the bedrock encountered during the geotechnical drilling investigation.

Alluvium Soils - Alluvium soils ranging from alluvium clay to sandy clay to sand was observed in test holes TH21-01, TH21-03 and TH21-04 at elevations ranging from 226.8 to 227.7 m and extending to elevations ranging from 211.6 to 219.0 m.

Lacustrine Clay – Lacustrine clay was encountered in test holes TH21-01, TH21-02 and TH21-03 overlying the silt till at elevations ranging from 213.6 to 219.0 m. The clay ranged in thickness from 0.6 to 6.1 m. The clay was typically brown to grey in colour, damp to moist, firm to stiff in consistency and of high plasticity. In general, the consistency of the clay decreased with depth. The undrained shear strength of the clay deposit, as determined using a field Torvane on disturbed samples, ranged from 30 to 80 kPa, generally decreasing with depth.

Glacial Silt Till - Glacial silt till was at elevations ranging from 211.6 to 212.9 m in the test holes. The till ranged in thickness from 3.1 to 5.8 m. The silt till was brown in colour, damp to moist, compact to very dense and contained some fine to coarse grained gravel and some fine to coarse grained sand. The uncorrected Standard Penetration Test blow counts ranged from 17 to greater than 50 m, classifying the material as compact to very dense. Boulders and cobbles are commonly found within till and should be anticipated within the deposits at the project site.

Bedrock - The limestone bedrock in the area of the project site is Selkirk member of the Red River Formation. The Selkirk member typically is medium strength with compressive strengths that vary from 30 to 40 MPa. The Young's modulus (E) generally ranges from 15 to 25 GPa (University of Manitoba, 1983). The bulk modulus (k) typically ranges from 40 to 50 GPa, and the shear modulus ranges from 5 to 10 MPa. Rock Quality Designation (RQD) of the limestone bedrock is generally between 75% and 100% indicating typically good rock quality.

Based on the borehole drilling, bedrock was encountered below the silt till at elevations ranging from 207.1 to 209.7 m. However, the seismic refraction survey suggests that top of bedrock may be lower on the east side of the river, at an elevation of approximately 198 m along the proposed alignment. The core samples retrieved from the borehole and the seismic survey indicate that the quality of the bedrock is generally better on the east side of the river compared to the west especially near the upper section above elevation 202 m. The estimated bulk compressive wave velocity (Vp) for the upper bedrock is 4100 m/s and 3200 m/s on the east side and west side, respectively. These estimated velocities suggest that the bedrock is more fractured on the west side.

The bedrock consists of limestone and mottled limestone. Dolomite was observed in test hole TH21-01 from elevation 208.0 to 209.7 m.

8.3.1 Groundwater Monitoring

Two standpipe piezometers were installed as part of the 2021 geotechnical investigation. Since installation, groundwater monitoring has been completed once. The measured groundwater levels are listed below in **Table 8-1**. These piezometric levels are slightly lower than the approximate Red River level (223.7 m) at the time the piezometers were read.

Table 8-1
Groundwater Monitoring Results

Test Hole ID	TH21-01	TH21-03
Ground Elevation (m)	228.19	226.87
Piezometer Type	Standpipe	Standpipe
Tip Elevation (m)	211.4	205.47
Monitoring Zone	Glacial Till	Bedrock
Reading Date		
9/10/2021	222.3	222.7

8.4 Preliminary Riverbank Stability

8.4.1 Visual Inspection

As part of the field investigation, a riverbank visual inspection was completed for the east and west banks. The site is located at the start of a gradual bend in the river, with the west side of the river on the inside of the bend and the east side on the outside. Erosion is typically observed on the outside bend of rivers.

The east side of the riverbank is approximately 8 m high with benches at approximately elevation 222.5 m and 225.9 m, these elevations generally coincide with approximate average summer river level and ordinary high-water level (2-year flood level), respectively. The slope of the riverbank at the top of bank above the upper bench at 225.9 m was approximately 3H:1V, from the upper bench to lower bench the slope is approximately 3.5H:1V and below the lower bench to the bottom of channel the slope is approximately 8H:1V. The benching and shallow slope of the riverbank suggest historical erosion along this segment of the river.

At the time of the site inspection there were no visual signs of deep-seated slope movement including slumps, sloughing, headscraps, or tension cracking. The downstream slope was vegetated with tall grass and shrubs and mature trees at the top of the bank.

The west side of the riverbank is approximately 10 m high with a bench at approximate the normal summer water level (222.5 m). The slope of the riverbank above to the bench is approximately 4H:1V and the lower slope to the channel is approximately 5H:1V. The riverbank slope flattens downstream of the site. An existing headscrap was observed downstream of the outfall pipe during the site inspection. At the time of the site inspection, no additional visual signs of deep-seated slope instability such as slumps, sloughing, headscraps, or tension cracking with exception of the historical headscrap downstream were noted. The downstream slope was vegetated with tall grass and shrubs and mature trees at the top of the bank.

Based on the visual inspection, the east riverbank has benching and shallow slopes, which suggest historical erosion along this segment of the river. Additionally, it is located on an outside bend which are known to be susceptible to erosion. No erosion protection was observed along the east shoreline during the visual inspection. It is recommended that a riprap blanket be placed in the lower bank area within the normal summer river level to minimize the potential for toe erosion which will result in a reduction in the stability over time. The riprap blanket should extend a minimum of 1.5 m above and below the normal summer river level.

8.4.2 Stability Modelling

KGS Group completed limit equilibrium (LE) slope stability analyses to determine the current stability of the riverbank on either side of the proposed crossing. The slope stability analysis approach incorporates LE techniques based on two-dimensional slope stability analysis using SLOPE/W software by Geo-Slope International Ltd.

The stability analysis was completed on both sides of the Red River along the proposed pipe alignment to determine the minimum factor of safety. The analysis indicated the existing factor of safety for both banks is equal to or greater than 1.5. Furthermore, the proposed entry and exit location for the new force main will be located beyond the potential slip surfaces. Hence, the proposed construction will not have a detrimental impact the stability of the riverbank.

8.5 Summary

In general, the soil stratigraphy consists of alluvium soils over lacustrine clay, silt till and bedrock. Bedrock was encountered below the silt till at elevations ranging from 207.1 to 209.7 m. The bedrock consists of limestone and mottled limestone. Dolomite was observed in test hole TH21-01 from elevation 208.0 to 209.7 m.

The groundwater level in the till and bedrock was observed to be at elevation 222.3 m and 222.7 m respectively. The stability analysis was completed on both sides of the Red River along the proposed pipe alignment to determine the minimum factor of safety (FOS = 1.5). The analysis indicated the existing factor of safety for both banks is satisfactory and equal to or greater than 1.5. It is recommended that a riprap blanket be placed in the east side lower bank area within the normal summer river level to minimize the potential for toe erosion which will result in a reduction in the stability over time.

The limestone bedrock joints/fractures can result in migration of drilling fluid (loss of circulation) and instability of the borehole. The possible occurrence of cobbles and boulders within glacial till soils above the bedrock is another fissure that could provide paths for fluid to migrate out of the borepath. However, these risks may be mitigated by using drilling additives to consolidate and reduce the permeability of joints and fractures.

Karst openings are commonly encountered in limestone and dolomite formations around Winnipeg; these features are results of bedrock solution processes and can also be a source of loss of circulation and mud control problems. However, no extensive karst features that would be of concern were observed in any of the boreholes that were drilled at the site. Based on the RQDs the bedrock quality is good from elevation 190 m to 204 m, and excellent below 190 m.

Both horizontal directional drilling and microtunnelling are feasible trenchless installation methods at the site based on the strength, hardness and quality of the bedrock.

9 BASIS OF ESTIMATION

The City of Winnipeg Basis of Estimate template was used to develop a cost estimate for **Option 3 - HDD from Fraser's Grove Park to Kildonan Park.** The estimate incorporates the construction costs estimated in Section 5 (**Appendix B**) however the contingency is reduced to 30% to reflect a Class 3 cost estimate.

Table 9-1 summarizes the lines items and the justification for the cost. Costs are based on actual costs from projects of similar scope of trenchless installations.

Table 9-1
Basis of Estimation Summary

Item	Description	Justification
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	Previous project experience has shown this cost to be around 10% of the overall cost of the project. These include the North Kildonan Feedermain, Northeast Interceptor and projects outside of Manitoba. Includes the transportation and delivery of associated equipment and materials of the specialized contractor to the crossing site.
2.0	Site Preparation and Restoration	Due to the work space needed for the drill rig and pipe preparation green space and road rehabilitation was included due to the expected work site in Kildonan Park requiring asphalt replacement. This includes the nearly 6,000 m^2 of working area and pipe preparation and the replacement of 100 m, of 5 m width roadway.
3.0	Supply and Install 450 mm nominal (350mm ID) DR9 HDPE Force Main by Horizontal Directional Drilling	Price is based on other trenchless installations which include the North Kildonan Feedermain and other projects outside of Manitoba.
4.0	Connection to Existing Force Main	Price includes estimation of work required to connect the existing chamber in Fraser Grove Park and on Scotia Street and Newton Avenue.
5.0	Abandon Existing Force Main (Drain and Cap)	Price includes an estimation work for the draining the abandoned line taken out of service.
6.0	Supply and Install 375 mm Sewer on Scotia Street	Install a new sanitary sewer along Scotia Street to the Newton Avenue connection. Price includes trench width roadway replacement.
7.0	Supply and Install 375 mm Sewer In Fraser's Grove Park	Install a new sanitary sewer along Scotia Street to the Newton Avenue connection. Price includes trench width roadway replacement.

The City of Winnipeg confirmed that input on the operation and maintenance was not required for this analysis. The Basis of Estimation assessment is included in **Appendix F.**

10 CONCEPT DESIGN

10.1 HDD Design Considerations

The depth of cover selected for a river crossing is based upon geometric restraints and a hydrofracture analysis. Geometric constraints include the minimum bend radius of the drill pipe and the product pipe as well as the consideration for conductor casing. When drilling through bedrock, high fluid flows are needed to carry the cuttings created by the drilling and reaming process. This can erode the softer overburden material resulting in a collapsed borehole. Conductor casings are steel pipes, which are sized to accept the largest reamer expected and are embedded in the bedrock to enable the slurry to return back to the rig. Casings are straight tangents which extend from the surface to a short distance inside the bedrock. Casings have been included on both the entry and exit side of the concept design.

Drilling fluid pressures are modelled to assess the required depth of the installation. Pressures are based on depth, length, borehole size, and expected fluid rheology. A formation's maximum allowable pressure, or confining pressure, is modeled using the geotechnical information collected. The anticipated drilling pressure is then compared to the formations allowable drilling pressure to determine the hydrofracture factor of safety. If the factor of safety is not suitable, the geometry is altered to lower its depth and pressure comparison is revaluated. HDD designs are typically an iterative process.

Developing a feasible design requires consideration of a number of design and constructability aspects. The **Option 3** alignment affords a large and open work area in both Kildonan and Fraser Grove Parks. Workspace needed for a drill of this scope is typically 40 m by 60 m for the entry area, 20 m by 20 m for the exit area, and a 20 m wide area the length of the drill section for the pipe preparation and fusing area. Fraser's Grove Park is well suited for the entry area with the public path potentially serving as the equipment and vehicle access. The area along Rainbow Drive and McKay Drive within Kildonan Park space provides a large open space in the park to serve as an exit area. Armstrong Avenue or the open green space within Kildonan Park would both provide suitable workspace to stage the product pipe. The borepath is approximately 440 m in length. An area approximately 450 m long is required to layout and fuse the pipe string. An open path from that area to the exit area is required to allow the pipe pull. A conceptual HDD plan and profile of the **Option 3** alignment is included in **Figure 10-1.**

We recommend that an in-depth utility investigation consisting of hydrovac and survey of the utilities in proximity to the borepath be completed during detailed design. Additionally, we recommend collecting additional information regarding the structures close to the alignment including the records drawings of the outfall. With this information the borepath can be updated for construction.

10.2 Open Cut Connections and Chambers

Open cut connections are required on either end of the HDD crossing. On the east side of the river, a small open cut connection is required to tie-in to the Fraser Grove chamber. On the west side of the river, an existing sanitary sewer currently runs south down Scotia Street, connecting to the sanitary sewer on Newton Avenue. An assessment of flow requirements can be done during detailed design if the 375 mm could be replaced with a larger pipe, which would accommodate the flows of both the force main and the local gravity system. This would reduce the pumping length of the force main. At this stage, it is assumed that a new section of force main will be installed along Scotia Street to connect to the sanitary trunk at Newton Avenue. A conceptual open cut plan and profile of the **Option 3** alignment is included in **Figure 10-2.**

During detailed design, the City will need to consider if any chamber rehabilitation or replacement will be needed and if the two force mains are to remain interconnected.

10.3 Dual Containment

The need for dual containment of the sanitary force main was reviewed by EGE Engineering Ltd. And it was determined that dual containment is not required since the crossing will be installed in competent limestone bedrock beneath the river. The design drawing has been developed assuming a 450 mm diameter (350mm ID) HDPE force main, but the same design could be adapted for a larger diameter pipe if a dual containment system is required.

Various options exist for a dual containment system should it be needed. Generally, HDPE is used for the casing pipe in a horizontal directional drill application. The carrier pipe could be HDPE, fusible PVC, or a secondary flexible liner.

10.4 Environmental Impact

Construction of the new force main will primarily be done within park space and may require the removal of large trees and excavations near the existing force mains in the park. These risks can be mitigated during detailed design but not eliminated entirely. Crossing the river also includes the risk of losing drilling slurry into the river depending on the conditions encountered during the installation. While the iterative design process is intended to limit the risk of hydro fracture, it does not eliminate the risk.

10.5 Social Impact

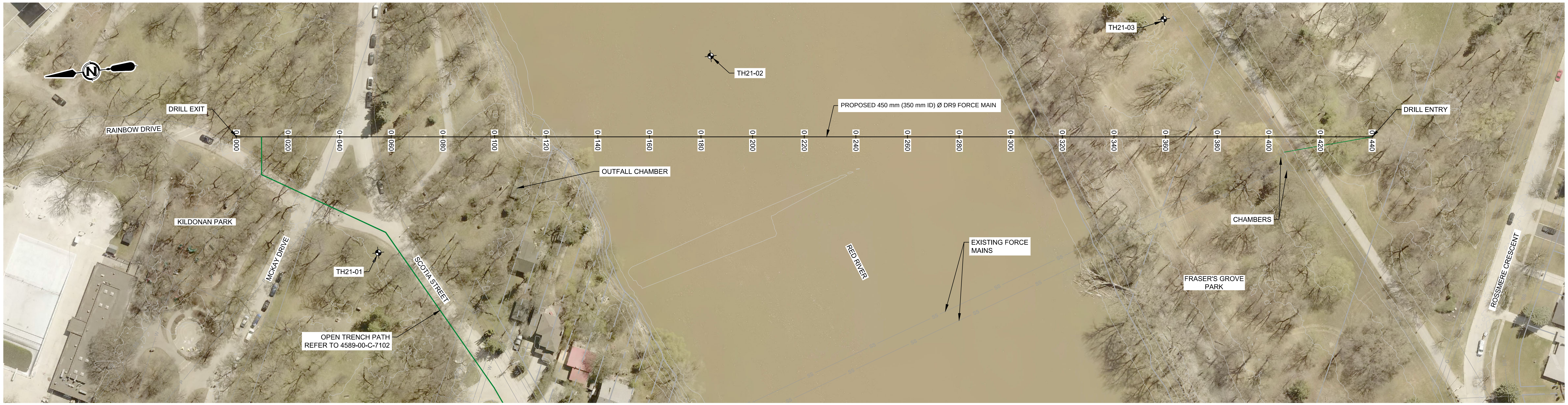
Work within parks on both ends of the crossing will result in park space being closed, trails being temporarily rerouted, and roads occupied by construction vehicles. HDD does require continuous 24 hours a day operation using large generators and excavators creating constant noise. While the effects are temporary, they can be significant. Plans can be considered during detailed design and tendering to limit these effects.

10.6 Lessons Learned

Trenchless designers are constantly improving their design methodologies and strategies through reviewing past project experience. Some of the lessons learned working on City of Winnipeg projects are as follow:

- Construction Strategy – The North Kildonan Feedermain was originally designed and tendered with the trenchless installation, valve chambers, and connections together in one package. Due to their inexperience with major crossings, the general contractors added large mark ups on the trenchless line items to cover their unknown risk, which increased the cost of the project. As a result, the trenchless components were re-tendered separately from the chambers and remaining connection works, which reduced the bid pricing.
- Construction Duration – When receiving a contractor's schedule during a tender, a contingency should be included to consider unforeseen risks inherent with trenchless installations.
- Geotechnical Investigations – When conducting river crossings, it is best to have a borehole and a geophysical scan within the river cross section. This enables the designer to have a clear picture of the geotechnical conditions and the contractor to price the risk accordingly.
- Contractor Prequalification - Trenchless crossings can be complex and risky projects. The contractors who attempt them should have a minimal amount of experience. For major installations Associated Engineering conducts prequalification's to ensure contractors meet a minimum standard based on the project scope.

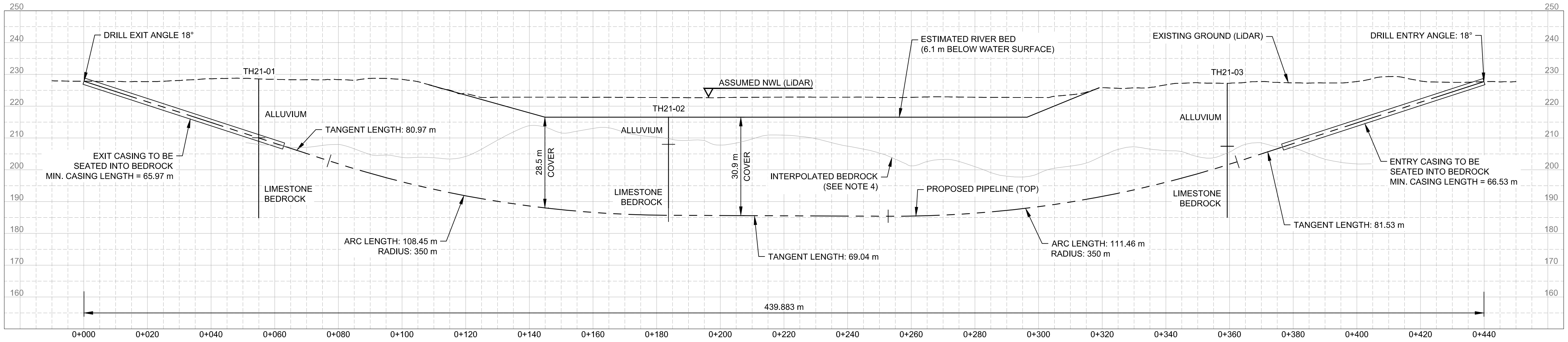
IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



PLAN 1:750

NOTES:

1. REFER TO NEWTON FORCE MAIN RED RIVER CROSSING REPLACEMENT TEST HOLE LOGS (KGS GROUP, AUGUST 2021) FOR DETAILED STRATIGRAPHY. BEDROCK INTERFACE DEPICTED ON PRELIMINARY HDD PLAN/PROFILE FOR CLARITY.
2. EXISTING GROUND TOPOGRAPHY BASED ON AVAILABLE LIDAR DATA.
3. RED RIVER BATHYMETRY TO BE CONFIRMED. ESTIMATED RIVER BED ELEVATION BASED ON KGS GROUP TEST HOLE LOG TH21-02 NOTE 4: DEPTH OF RED RIVER IS 6.1 m.
4. BEDROCK SURFACE FROM INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL21-02. REFER TO NEWTON AVE FORCEMAIN RED RIVER CROSSING 2021 PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT (KGS GROUP, SEPTEMBER 2021) APPENDIX C SEISMIC REFRACTION SURVEY (FRONTIER GEOSCIENCES).
5. DEPICTED BOREPATH IS FOR CONCEPT USE ONLY.



PROFILE 1:750

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Associated Engineering

CANADA BEST MANAGED COMPANIES
Platinum member

AE PROJECT No.	2021-4589
SCALE	1:750
APPROVED	C. LAMONT
DATE	2021NOV04
REV	B
DESCRIPTION	ISSUED FOR REPORT

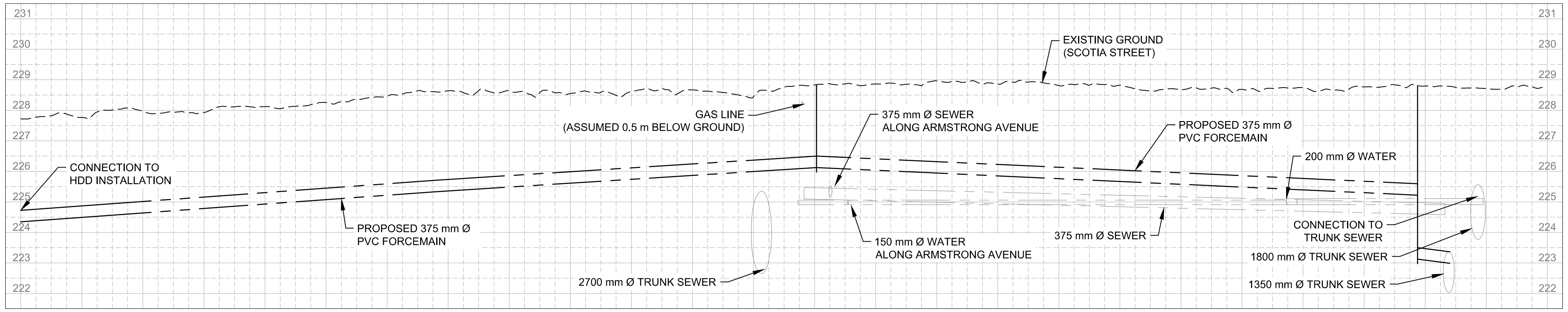
FIGURE 10-1

CITY OF WINNIPEG

CIVIL
NEWTON FORCE MAIN RED RIVER CROSSING
CONCEPT HDD - PLAN AND PROFILE

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

PLAN 1:500



PROFILE 1:500

NOTES:

1. REFER TO NEWTON FORCE MAIN RED RIVER CROSSING REPLACEMENT TEST HOLE LOGS (KGS GROUP, AUGUST 2021) FOR DETAILED STRATIGRAPHY.
2. EXISTING GROUND TOPOGRAPHY BASED ON AVAILABLE LIDAR DATA.

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Associated Engineering

BEST MANAGED COMPANIES
Platinum member

AE PROJECT No.	2021-4589
SCALE	1:500
APPROVED	C. LAMONT
DATE	2021NOV04
REV	A
DESCRIPTION	ISSUED FOR REPORT

FIGURE 10-2

CITY OF WINNIPEG

CIVIL
NEWTON FORCE MAIN ON SCOTIA STREET
OPEN CUT INSTALLATION - PLAN AND PROFILE

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

This report summarizes the work undertaken to determine the most suitable solution to replace the Newton Force Main Red River Crossing. A total of eight conceptual alignments were developed with input from Associated Engineering, KGS Group and the City of Winnipeg. Advantages, disadvantages, estimated construction costs, regulatory requirements, construction scope and sequence were developed for each alignment.

Microtunnelling and horizontal directional drilling were both considered for installation of the new force main. The advantages and disadvantages of each construction methodology were considered during the option evaluation and the cost of installation was considered. Options were developed based on the two methods on four alignments. Two horizontal directional drilling alternatives were not considered due to the limited setback and risk to adjacent infrastructure.

An environmental and regulatory review of the proposed alternatives was conducted, and it was determined that all alignments require the same approvals and the same level of effort to attain the approvals.

A two-part decision support workshop was held on June 16, 2021, and June 22, 2021 via teleconference. Representatives from Associated Engineering, KGS Group and the City of Winnipeg were present. The Workshop attendees participated in an analytical hierarchy process facilitated by Associated Engineering to develop evaluation criteria based on the goals and premises of the project. These were then used to evaluate and rank each option. The criteria developed include Social Impacts, Constructability, New Infrastructure, Environmental Impact, Impact to Private Property, and Geotechnical Considerations. The attendees determine the criteria with the highest weight is Constructability followed by Geotechnical Considerations and Impact to private Property.

Workshop attendees ranked each option on its ability to satisfy the criteria. The highest ranked option was **Option 4 - MT from Fraser's Grove Park to Kildonan Park** followed closely by **Option 3 - HDD from Fraser's Grove Park to Kildonan Park**. Options 3 and 4 follow the same alignment, which indicates that this crossing location is preferred regardless of construction methodology.

A Value Ratio Analysis was completed by dividing the total weighted score by the options capital (construction) cost which provides the option best suited to meet the project objectives for the least cost. The option with the highest value ratio was **Option 3 - HDD from Fraser's Grove Park to Kildonan Park** followed by **Option 6 – HDD from Rowandale Crescent to Kildonan Park.** Due to the increased cost of microtunnelling installation, all microtunnelling options scored lower than the lowest horizontal directional drilling option. If microtunnelling installation is required due to ground conditions, **Option 4 - MT from Fraser's Grove Park to Kildonan Park** and **Option 5 - MT from Rowandale Crescent to Kildonan Park** are the highest ranked microtunnelling options. Additional consideration may be required to select an alignment between Options 4 and 5 such as whether the crossing will be a dual crossing or a single upsized pipe, and the operation implications of the crossing location on the east side of the river.

Based on the Analytical Hierarchy Process, **Option 3 - HDD from Fraser's Grove Park to Kildonan Park** is the most suitable option for the replacement of the Newton Force Main. If microtunnelling installation is required, **Option 4 - MT from Fraser's Grove Park to Kildonan Park** is the most suitable option.

The geotechnical investigation completed along the proposed alignment revealed that the soil stratigraphy consists of alluvium soils over lacustrine clay, silt till and bedrock. Limestone bedrock was encountered below the silt till. Rock Quality Designation confirms the bedrock to have good rock quality. Horizontal directional drilling is considered feasible trenchless installation methods at the site based on the strength, hardness and quality of the bedrock.

The bank stability analysis indicated the existing factor of safety for both banks is satisfactory however, it is recommended that a riprap blanket be placed in the east side lower bank area within the normal summer river level to minimize the potential for toe erosion which will result in a reduction in the stability over time. Based on the conditions found during the geotechnical investigation horizontal directional drilling is feasible.

A conceptual plan and profile of the proposed borepath was developed. The conceptual borepath considers the potential for hydrofracture, the bend radius of the product pipe and drill rods and the geometry of the casing. The borepath can be updated for detailed design and construction after an in depth utility investigation is complete.

11.2 Recommendations

Associated Engineering recommends moving forward with the preliminary design for the replacement of the Newton Force Main Red River Crossing based on **Option 3 - HDD from Fraser's Grove Park to Kildonan Park**. Additionally, it is recommended that a utility location plan be conducted to identify and expose all utilities in close proximity to the borepath that could be impacted. A geotechnical baseline report should be developed during the preliminary and detailed design stage.

CLOSURE

This report was prepared for the City of Winnipeg to recommend the best strategy to replace the Newton Force Main Red River Crossing.

The services provided by Associated Engineering (Sask.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering (Sask.) Ltd.

J. S.
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36827

Nov 10, 2021

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ENGINEERS
GEOSCIENTISTS
MANITOBA
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Associated Engineering (Sask) Ltd
No. 396 Date 11/10/2021

APPENDIX A - WORKSHOP BOOKLET

BOOKLET

Newton Force Main Red River Crossing

Preliminary Design Workshop

June 2021

Associated Engineering (Sask) Ltd.
Project Manager: Jason Lueke, Ph.D., P.Eng.
Email: luekej@ae.ca
Ph: (780) 969-6344

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1 INTRODUCTION AND PROJECT BACKGROUND

The Newton Force Main Red River Crossing is a dual crossing of the Red River between Fraser Grove Park and Newton Avenue. The twin crossing consists of a 350 mm diameter steel force main from the Linden Combined Sewer District (CSD) to the south constructed in 1960, and a 350 mm diameter HDPE force main from the Hawthorne CSD to the north constructed in 1978. The crossings carry flows from the Linden and Hawthorne Districts to a secondary sewer on the west side of the Red River near the intersection of Scotia Street and Newton Avenue in the vicinity of the Newton Pump Station. The wastewater then flows by gravity to the Main Street Interceptor and is conveyed to the North End Pollution Control Centre.

Originally flows from both the Linden and Hawthorne pump stations were serviced by the 350 mm steel force main. In 1977 the second HDPE force main was added on a parallel alignment across the Red River. Hydraulic modelling has indicated that flows from both the Linden and Hawthorne pump stations could be served by a single force main during peak dry weather flows.

The Newton Force Mains were inspected as part of the High Risk River Crossing Program. The steel force main was inspected during Phase 1 of the program, in 2014, and was found to be in good condition with virtually no wall loss due to corrosion. The assessment determined this force main has over 100 years of serviceable life remaining with some minor work required on the banks to prevent future erosion at the crossing location.

The HDPE force main was inspected during Phase 2 of the program in 2018 and was found to have leaks and evidence of excessive deformations. The investigation found the HDPE pipe to have very low resistance to Slow Crack Growth (SCG), which can make the pipe susceptible to brittle failure in response to long-term exposure to either sustained pressure or intermittent short-term over-pressure. A low head leakage test identified an apparent leak of over 800 l/hr, and CCTV inspection identified a circumferential split in the HDPE pipe immediately adjacent to the downstream end of the siphon. The leaks in the force main were repaired and the force main was flagged for replacement in the near future. No evidence of global slope instabilities was observed but armoring of the lower riverbanks was recommended to address erosion issues.

Associated Engineering (AE) was retained by the City of Winnipeg to develop and evaluate at least four different replacement alignments for the Newton Force Mains using two different construction methods. AE has summarized the proposed replacement options in this workshop booklet.

2 FEASIBILITY ASSESSMENT

Microtunnelling and Horizontal Directional Drilling methods are widely used for crossings of this nature. Brief summaries of the installation methods are provided in Section 2.1.

2.1 Installation Methods

2.1.1 Microtunnelling

Microtunnelling is a term used to describe a family of horizontal earth boring installation methods that also do not require personnel to enter the pipe during its installation. It is guided, steerable, and capable of installing pipes with tight tolerances on line and grade. Traditional methods utilize a microtunnel boring machine (MTBM) to excavate the tunnel along the alignment. A jacking frame is set within the launch shaft on the proposed line and grade of the installation and used to first launch the MTBM into the ground, and then continue to advance it by pushing pieces of sectional jacking pipe behind the trailing unit. The jacking pipe is specifically designed and manufactured to withstand the jacking forces developed during the installation process. Once the jacking pipe is installed the carrier pipe would be installed and connected to the forcemain system through the shafts.

The microtunnelling option would entail the installation of a minimum 1500 mm diameter concrete jacking casing pipe containing a 450 mm nominal (350mm ID) diameter High Density Polyethylene (HDPE) force main. During this stage of the assessment AE is assuming a size for size replacement. Provincial requirements necessitate river crossings have two sealed systems meant to act as “dual containment”. The concrete jacking pipe and HDPE forcemain act as a dual encasement system.

Advantages:

- Reduced setback distance from the rivers edge.
- Lower slurry operating pressure and flow required during the installation.
- Greater ability to adapt to changes in geotechnical conditions.

Disadvantages:

- Larger construction equipment and footprint required.
- Installation requires the use of a larger diameter casing to house the forcemain.
- Requires large deep shafts.
- Longer construction schedule.

2.1.2 Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is a surface to surface installation method widely used for river crossings of similar scope. Installation by HDD involves three steps:

1) drilling of the pilot bore,
2) pre-ream
3) product pullback.

During the installation process, the drill rig provides the thrust, pullback and rotational torque required to maneuver the drill string and product pipe during the installation. For all three phases of the installation, a drilling fluid is utilized that assists with stabilizing the borehole, transporting soil cuttings out of the borehole, and reducing friction within the borehole during product pullback. Once the casing pipe is pulled in, the carrier pipe would be pulled inside and connected to the forcemain system.

The HDD option would likely entail the installation of a 900 mm nominal diameter HDPE casing pipe containing a 450 mm nominal (350mm ID) diameter HDPE force main. During this stage of the assessment AE is assuming a size for size replacement at this point in time. The two HDPE pipes act as a dual encasement system.

Advantages:

- Smaller casing pipe required.
- Smaller excavations needed.
- Shorter construction schedule.

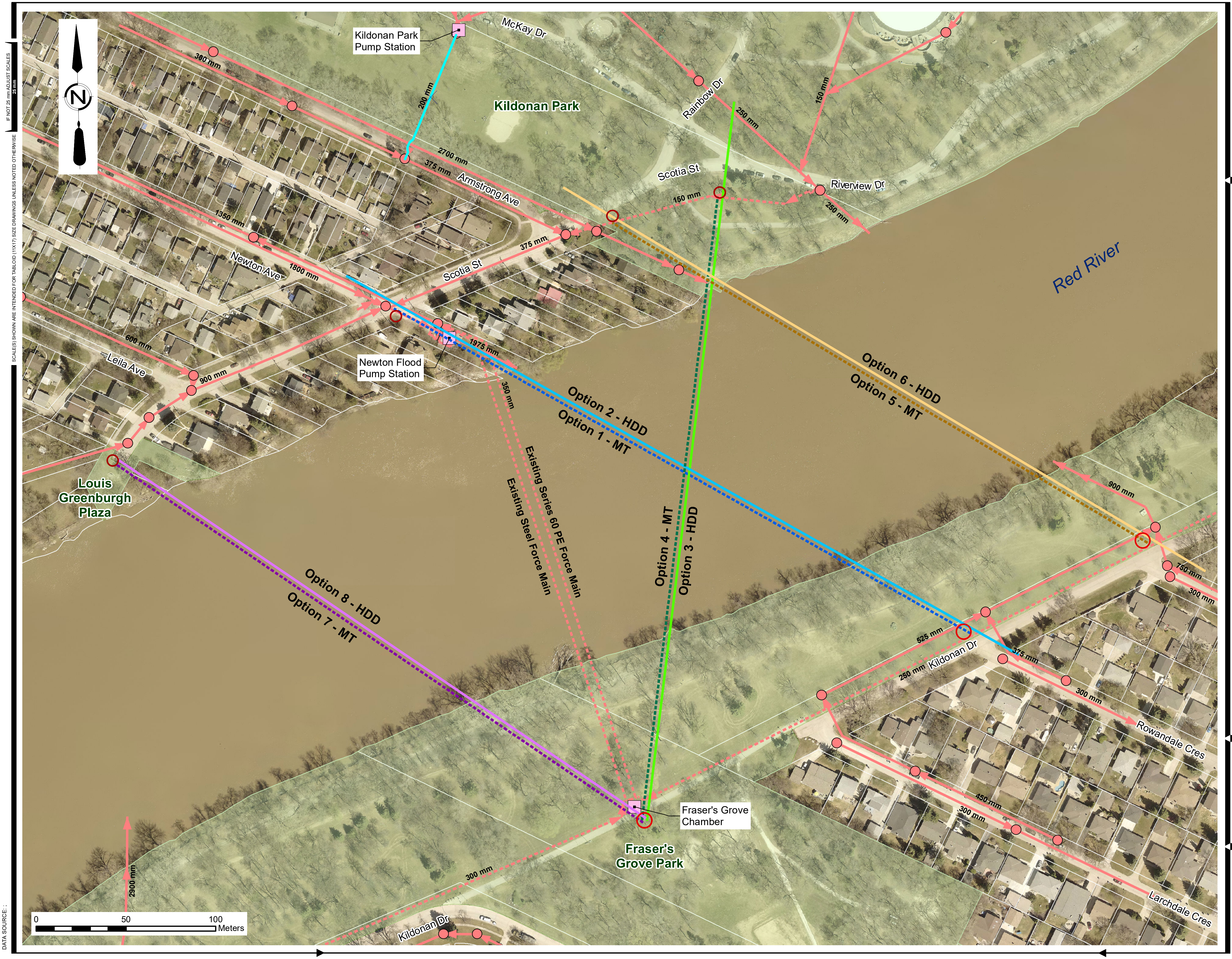
Disadvantages:

- Large setbacks required for drilling geometry restrictions.
- Large entry casing required to contain flows and bridge potential sand seams.
- Reduced capability to adjust to change in conditions.

2.2 Preliminary Alignments

Eight options were identified for the replacement which include four alignments and the two trenchless methods. Figure 1 shows an overall map of the options and their proposed alignments. Each option is discussed in detail in Section 3.

Option	Method	Description
Option 1	Microtunnelling	Includes the installation of a casing pipe from the green space west of the intersection of Kildonan Drive and Rowandale Crescent beneath the Red River to the intersection of Scotia Street and Newton Ave. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 2	HDD	Includes the installation of a casing pipe from the green space west of the intersection of Kildonan Drive and Rowandale Crescent beneath the Red River to west of the intersection of Scotia Street and Newton Ave. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 3	HDD	Includes the installation of a casing pipe from Fraser’s Glove Park beneath the Red River to the transition of Scotia Street to Riverview Drive occurs in Kildonan Park. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 4	Microtunnelling	Includes the installation of a casing pipe from Fraser’s Glove Park beneath the Red River to the transition of Scotia Street to Riverview Drive in Kildonan Park. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 5	Microtunnelling	Includes the installation of a casing pipe from the green space west of the intersection of Kildonan Drive and Rowandale Crescent beneath the Red River to the intersection of Scotia Street and Armstrong Ave. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 6	HDD	Includes the installation of a casing pipe from the green space west of the intersection of Kildonan Drive and Rowandale Crescent beneath the Red River to the intersection of Scotia Street and Armstrong Ave. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 7	Microtunnelling	Includes the installation of a casing pipe from Fraser’s Glove Park beneath the Red River to the Louis Greenburg Plaza. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.
Option 8	HDD	Includes the installation of a casing pipe from Fraser’s Glove Park beneath the Red River to the Louis Greenburg Plaza. A carrier pipe will be installed in the casing, shaft, and then connected to the existing system.



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LEGEND:

- Option 1, MT
- Option 2, HDD
- Option 3, HDD
- Option 4, MT
- Option 5, MT
- Option 6, HDD
- Option 7, MT
- Option 8, HDD
- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main

Winnipeg

FIGURE 1

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT OPTIONS

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2.3 Constructability Assessment

Associated Engineering has completed two trenchless assessment and designs within a kilometer of the Newton Forcemain crossings. One was constructed by HDD and the other by microtunnelling. Using this experience a trenchless constructability review has been done. Table 2-1 reviews the trenchless constructability of each option based on the known site conditions and trenchless methodology requirements.

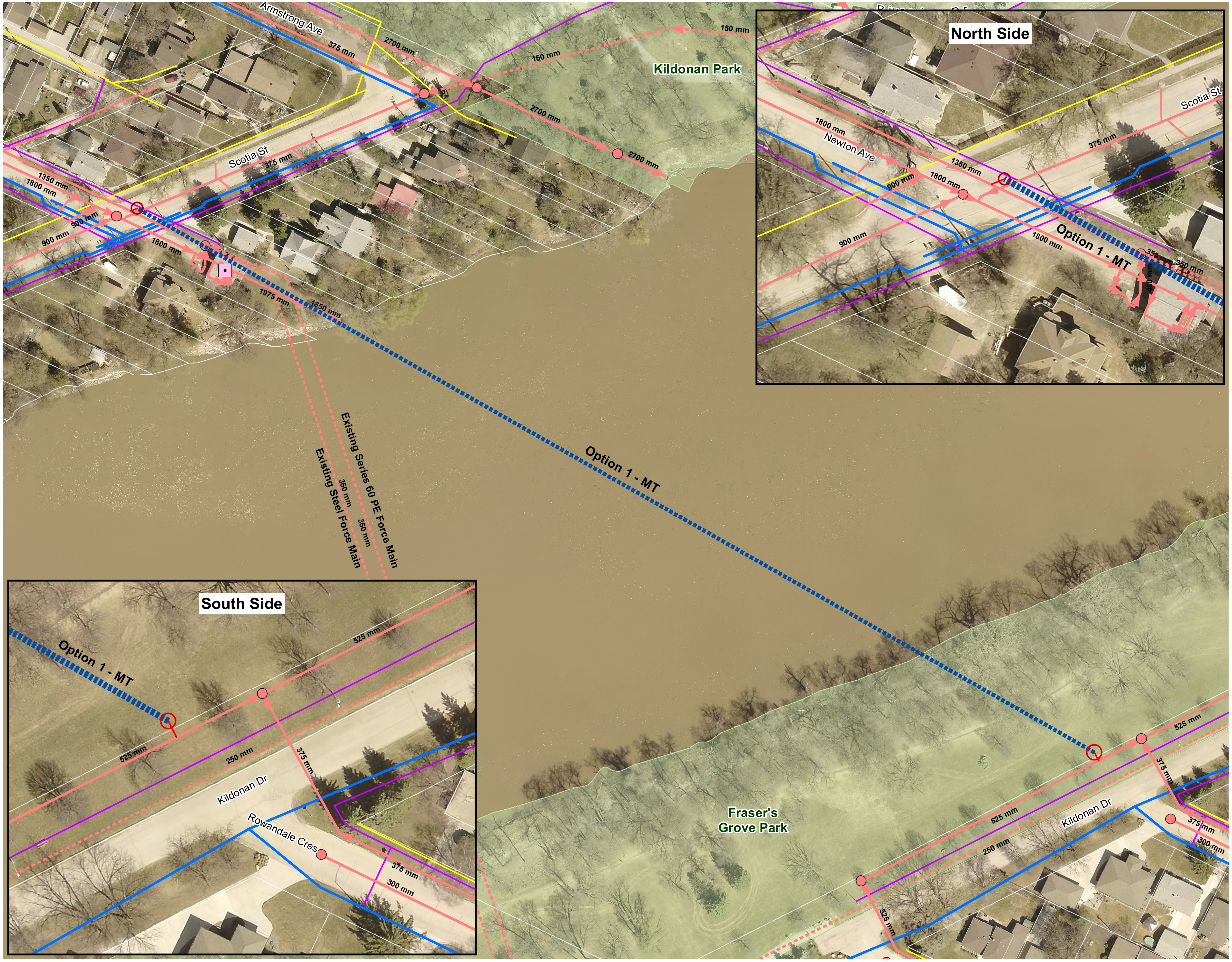
*Indicates Options that will not be considered further as they are not considered feasible.

Table 2-1 Constructability Assessment

Alignment	Installation Method	Length (m)	Pipe Material	Constructability Discussion
Option 1: Rowandale Crescent to Scotia Street	Microtunnel	370	Concrete Jacking Pipe Casing, HDPE Carrier	The east side is open, accessible, and would serve as a suitable staging area. The west side is congested with a number of ariel and subsurface utilities and limited area for shaft excavation and cranes needed to construct the work. Microtunnelling with in the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible with significant utility relocation.
*Option 2: Rowandale Crescent to Scotia Street	HDD	430	HDPE Casing, HDPE/PVC/Liner Carrier	It is estimated that the entry and exit pits must be located at least 100m from the river's edge based on experience in the area. To meet these setback distances the entry and exit pits will be located on residential streets near homes on Newton Avenue and Rowandale Crescent. The residential streets do not provide the required working area for construction. This alignment is further complicated by the existing utilities at the Newton Avenue Lift Station and at the intersection of Scotia Street and Newton Avenue. To avoid utility conflicts on the pump station site, the new force main will need to be installed beneath the pump station and require a large casing installation under several existing utilities in Scotia Street. This alignment will also result in the installation of the forcemain under the sidewalk on Newton Avenue. Challenges exist on the east side with the proximity to homes and utilities as well but not as significant as on Scotia Street. This alignment is not considered feasible.
Option 3: Fraser's Grove Park to Kildonan Park	HDD	405	HDPE Casing, HDPE/PVC/Liner Carrier	Entry and exit pits require around a 100m set back from the rivers edge. The east side Fraser Grove Park is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable entry area. Kildonan Park on the west is also large and open but does have some utilities which require consideration for the placement of the exit area. The Park is suitable to stage the pipe string out for pullback. HDD is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 4: Fraser's Grove Park to Kildonan Park	Microtunnel	350	Concrete Jacking Pipe Casing, HDPE Carrier	Fraser Grove Park on the east side is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable working area and launch shaft location. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and reception shaft but is suitable for the work. Microtunnelling with in the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 5: Rowandale Crescent to Kildonan Park	Microtunnel	350	Concrete Jacking Pipe Casing, HDPE Carrier	The green space along the river valley parallel to Kildonan Drive near Rowandale Crescent is open with minimal utility conflicts, good site access and would serve well as a launch shaft location and working area. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and reception shaft but is suitable for the work. Microtunnelling with in the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 6: Rowandale Crescent to Kildonan Park	HDD	415	HDPE Casing, HDPE/PVC/Liner Carrier	The needed setback of 100m would place the entry area along Rowandale Crescent in front of resident's homes. Installation of a large diameter entry casing is challenging but feasible. The green space along the river valley parallel to Kildonan Drive near Rowandale Crescent is open with minimal utility conflicts, good site access and would serve well as a working area. Kildonan Park is also large and open but does have some utilities which require consideration for the placement of the working area and pipe string out but is suitable for the work. HDD is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
Option 7: Fraser's Grove Park to Louis Greenburgh Plaza	Microtunnel	355	Concrete Jacking Pipe Casing, HDPE Carrier	The east side Fraser Grove Park is a large open area with manageable access and minimal utilities to avoid and would serve as a suitable working are and launch shaft. Luis Greenburgh Plaza is a small green space with limited utility conflicts and moderate access. This location is suitable for a working area and reception shaft. Microtunnelling with in the bedrock is feasible but requires confirmation of the bedrock quality and condition. This alignment is considered feasible.
*Option 8: Fraser's Grove Park to Louis Greenburgh Plaza	HDD	355	HDPE Casing, HDPE/PVC/Liner Carrier	The required setback of 100m is feasible on the east side with workspace available within the Fraser Grove Park. Luis Greenburgh Plaza is a small green space on the west side of the river with little more than 40-50m of workspace from the edge of riverbank. There is insufficient setback for the use of HDD in this location. HDD is feasible within bedrock but requires confirmation of the bedrock quality and condition. This alignment is not considered feasible.

3 CROSSING OPTIONS

Option 1 – Microtunnel from Rowandale Crescent to Scotia Street	
Description	Option 1 involves the use of Microtunnelling to install a new forcemain beneath the Red River. This includes the installation of a casing pipe from a jacking shaft in the green space west of Kildonan Drive and Rowandale Crescent to a reception shaft near the intersection of Scotia Street and Newton Ave. A carrier pipe would be installed in the casing pipe and then grouted in place before being connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-1.
Scope	Construction concept for Option 1 is as follows: 1. Relocate above ground utilities to allow space for construction of the Retrieval Shaft. 2. Construction of a 25 meters deep Launch Shaft. 3. Construction of a 25 meters deep Retrieval shaft. 4. Microtunnel 370 meters of 1500mm diameter concrete jacking pipe between the two shafts from east to west. 5. Installation of the carrier pipe within the concrete jacking pipe and the risers within the shafts. 6. Connection to the existing forcemain. 7. Commission new crossing and decommission and abandon the existing force main crossing.
Advantages	• Decreased length of force main. • Provides flexibility to install additional infrastructure beneath the river.
Disadvantages	• Utility relocations required to allow work to occur. • Working in close proximity to private residences. • Small workspace on the west side. • Working within park space.
Risks	• Installation crosses beneath the existing lift station and tunnels in the intersection of Scotia Street and Newton Ave.
Key Issues	• Congested area along Scotia Avenue with limited space to construct a shaft with sufficient space to place equipment. • Possible vibration and noise disturbance for surrounding neighbourhoods. • Utility relocation delay risks. • Secondary connection requirements to Fraser's Grove Park chamber to be confirmed.



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LEGEND:

○ 5 m ø Reception Shaft
○ 8 m ø Working Shaft
— Connection
● Sewer Manhole
→ Sewer Main
⇢ Force Main
— Waterline
— Electric Line
— Gas Line

FIGURE 3-1

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 1

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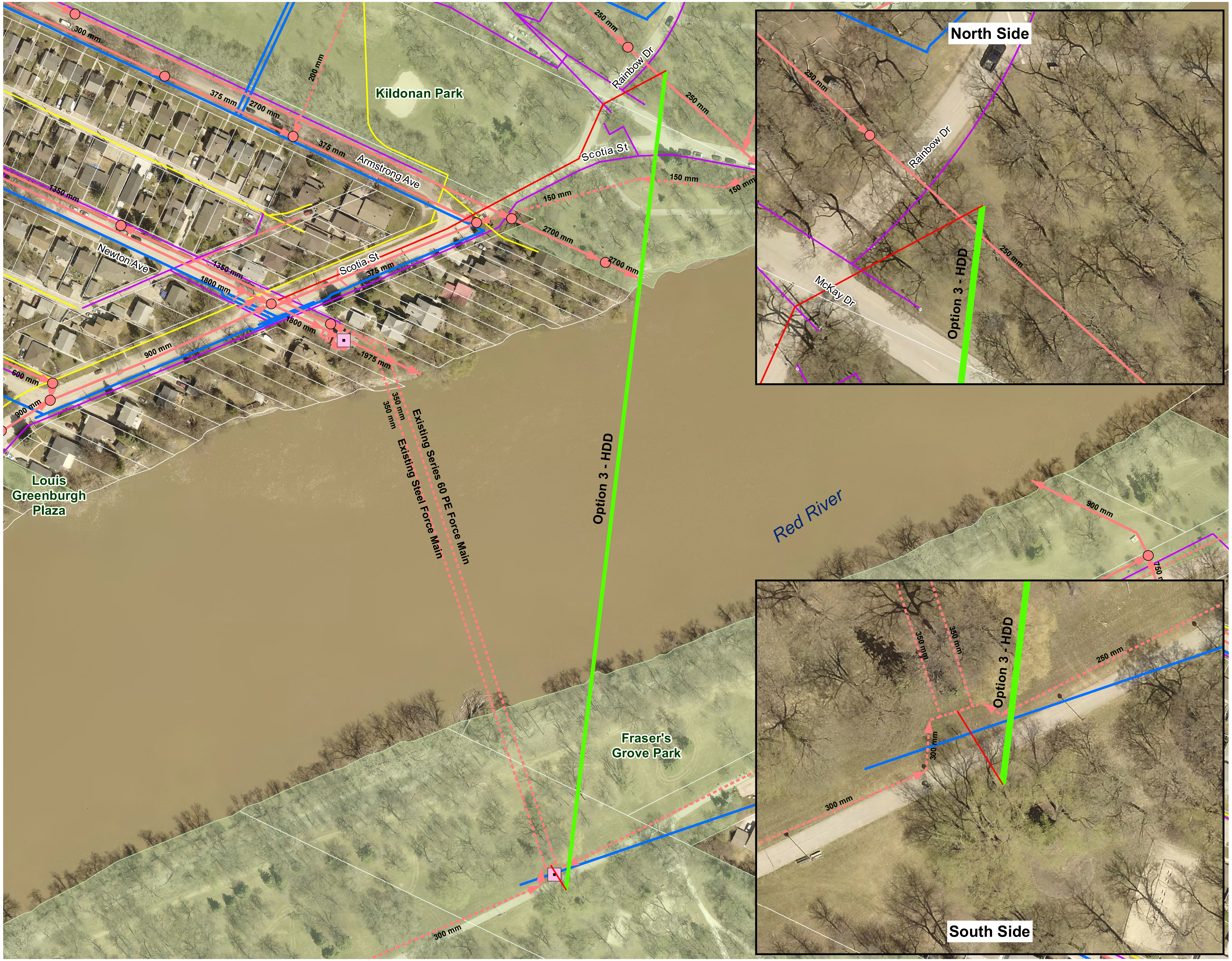
Option 3: HDD from Fraser's Grove Park to Kildonan Park	
Description	Option 3 involved the use of HDD to install a new forcemain beneath the Red River. This includes casing pipe from the entry area within Frasers Grove Park across to the Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. Entry and exit casing would be needed at both ends of the installation. A carrier pipe would be pulled in the casing pipe and then connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-2.
Scope	The construction concept for Option 3 is as follows: 1. Mobilize and setup drill rig in the east side within the Fraser's Grove Park. 2. Drill pilot bore approximately 405 meters in length across the river at a sufficient depth to prevent hydro-fracture. 3. Pre-ream the borehole to expand the pilot bore. 4. String out the casing and carrier pipe within the Kildonan Park along Mckay Drive. 5. Pull and install the 900mm diameter casing pipe. 6. Pull and install the 450mm diameter carrier pipe. 7. Excavate and connect to the forcemain and Fraser's Grove Chamber. 8. Excavate and install new forcemain along Scotia Street and connect to the sanitary main along Newton Ave. 9. Commission new crossing and decommission the existing force main. 10. Backfill and restore surrounding area.
Advantages	• No relocations required. • Large open workspaces on both sides.
Disadvantages	• Increased length of forcemain and associated maintenance. • Open trench impacting private residents. • Minimal future upsizing potential. • Working within park space.
Risks	• Crossing large diameter storm sewer outfall. • Crossing documented unstable riverbank.
Key Issues	• Connection pipe size requirements along Scotia Street to be confirmed.



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Platinum member

Winnipeg

LEGEND:

—	Connection
●	Sewer Manhole
→	Sewer Main
- - →	Force Main
—	Waterline
—	Electric Line
—	Gas Line

N

0 25 50
m

FIGURE 3-2

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 3

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Option 4: Microtunnel from Fraser’s Grove Park to Kildonan Park	
Description	Option 4 involves the use of Microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area within Frasers Grove Park across to a receiving shaft within Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-3.
Scope	Construction concept for Option 4 is as follows: 1. Construction of a 25 meters deep Launch Shaft. 2. Construction of a 25 meters deep Retrieval shaft. 3. Microtunnel 350 meters of 1500mm diameter concrete jacking pipe between the two shafts from east to west. 4. Installation of the carrier pipe within the concrete jacking pipe and the risers within the shafts. 5. Connection to the existing forcemain. 6. Commission new crossing and decommission and abandon the existing force main crossing.
Advantages	• Provides flexibility to install additional infrastructure beneath the river. • Large open workspaces on both sides.
Disadvantages	• Increased length of forcemain and associated maintenance. • Working within park space.
Risks	• Crossing documented unstable riverbank. • Crossing large diameter storm sewer outfall.
Key Issues	• Connection pipe size requirements along Scotia Street to be confirmed.

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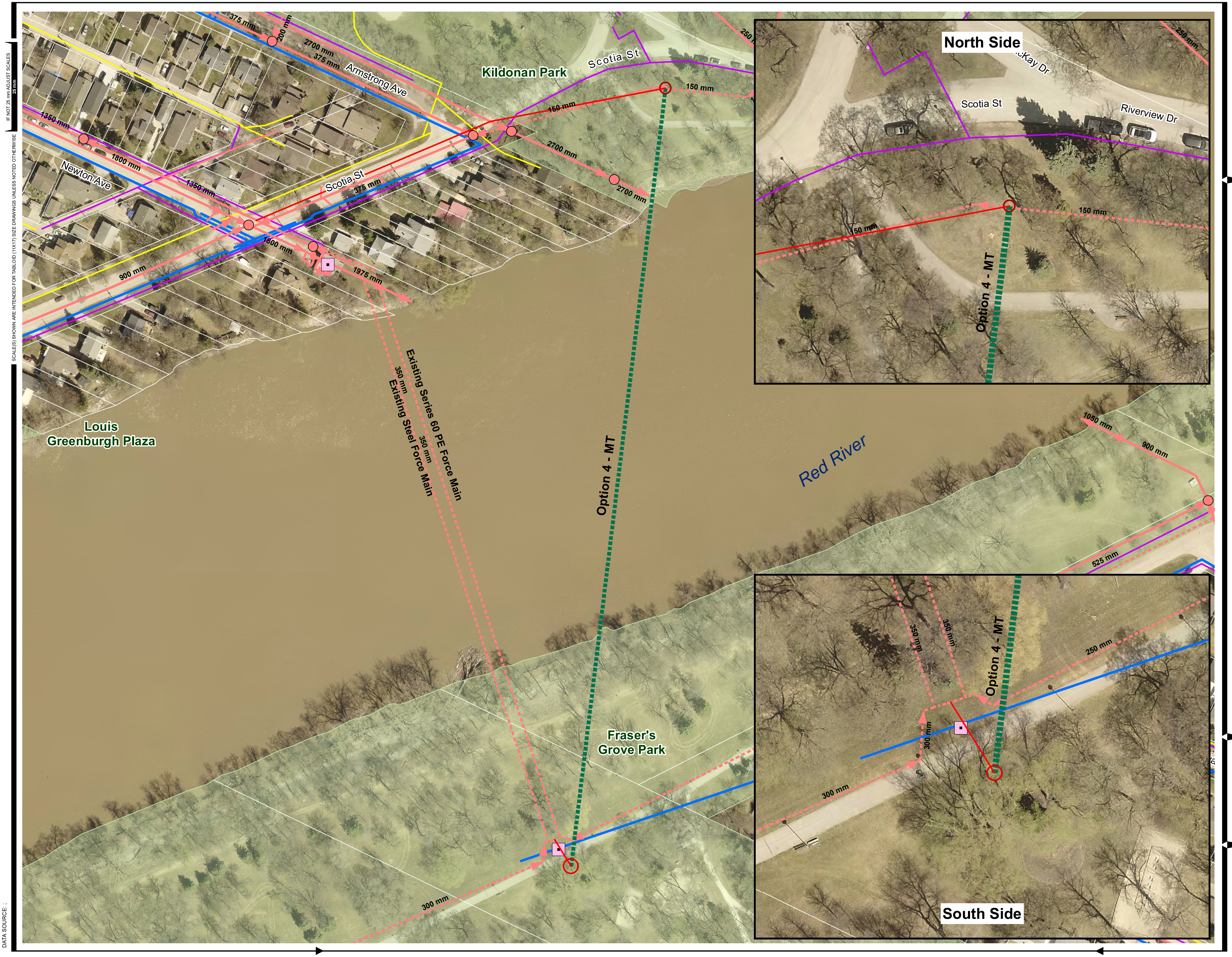

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LEGEND:

○	5 m ø Reception Shaft
○	8 m ø Working Shaft
—	Connection
●	Sewer Manhole
→	Sewer Main
⇢	Force Main
—	Waterline
—	Electric Line
—	Gas Line

N

0 25 50
m

FIGURE 3-3

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 4

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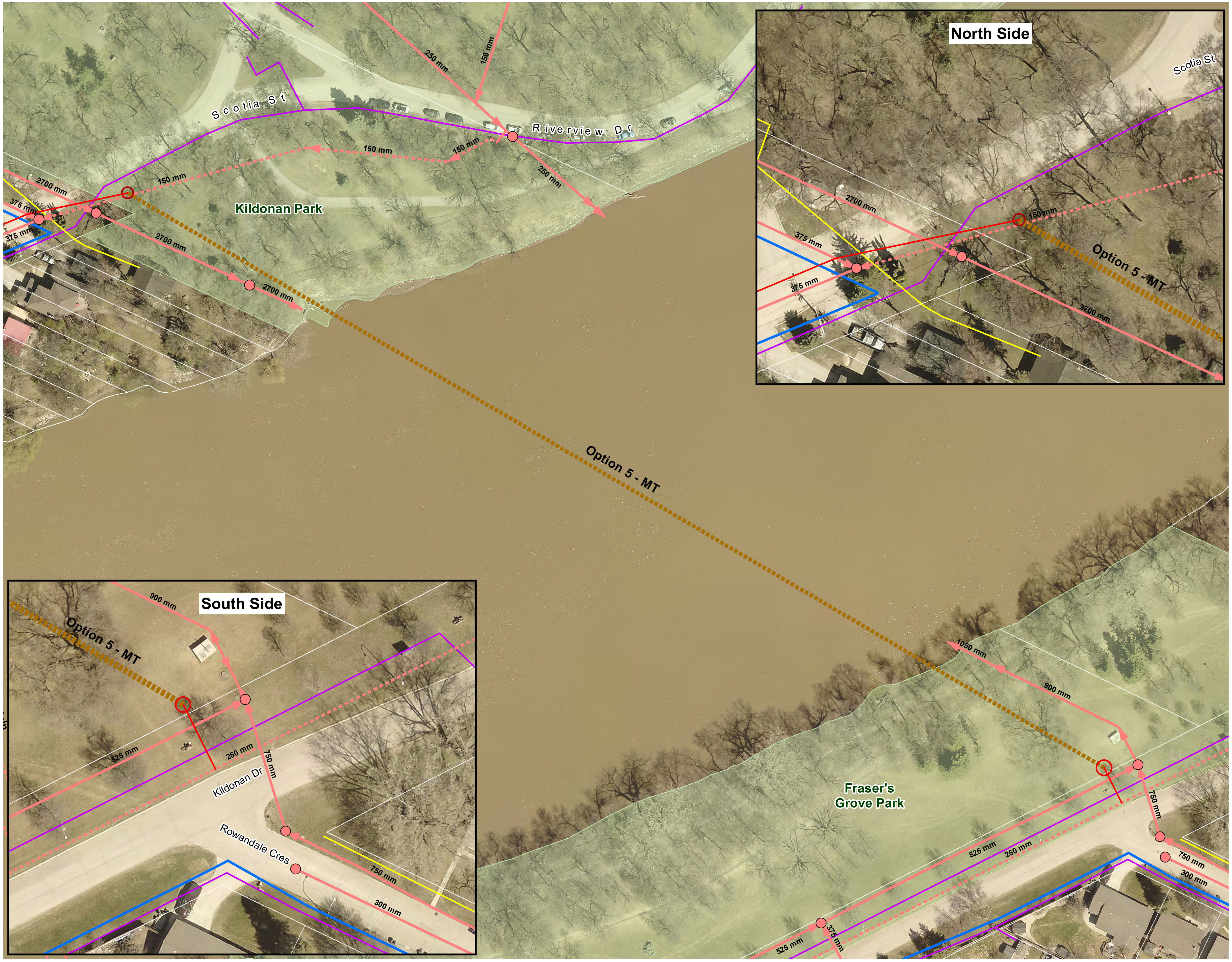
Option 5: Microtunnel from Rowandale Crescent to Kildonan Park	
Description	Option 5 involves the use of Microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area just west of the intersection of Kildonan Drive and Rowandale Crescent across to a receiving shaft within Kildonan Park near the intersection of Scotia Street and Armstrong Ave. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-4.
Scope	Construction concept for Option 5 is as follows: 1. Construction of a 25 meters deep Launch Shaft. 2. Construction of a 25 meters deep Retrieval shaft. 3. Microtunnel 350 meters of 1500mm diameter concrete jacking pipe between the two shafts from east to west. 4. Installation of the carrier pipe within the concrete jacking pipe and the risers within the shafts. 5. Connection to the existing forcemain. 6. Commission new crossing and decommission and abandon the existing force main crossing.
Advantages	• Provides flexibility to install additional infrastructure beneath the river. • Large open workspaces on both sides. • Decreased length of force main.
Disadvantages	• Working in close proximity to private residences. • Working within park space.
Risks	• Crossing documented unstable riverbank. • Excavation of deep shafts required within potentially compromised bedrock potentially connected to the rivers water table.
Key Issues	• Connection pipe size requirements along Scotia Street to be confirmed. • Secondary connection requirements to Fraser’s Grove Park chamber to be confirmed.



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LEGEND:
- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main
- Waterline
- Electric Line
- Gas Line

N

0 25 50
m

FIGURE 3-4

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 5

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DESCRIPTION	ISSUED FOR DRAFT

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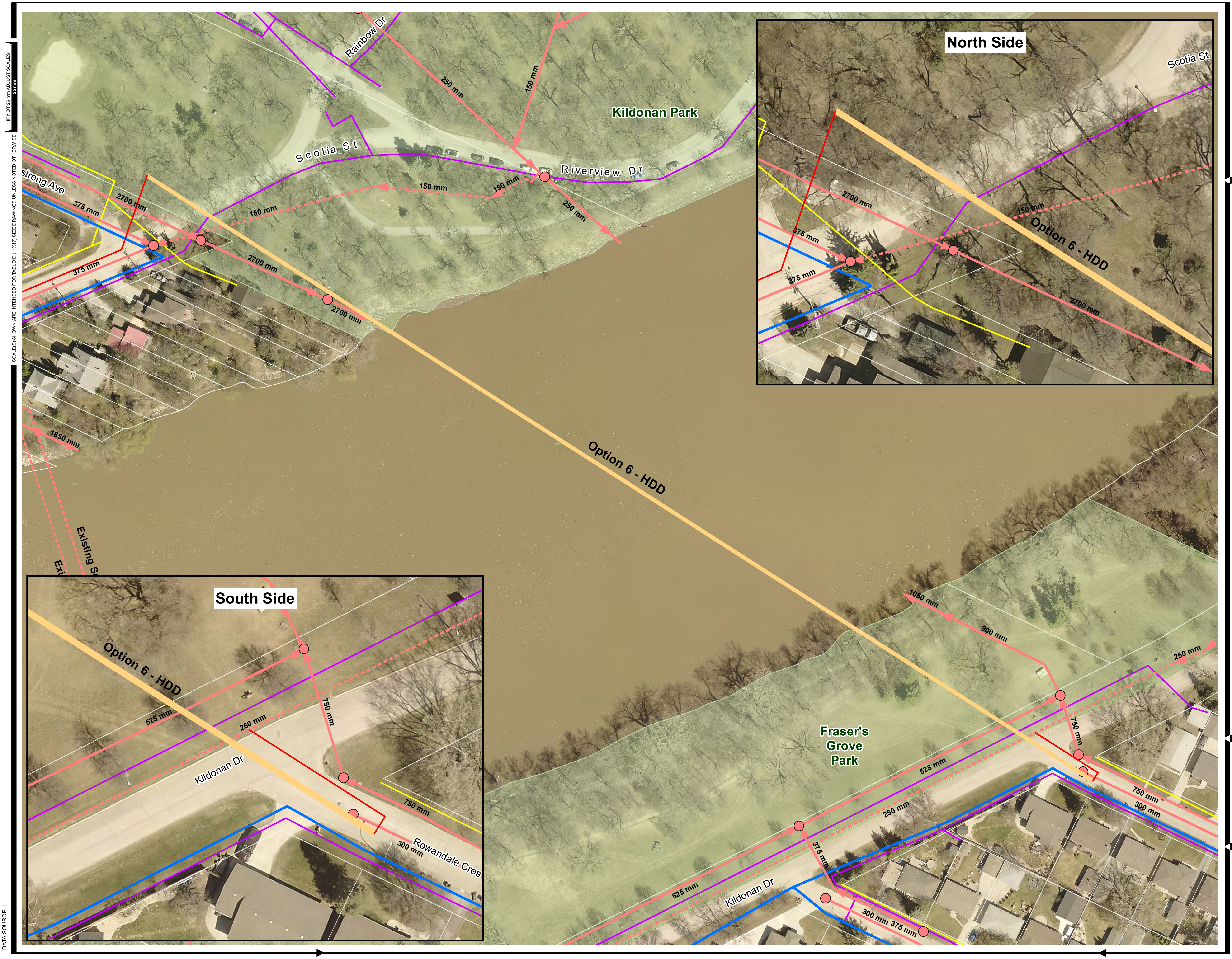
DATA SOURCE: ;

Option 6: HDD from Rowandale Crescent to Kildonan Park	
Description	Use of HDD to install a casing pipe from the entry area within Frasers Grove Park across to the Kildonan Park near the intersection where Scotia Street transitions to Riverview Drive. Entry and exit casing would be needed at both ends of the installation. A carrier pipe would be pulled in the casing pipe and then connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-5.
Scope	The construction concept for Option 6 is as follows: 1. Mobilize and setup drill rig in the east side within the Fraser's Grove Park. 2. Drill pilot bore approximately 415 meters in length across the river at a sufficient depth to prevent hydro-fracture. 3. Pre-ream the borehole to expand the pilot bore. 4. String out the casing and carrier pipe within the Kildonan Park along Mckay Drive. 5. Pull and install the casing pipe. 6. Pull and install the carrier pipe. 7. Excavate and connect to the forcemain and Fraser's Grove Chamber. 8. Excavate and install new forcemain along Scotia Street and connect to the sanitary main along Newton Ave. 9. Commission new crossing and decommission the existing force main. 10. Backfill and restore surrounding area.
Advantages	• Large open workspaces on both sides. • Decreased length of force main.
Disadvantages	• Working in close proximity to private residences. • Working within park space.
Risks	• Crossing documented unstable riverbank. • Possible vibration impact to surrounding infrastructure and private residents.
Key Issues	• Connection pipe size requirements along Scotia Street to be confirmed. • Secondary connection requirements to Fraser's Grove Park chamber to be confirmed.



Associated Engineering

CANADA'S BEST MANAGED COMPANIES
Platinum member

Winnipeg

LEGEND:

- ━ Connection
- ● Sewer Manhole
- ➔ Sewer Main
- ┅➤ Force Main
- ━ Waterline
- ━ Electric Line
- ━ Gas Line

N

0 25 50
m

FIGURE 3-5

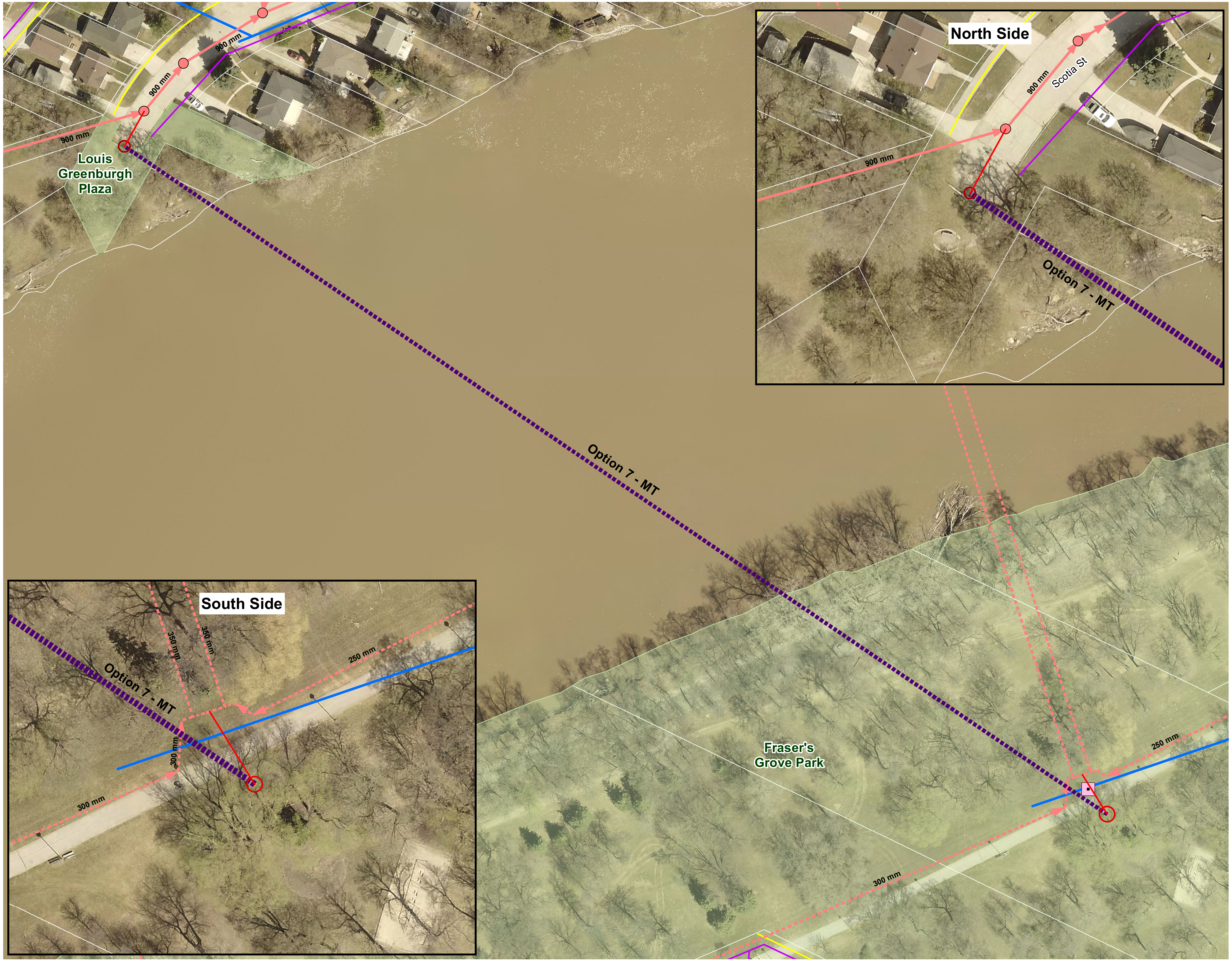
CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 6

AE PROJECT No.	2021-4589
SCALE	1:1,300
APPROVED	
DATE	2021JUN15
REV	
DESCRIPTION	ISSUED FOR DRAFT

SAVE DATE: 6/15/2021 4:31:45 PM SAVED BY:
DRAWING PATH: C:\Users\richardsonk\Desktop\2021_4589_WPG_FM\nfm_fig_3_Option6.mxd
DATA SOURCE: :

Option 7: Microtunnel from Fraser’s Grove Park to Louis Greenburgh Plaza	
Description	Option 7 involves the use of Microtunnelling to install a new siphon beneath the Red River. This includes the installation of a casing pipe from the launch area in Fraser’s Grove Park across to a receiving shaft within Louis Greenburgh Plaza. A carrier pipe would be installed into the casing pipe and then connected to the existing system. The old river crossing would then be abandoned in place or removed from the river bottom. Refer to Figure 3-6.
Scope	Construction concept for Option 7 is as follows: 1. Construction of a 25 meters deep Launch Shaft. 2. Construction of a 25 meters deep Retrieval shaft. 3. Microtunnel 355 meters of 1500 mm diameter concrete jacking pipe between the two shafts from east to west. 4. Installation of the carrier pipe within the concrete jacking pipe and the risers within the shafts. 5. Connection to the existing forcemain. 6. Commission new crossing and decommission and abandon the existing force main crossing.
Advantages	• Provides flexibility to install additional infrastructure beneath the river.
Disadvantages	• Working in close proximity to private residences. • Limited construction vehicle access. • Increased length of forcemain and associated maintenance. • Working within park space.
Risks	• Reduced setback from the riverbank.
Key Issues	• Small workspace within Louis Greenburgh Plaza. • Connection pipe size requirements along Scotia Street to be confirmed.



Associated Engineering

CANADA'S BEST MANAGED COMPANIES
Platinum member

Winnipeg

LEGEND:

- ○ 5 m ø Reception Shaft
- ○ 8 m ø Working Shaft
- — Connection
- ● Sewer Manhole
- → Sewer Main
- ⇢ Force Main
- — Waterline
- — Electric Line
- — Gas Line

N

0 25 50 m

FIGURE 3-6

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT
OPTION 7

AE PROJECT No.	2021-4589
SCALE	1:1,100
APPROVED	
DATE	2021JUN15
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES
25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

SAVE DATE: 6/14/2021 4:39:08 PM SAVED BY:
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DATA SOURCE: ;

4 ENVIRONMENTAL REGULATIONS

Table 4-1 below summarizes the environmental approvals and licensing processes that are relevant to the Newton Force Main crossing of the Red River in Winnipeg. This table outlines general environmental regulations based on our previous experience on the North Kildonan Feedermain and North East Interceptor Trunk approximately 1km downstream of this location. Site specific environmental regulations are currently being evaluated and will be updated at a later date.

Table 4-1
Summary of Applicable Environmental Legislation and Project Options

Legislation	Microtunnelling	Directional Drilling
Manitoba Environment Act	Existing License - Submit Plans	Existing License - Submit Plans
Manitoba Public Health Act	Does not Apply	Does not Apply
CEAA 2012	Does Not Apply	Does Not Apply
Fisheries Act	Applies (Request for Review)	Applies (Request for Review)
Navigation and Protection Act	Does Not Apply	Does Not Apply
Species at Risk	Applies (general)	Applies (general)
Migratory Birds Convention Act	Applies (general)	Applies (general)

5 EXAMPLE EVALUATION CRITERIA

Environmental	The impact from the construction on the natural environment. Some of the factors considered in this criterion include regulatory acceptance, amount of disturbance to and clearing of trees or vegetation required to implement the option, and impact to the river and wildlife in the immediate area.
Constructability	The technical feasibility of installing the utilities along the proposed alignment using the proposed construction methodology. Factors considered in this evaluation include the ability to find contractors to undertake the work, the technical feasibility of pipe diameters and lengths proposed, space requirements, compatibility with soil conditions, and construction risks.
Social Impact	This criterion considers the potential impacts the proposed crossing methodology may have socially. This may include opportunities for recreation, access for pedestrian traffic, or even benefits to the community the project may have that are difficult to quantify in a monetary sense.
Maintainability	The ability to maintain, inspect, and service the pipes along the proposed alignment considering the lengths and potential access points.
Operability	The extent to which the option fits within the City’s operational philosophy for the water distribution system, and the intended level of service.
Security	Refers to the ability of a particular option to remain operational from the effects of infrastructure failure, acts of terrorism, natural disasters, and vandalism.
Longevity	The anticipated life expectancy of the repair or installation, the expected life cycle costs, maintenance requirements, and inspection needs.
Sustainability	Considers that in the future, this piece of infrastructure may need to be repaired, rehabilitated, or even expanded to meet future growth or changes in usage. This criterion evaluates how flexible the solution is to changing conditions, how it can be adapted to meet different needs, and potential changes to the surrounding area.

APPENDIX B - ESTIMATED CONSTRUCTION COSTS

Associated Engineering GLOBAL PERSPECTIVE. LOCAL FOCUS.

Winnipeg

WORKSHOP

City of Winnipeg

Newton Forcemain Replacement
Cost Estimates

These cost estimates are AACE Class 4 estimates based on historical project costs in Western Canada.

Associated Engineering

Newton Force Main Replacement:
Option Cost Summary (AACE Class 5)

Client:
City of Winnipeg
Subject:
Concept Cost Comparison

Option	Description	Cost			
		Subtotal	Contingency	Engineering	Total
1	MT from Rowandale Crescent to Scotia Street	$ 9,465,000	$ 4,732,500	$ 1,419,750	$ 15,617,250
3	HDD from Fraser's Grove Park to Kildonan Park - Single Pipe	$ 3,055,000	$ 1,527,500	$ 458,250	$ 5,040,750
3a	HDD from Fraser's Grove Park to Kildonan Park - Dual Pipe	$ 5,505,000	$ 2,752,500	$ 825,750	$ 9,083,250
3b	HDD from Fraser's Grove Park to Kildonan Park - Single Upsized Pipe	$ 4,192,500	$ 2,096,250	$ 628,875	$ 6,917,625
4	MT from Fraser's Grove Park to Kildonan Park	$ 9,576,000	$ 4,788,000	$ 1,436,400	$ 15,800,400
5	MT from Rowandale Crescent to Kildonan Park	$ 9,459,000	$ 4,729,500	$ 1,418,850	$ 15,607,350
6	HDD from Rowandale Crescent to Kildonan Park - Single Pipe	$ 2,925,000	$ 1,462,500	$ 438,750	$ 4,826,250
7	MT from Fraser's Grove Park to Louis Greenburgh Plaza	$ 9,300,000	$ 4,650,000	$ 1,395,000	$ 15,345,000

Newton Force Main Replacement
Option 1:
MT from Rowandale Crescent to Scotia Street

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 700,000	$ 700,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Excavation of Microtunnelling Shafts	v.m.	50	$ 80,000	$ 4,000,000
4.0	Supply and Install 450mm DR9 HDPE Force Main Encased in 1500mm Concrete Jacking Pipe	l.m.	370	$ 12,000	$ 4,440,000
5.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
6.0	Abandonment of Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
	Assumptions:	**SUBTOTAL**			**$ 9,465,000**
		Engineering (15%)			$ 1,419,750
		Contingency (50%)			$ 4,732,500
		TOTAL			**$ 15,617,250**

Newton Force Main Replacement
Option 3:
HDD from Fraser's Grove Park to Kildonan Park - Single Pipe

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 300,000	$ 300,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 450mm DR9 HDPE Force Main by Horizontal Directional Drilling	l.m.	405	$ 5,000	$ 2,025,000
4.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
5.0	Abandon Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
6.0	Upsize 375 mm Sewer on Scotia Street to 600 mm	l.m.	225	$ 1,800	$ 405,000
	Assumptions:	**SUBTOTAL**			**$ 3,055,000**
	- The 375 mm pipe on Scotia Street does not have capacity for the force main flows	Engineering (15%)			$ 458,250
		Contingency (50%)			$ 1,527,500
		TOTAL			**$ 5,040,750**

Associated Engineering

Newton Force Main Replacement
Option 3a:
HDD from Fraser's Grove Park to Kildonan Park - Dual Pipe

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 500,000	$ 500,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 2x450mm HDPE Force Main by Horizontal Directional Drilling	l.m.	810	$ 5,000	$ 4,050,000
4.0	Connection to Existing Force Main	EA	4	$ 100,000	$ 400,000
5.0	Abandon Existing Force Main (Drain and Cap)	LS	2	$ 25,000	$ 50,000
6.0	Upsize 375 mm Sewer on Scotia Street to 600 mm	l.m.	225	$ 1,800	$ 405,000

Assumptions:

- The 375 mm pipe on Scotia Street does not have capacity for the force main flows

SUBTOTAL	**$ 5,505,000**
Engineering (15%)	$ 825,750
Contingency (50%)	$ 2,752,500
TOTAL	**$ 9,083,250**

Newton Force Main Replacement
Option 3b:
HDD from Fraser's Grove Park to Kildonan Park - Single Upsized Pipe

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 400,000	$ 400,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 750mm HDPE Force Main by Horizontal Directional Drilling	l.m.	405	$ 7,500	$ 3,037,500
4.0	Connection to Existing Force Main	EA	2	$ 100,000	$ 200,000
5.0	Abandon Existing Force Main (Drain and Cap)	LS	2	$ 25,000	$ 50,000
6.0	Upsize 375 mm Sewer on Scotia Street to 600 mm	l.m.	225	$ 1,800	$ 405,000

Assumptions:

- The 375 mm pipe on Scotia Street does not have capacity for the force main flows

SUBTOTAL	**$ 4,192,500**
Engineering (15%)	$ 628,875
Contingency (50%)	$ 2,096,250
TOTAL	**$ 6,917,625**

Associated Engineering

Newton Force Main Replacement
Option 4:
MT from Fraser's Grove Park to Kildonan Park

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 700,000	$ 700,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Excavation of Microtunnelling Shafts	v.m.	50	$ 80,000	$ 4,000,000
4.0	Supply and Install 450mm DR9 HDPE Force Main Encased in 1500mm Concrete Jacking Pipe	l.m.	350	$ 12,000	$ 4,200,000
5.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
6.0	Abandonment of Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
6.0	Upsize 375 mm Sewer on Scotia Street to 600 mm	l.m.	195	$ 1,800	$ 351,000

Assumptions:

- The 375 mm pipe on Scotia Street does not have capacity for the force main flows

SUBTOTAL	**$ 9,576,000**
Engineering (15%)	$ 1,436,400
Contingency (50%)	$ 4,788,000
TOTAL	**$ 15,800,400**

Associated Engineering

Newton Force Main Replacement
Option 5:
MT from Rowandale Crescent to Kildonan Park

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 700,000	$ 700,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Excavation of Microtunnelling Shafts	v.m.	50	$ 80,000	$ 4,000,000
4.0	Supply and Install 450mm DR9 HDPE Force Main Encased in 1500mm Concrete Jacking Pipe	l.m.	350	$ 12,000	$ 4,200,000
5.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
6.0	Abandonment of Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
7.0	Upsize 375 mm Sewer on Scotia Street	l.m.	130	$ 1,800	$ 234,000
	Assumptions:	**SUBTOTAL**			**$ 9,459,000**
	- The exising forcemain will be backgraded to convey flows to the new connection point.	Engineering (15%)			$ 1,418,850
		Contingency (50%)			$ 4,729,500
		TOTAL			**$ 15,607,350**

Associated Engineering

Newton Force Main Replacement
Option 6:
HDD from Rowandale Crescent to Kildonan Park - Single Pipe

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 300,000	$ 300,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 450mm HDPE Force Main by Horizontal Directional Drilling	l.m.	415	$ 5,000	$ 2,075,000
4.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
5.0	Abandon Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
6.0	Upsize 375 mm Sewer on Scotia Street to 600 mm	l.m.	125	$ 1,800	$ 225,000

Assumptions:

- The exising forcemain will be backgraded to convey flows to the new connection point.

SUBTOTAL	**$ 2,925,000**
Engineering (15%)	$ 438,750
Contingency (50%)	$ 1,462,500
TOTAL	**$ 4,826,250**

Associated Engineering

Newton Force Main Replacement
Option 7:
MT from Fraser's Grove Park to Louis Greenburgh Plaza

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 700,000	$ 700,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Excavation of Microtunnelling Shafts	v.m.	50	$ 80,000	$ 4,000,000
4.0	Supply and Install 450mm DR9 HDPE Force Main Encased in 1500mm Concrete Jacking Pipe	l.m.	355	$ 12,000	$ 4,260,000
5.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
6.0	Abandonment of Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
7.0	Supply and Install 350 mm Sewer on Scotia Street	l.m.	15	$ 1,000	$ 15,000
	Assumptions: - The existing 900 mm pipe on Scotia Street can accommodate the flow from the force main	**SUBTOTAL**			**$ 9,300,000**
		Engineering (15%)			$ 1,395,000
		Contingency (50%)			$ 4,650,000
		TOTAL			**$ 15,345,000**

Associated Engineering

Newton Force Main Replacement
Option 7:
MT from Fraser's Grove Park to Louis Greenburgh Plaza

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 700,000	$ 700,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 450mm HDPE Force Main by Horizontal Directional Drilling	l.m.	355	$ 5,000	$ 1,775,000
4.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
5.0	Abandonment of Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
7.0	Supply and Install 350 mm Sewer on Scotia Street	l.m.	15	$ 1,000	$ 15,000

Assumptions:

- The existing 900 mm pipe on Scotia Street can accommodate the flow from the force main

SUBTOTAL	**$ 2,815,000**
Engineering (15%)	$ 422,250
Contingency (50%)	$ 1,407,500
TOTAL	**$ 4,644,750**

APPENDIX C - EGE ENGINEERING REPORT

EGE Engineering Ltd.

July 26, 2021 File: 0137 007 01

Associated Engineering Alberta Ltd.
500, 9888 Jasper Avenue
Edmonton, Alberta
T5J 5C6

Attention: Mr. Jason Lueke, Ph.D., P.Eng.
National Practice Leader - Trenchless Technologies

RE: Environmental Legislation and Approvals Process Review
Newton Force Main Red River Crossing - Preliminary Design
Winnipeg, Manitoba

EGE Engineering Ltd. (EGE) is pleased to submit the following information with respect to a review of the environmental legislation and regulatory approval processes associated with the preliminary design for the Newton Force Main Red River Crossing in Winnipeg, Manitoba. The scope of work included a review of federal (*Impact Assessment Act*, *Fisheries Act*, *Canadian Navigable Waters Act*, *Species at Risk Act* and *Migratory Birds Convention Act*) and provincial (*Environment Act*, *Public Health Act* and *Endangered Species and Ecosystems Act*) legislation and approval processes related to the river crossing alignment options under consideration in the preliminary design.

EGE notes that all information presented herein is based on knowledge of existing review processes, review of published guidance and legislation to obtain the most current information as of the date of this document, previous direct consultation with governmental agencies for other sanitary sewer river crossing projects in Winnipeg and information provided by Associated Engineering Alberta Ltd. (AE) with respect to the construction and alignment options for the Newton Force Main Red River Crossing project.

1.0 PROJECT DESCRIPTION

AE provided a brief project description which was used to review the federal and provincial regulatory processes. The information provided by AE and information from the City of Winnipeg in the Terms of Reference (ToR) for the project is summarized below.

The Newton Force Main Red River Crossing is a dual pipe crossing the Red River between the Fraser's Grove Chamber on the east side of the river and the Newton Flood Pumping Station on the west side. The dual crossing consists of a 350 mm high density polyethylene (HDPE) pipe and a 350 mm steel pipe that convey combined sewage flows from the Linden and Hawthorne Combined Sewer Districts (CSD) via the Linden and Hawthorne Pumping Stations to a secondary sewer on the west side of the Red River near the intersection of Scotia Street and Newton Avenue and the Newton Flood Pumping Station. The water then flows by gravity to the Main Street Interceptor and eventually to the North End Pollution Control Centre (NEPCC) for treatment.

The original steel pipe crossing was constructed in 1960 and the HDPE force main was constructed in 1978. The pipes were operated in parallel until they were physically separated in 1984. The steel force main was inspected in 2014 and the HDPE force main was inspected in 2018. The steel force main was considered to be in good condition; however, the HDPE force main was found to have evidence of excessive pipe deflections, poor material traits and documented leaks. It was recommended that the crossing be replaced in the very near term.

The preliminary design has identified two construction methods for installation of the Newton Force Main Red River Crossing, along with four alignment sub-options each consisting of a microtunnelling (MT) and horizontal directional drilling (HDD) option. Secondary containment with sleeve encasement is required for pressurized waterway crossings unless trenchless technologies are utilized for installation and the pipe is installed within the bedrock strata. At this time, the preliminary design options under consideration consist only of trenchless technologies with bedrock installation; therefore, there is no requirement for sleeve encasement as part of this project.

1. **Microtunnelling (MT)** - This option involves a horizontal earth boring installation of a 350 mm force main pipe. The force main pipe materials under consideration are HDPE, polyvinyl chloride (PVC) and a Kevlar flexible pressure lining tube. Traditional MT construction methods involve the use of a microtunnel boring machine (MTBM) operated between two excavated shafts. An 8 m diameter working shaft would be required on the east side entry point and a 5 m diameter reception shaft would be required on the west side exit point. A jacking frame would be set on the proposed line and grade and used to launch the MTBM into the ground, and then continues to advance by pushing pieces of sectional pipe behind the trailing unit. Four alignment options utilizing MT construction methods have been identified:
    - Option 1 - crossing from Kildonan Drive (east) to Scotia Street (west);
    - Option 4 - crossing from Fraser’s Grove Park (east) to Kildonan Park (west)
    - Option 5 - crossing from Kildonan Drive (east) to Kildonan Park (west); and
    - Option 7 - crossing from Fraser’s Grove Park (east) to Louis Greenburg Plaza (west).
2. **Horizontal Directional Drilling (HDD)** - This option involves the surface to surface installation of a new 350 mm force main pipe without the need for the deep excavation shafts used in microtunnelling. The HDD process includes drilling a pilot borehole, pre-ream and product pullback, and uses a drilling fluid to stabilize the borehole, transport soil cuttings out of the borehole and reduce friction during pullback. Excavations will be required to tie the new pipe into the existing system. Four alignment options utilizing HDD construction methods have been identified:
    - Option 2 - crossing from Kildonan Drive (east) to Scotia Street (west);
    - Option 3 - crossing from Fraser’s Grove Park (east) to Kildonan Park (west)
    - Option 6 - crossing from Kildonan Drive (east) to Kildonan Park (west); and
    - Option 8 - crossing from Fraser’s Grove Park (east) to Louis Greenburg Plaza (west).

The total length of the force main and the river crossing lengths for each alignment option are summarized in Table 1 below.

Table 1 - Total and River Crossing Lengths for Alignment Options

Option	Location	Construction Method	Total Length (m)	River Crossing Length (m)
Option 1	Kildonan Drive to Scotia Street	MT	369.0	218
Option 2		HDD	430.3	
Option 3	Fraser’s Grove Chamber to Kildonan Park	HDD	403.8	190
Option 4		MT	350.3	
Option 5	Kildonan Drive to Kildonan Park	MT	347.5	205
Option 6		HDD	417.3	
Option 7	Fraser’s Grove Chamber to Louis Greenburgh Plaza	MT	355.2	205
Option 8		HDD	355.2	

As noted in Table 1, the MT options generally have a smaller total length than the equivalent HDD option for the same alignment, with the exception of the option between Fraser's Grove Chamber and Louis Greenburgh Plaza, where the total lengths are the same. The two longest options are the HDD Option 2 (430.3 m) between Kildonan Drive and Scotia Street and HDD Option 6 (417.3 m) between Kildonan Drive and Kildonan Park. The two shortest options are the MT Option 5 (347.5 m) between Kildonan Drive and Kildonan Park and MT Option 4 (350.3 m) between Fraser's Grove Chamber and Kildonan Park.

The river crossing distances are the same for the MT and HDD options at each of the four proposed crossing alignments. The shortest river crossing alignment (190 m) is for Option 3 (HDD) and Option 4 (MT) located between Fraser's Grove Chamber and Kildonan Park. The longest river crossing alignment (218 m) is for Option 1 (MT) and Option 2 (HDD) located between Kildonan Drive and Scotia Street.

The MT options require a working shaft at the east side and a reception shaft at the west side of the crossing locations; however, the HDD options do not require these shafts.

2.0 PROVINCIAL ENVIRONMENTAL LICENSING AND APPROVALS

2.1 Manitoba Environmental Act

The *Environment Act* (C.C.S.M. c. E125) is administered by the Environmental Approvals Branch (EAB) within Manitoba Conservation and Climate. The *Environment Act* outlines the environmental assessment and licensing process for developments in Manitoba that have the potential for significant environmental and/or human health effects. Projects are described in the Classes of Development Regulation (MR 164/88 last amended with MR 39/2016), which lists the types of projects that are defined as developments. If a project is listed as a development (Class 1, 2 or 3), it must undergo environmental assessment and licensing, and receive an Environment Act License prior to construction and operation. The construction of a force main or a force main river crossing is not explicitly listed in the Classes of Development Regulation.

Wastewater treatment plants, which include combined sewer overflows and sanitary sewer overflows and wastewater collection systems, are listed as a Class 2 development. As such, the NEPCC has already been licensed under the *Environment Act* (see below).

The City of Winnipeg wastewater collection system is licensed under the *Environment Act* with Environment Act License 2684 RRR dated June 2009. Various Notice of Alteration (NOA) approvals have been issued as projects are completed at the NEPCC and with additional licenses obtained by the City of Winnipeg for various wastewater projects, including the South End Water Pollution Control Centre Expansion (SEWPCC) Environment Act License 2716RR dated April 2012 and referenced below.

Clause 19 of the NEPCC Environment Act License is pertinent to the Newton Force Main Red River Crossing project and indicates that:

> *19. The Licensee shall, from the date of issuance of this License, construct and maintain new pipes which transport wastewater via river crossings by taking the following actions:*
> *a) Submit a proposal for a leak detection program, for the approval of the Director, including leak detection technologies and monitoring practices to be applied;*
> *b) Construct and maintain a sleeve encasement around the piping;*
> *c) Implement the leak detection program, as approved by the Director;*
> *d) Continuously measure and record the data gathered by the leak detection program; and*
> *e) Repair and replace all portions of the piping where leaks are detected in accordance with Clause 5 of this License.*

The City of Winnipeg received approval from Manitoba Conservation and Climate via an NOA for Environment Act License 2716RR to permit the installation of new river crossings using trenchless construction methods (microtunnel boring methods or horizontal directional drilling) without installing any sleeve encasement around the pipe (as required by Clause 19 above and a similar Clause 20 in the SEWPCC licence) if the new crossing is installed in bedrock strata, which provides an additional barrier from the river. The updated Clause 19 and 20 text for Environment Act License 2716RR is provided below (and now excludes the requirement to provide sleeve encasement noted in the text of Clause 19 on the previous page).

19. The Licencee shall:

- *a) Continuously monitor and record the data gathered by the continuous hydrostatic integrity monitoring of all pipes which transport wastewater via river crossings;*
- *b) Monitor and record the systematic condition assessment of all pipes which transport wastewater via river crossings, and of the river bank stability and riverbed erosion at an interval proposed in the technical memorandum dated December 7, 2017 or otherwise approved by the Director;*
- *c) Repair and/or replace all portions of the piping where leaks are detected;*
- *d) Complete augered, tunneled or bored waterway crossings in accordance with the Fisheries and Oceans Canada Measures to Avoid Causing Harm to Fish and Fish Habitat, and notify the Environment Officer if a frac out occurs; and*
- *e) Where conditions allow, excavate endpoints for directional drilling operations a minimum of 30 m from the high water mark of third and higher order waterways, and a minimum of 15 m from the high water mark of first and second order waterways.*

20. The Licencee shall:

- *a) Submit to the Director of Approvals Branch by February 28 of the following year, for review and approval, an annual river crossing monitoring report including monitoring of hydrostatic integrity of all river crossings and of river bank stability; and*
- *b) Submit to the Director of Approvals Branch, for review and approval, a systematic condition assessment report for all pipelines which transport wastewater via river crossings, and a systematic monitoring report of riverbank stability and riverbed erosion within 60 days from the completion of the formal inspection carried out at a frequency as proposed in the technical memorandum dated December 7, 2017 or otherwise approved by the Director.*

Based on this information and previous discussions between EGE and EAB representatives regarding similar sanitary sewer crossings of the Red River, an Environment Act Proposal submission, including environmental assessment and licensing, is not required for the Newton Force Main Red River Crossing for the preliminary design options under consideration. The project can be constructed under the terms and conditions of the existing License 2684 RRR and License 2716RR, amended by the NOA, and by following the requirements of Clauses 19 and 20 above.

The project would not be considered an alteration to the existing License, since no works are anticipated that are not covered by Clause 19 and 20 above (i.e. the eight preliminary design options all involve a new pipe crossing of the river).

To remain in compliance with the Licenses, the City of Winnipeg is required to submit a plan for the selected option that meets the requirements of Clauses 19 and 20 above. In addition to the specific requirements in Clauses 19 and 20 for the details of the leak detection program and operation/maintenance procedures, this plan should include details of any environmental mitigation measures that are designed into the project.

Manitoba and Canada have harmonized their approach to environmental assessment through the Canada-Manitoba Agreement on Environmental Assessment Cooperation, for projects that require assessment in both jurisdictions. A discussion of the federal process is provided in Section 3.0 below.

2.2 Manitoba Public Health Act

Within Manitoba Conservation and Climate, the EAB also administers the portion of the *Public Health Act* (C.C.S.M. c. P210) related to wastewater collection systems, including construction, modification, upgrading or extension of gravity or low pressure sewer collection systems, force mains and lift stations. Approval is required for the development of a new wastewater collection system or the alteration of an existing wastewater collection system under Sections 6 and 7 of the Water Works, Sewerage and Sewage Disposal Regulation (MR 331/88R) and its Amendment, issued under the *Public Health Act*.

The EAB applies the Recommended Standards for Wastewater Facilities (commonly known as the Ten States Standards), which guide in the design of plans and specifications for wastewater collection and treatment facilities. In addition, the EAB also applies Ontario's Design Guidelines for Sewerage Works.

To meet the requirements of the *Public Health Act*, the project proponent must submit an Application for a Certificate of Approval for any wastewater collection system project. EGE has previously consulted with the EAB regarding whether the City of Winnipeg is exempt from the requirements under the *Public Health Act*. The EAB representative advised that the City of Winnipeg has not historically been required to obtain Certificates of Approval for wastewater collection system projects because engineers working for the City have taken responsibility to design the wastewater collection system.

Based on this information, a submission under the *Public Health Act* is not required for any of the preliminary design options under consideration.

2.3 Manitoba Endangered Species and Ecosystems Act

Within the Agriculture and Resource Development department, the Wildlife and Fisheries Branch (WFB) is responsible for the administration of the *Endangered Species and Ecosystems Act* (C.C.S.M. c. E111). Under the Act, it is:

- Unlawful to kill, injure, possess, disturb or interfere with listed species;
- Destroy, disturb or interfere with the habitat of listed species;
- Damage, destroy, obstruct or remove a natural resource on which the species depends for its life and propagation; and
- Endangered or threatened ecosystems are given certain protections.

Two listed species (threatened) may be present in the Red River at the project location: Mapleleaf mussel; and Red-headed woodpecker (see below).

Under the *Accord for the Protection of Species at Risk in Canada*, and accompanying Framework, a mechanism for cooperation between Canada and Manitoba was established to ensure that species at risk are protected.

To investigate the potential for rare, threated, protected or at-risk species to be located within the project area and potentially impacted by the project activities, EGE initiated a search of the Manitoba Conservation Data Centre Rare Species database. The search request was based on the area of the Red River between Mossdale Avenue (south limit) and Hawthorne Avenue (north limit), plus the river bank and upland areas within 250 m of the river.

A response was received from Mr. Colin Murray, Information Manager, Manitoba Conservation Data Centre, dated June 23, 2021. The information provided indicated that four species are extant within the study limits: Red-headed Woodpecker; Monarch; Yellow-banded Bumble Bee; and Mapleleaf Mussel. An additional three historical or possibly historical records were noted (these species have not been recently observed and may not be extant): Silver Lamprey; Chestnut Lamprey; and Yellow Rail. The extant species within a 250 m radius of the project area included the above four species extant within the project limits plus: Cooper's Hawk; and Barred Owl. The same three historical species (may not be extant) were reported for the 250 m radius area. Three additional species were extant for the general area, but with low locational accuracy: Chimney Swift; Eastern Wood-pewee; and Barn Swallow. Historical species reports with no recent observations (may not be extant) included: Manitoba Oakworm Moth; Burrowing Owl; and Gypsy Cuckoo Bumble Bee.

These records are summarized in Table 2 below. A copy of the search results from the Manitoba Conservation Data Centre is provided in the Attachments.

Table 2 - Manitoba Conservation Data Centre Species Information

Scientific Name	Common Name	Species Rank	ESEA	SARA	COSEWIC	Comment
Within the Site Limits						
Melanerpes erythrocephalus	Red-headed Woodpecker	S3B	Threatened	Threatened	Endangered	Verified extant (viability not assessed)
Danaus plexippus	Monarch	S3S4B		Special Concern	Endangered	Verified extant (viability not assessed)
Bombus terricola	Yellow-banded Bumble Bee	S3S5		Special Concern	Special Concern	Verified extant (viability not assessed)
Quadrula quadrula	Mapleleaf Mussel	S1	Endangered	Threatened	Threatened	Good or fair estimated viability
Ichthyomyzon unicuspis	Silver Lamprey	SU			Special Concern	Possibly historical
Ichthyomyzon castaneus	Chestnut Lamprey	S3		Special Concern		Possibly historical
Coturnicops noveboracensis	Yellow Rail	S3B		Special Concern	Special Concern	Historical
Within 250 m Radius of the Site Limits						
Accipiter cooperii	Cooper's Hawk	S4S5B				Good estimated viability
Melanerpes erythrocephalus	Red-headed Woodpecker	S3B	Threatened	Threatened	Endangered	Verified extant (viability not assessed)
Strix varia	Barred Owl	S3S4				Verified extant (viability not assessed)
Danaus plexippus	Monarch	S3S4B		Special Concern	Endangered	Verified extant (viability not assessed)
Bombus terricola	Yellow-banded Bumble Bee	S3S5		Special Concern	Special Concern	Verified extant (viability not assessed)
Quadrula quadrula	Mapleleaf Mussel	S1	Endangered	Threatened	Threatened	Good or fair estimated viability
Ichthyomyzon unicuspis	Silver Lamprey	SU			Special Concern	Possibly historical
Ichthyomyzon castaneus	Chestnut Lamprey	S3		Special Concern		Possibly historical
Coturnicops noveboracensis	Yellow Rail	S3B		Special Concern	Special Concern	Historical

Taxonomic Group	Scientific Name	Common Name	Species Rank	ESEA	SARA	COSEWIC
General Area Records with Low Locational Accuracy						
Chaetura pelagica	Chimney Swift	S2B	Threatened	Threatened	Threatened	Good or fair estimated viability
Contopus virens	Eastern Wood-pewee	S3B		Special Concern	Special Concern	Verified extant (viability not assessed)
Riparia riparia	Bank Swallow	S4B		Threatened	Threatened	Good or fair estimated viability
Anisota manitobensis	Manitoba Oakworm Moth	S2			Special Concern	Historical
Athene cunicularia	Burrowing Owl	S1B	Endangered	Endangered	Endangered	Historical
Bombus bohemicus	Gypsy Cuckoo Bumble Bee	S1		Endangered	Endangered	Historical

For the extant species listed in Table 2 above (shaded in green), all of the species rank values (using the NatureServe Canada Conservation Status Ranks) are Subnational (S) and include critically imperiled (1), imperiled (2), vulnerable (3), apparently secure (4) and secure (5) ranks with breeding populations (B) identified for migratory species.

For the identified extant species within the project area, the Mapleleaf Mussel has an endangered ranking under the Endangered Species and Ecosystems Act (ESEA) and the Red-headed Woodpecker has a threatened ranking, while the Monarch and Yellow-banded Bumble Bee are not ranked. The Mapleleaf Mussel and Red-headed Woodpecker have threatened rankings under the federal Species at Risk Act (SARA) while the Monarch and Yellow-banded Bumble Bee are ranked special concern. The Red-headed Woodpecker and Monarch have an endangered ranking by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the Mapleleaf Mussel has a threatened ranking and the Yellow-banded Bumble Bee is ranked special concern.

3.0 FEDERAL ENVIRONMENTAL LICENSING AND APPROVALS

3.1 Impact Assessment Act

On August 28, 2019, the *Impact Assessment Act* (S.C. 2019, c. 28 s. 1) came into force, creating the new Impact Assessment Agency of Canada and repealing the *Canadian Environmental Assessment Act,* 2012. The *Impact Assessment Act* (IAA) establishes the legislative basis for the federal practice of environmental impact assessment in most regions of Canada, including Manitoba. As noted in Section 2.1 above, Canada and Manitoba have signed a harmonization agreement to jointly conduct environmental assessments for projects that require assessment under both federal and provincial jurisdictions.

The IAA applies to projects that fall under two categories:

- Projects described in the Physical Activities Regulations (SOR/2019-285); and
- Projects designated by the Minister of Environment and Climate Change (the Minister).

For the first category, the project proponent is responsible for self-assessment to determine if their project is included under the Physical Activities Regulations. Based on EGE's review of the Regulation, the proposed project, including all of the preliminary design options under consideration, is not included in the list of physical activities that requires application of the IAA.

A project may still be designated under the IAA by the Minister if the Minster is of the opinion that carrying out the project may cause adverse environmental effects or that public concerns related to those effects warrant the designation. If a project is designated by the Minister, an environmental assessment under the IAA is required.

EGE has previously consulted with a representative of the Canadian Environmental Assessment Agency (now Impact Agency of Canada) regarding similar sanitary sewer river crossing projects in Winnipeg. The representative provided some context regarding how projects are designated by the Minister. To be designated, the public and/or another government agency would need to request the Minister review the project for designation. Typically, this would occur for large, complex projects in sensitive environmental locations, projects on Aboriginal lands and/or impact areas of federal jurisdiction. During these previous consultations, the representative considered it unlikely that the sanitary sewer crossing projects in Winnipeg would trigger such a request to the Minister.

Based on this information, it is not expected that the project, including any of the preliminary design options, will require environmental assessment under the IAA.

3.2 Fisheries Act

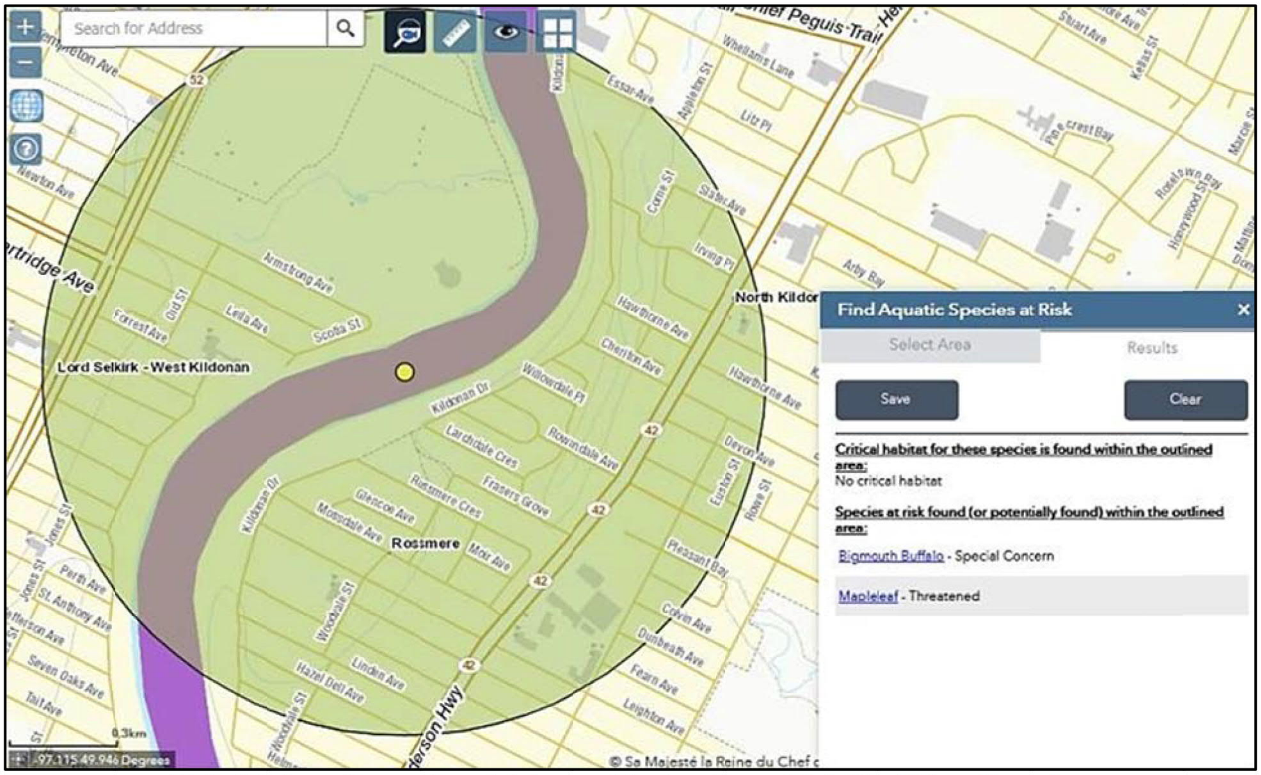
The *Fisheries Act* (R.S.C., 1985, c. F-14, last amended August 28, 2019) was substantially amended in 2019 to reinstate lost protections by providing comprehensive protection for all fish and fish habitat (not just recreational, commercial and Aboriginal fisheries as per the previous major amendment) and to restore the previous prohibition against the harmful alteration, disruption or destruction (HADD) of fish habitat and the death of fish other than by fishing. If HADD or the death of fish cannot be avoided for a proposed project, an authorization from the Minister of Fisheries and Oceans Canada is required, and can be obtained by submitting an Application for Authorization.

DFO has established the Fish and Fish Habitat Protection Program to ensure compliance with relevant provisions under the *Fisheries Act* and the *Species at Risk Act*. The Fish and Fish Habitat Protection Program reviews proposed works that may impact fish and fish habitat and a project proponent can submit plans for review and advice (called a Request for Review). The Program will identify the potential risks of the project to the conservation and protection of fish and fish habitat and work with the proponent to ensure that the impacts are managed in the best way possible. The Request for Review will also determine if an Application for Authorization is required. DFO also publishes codes of practice to avoid harm which should be considered by project proponents.

In summary, the *Fisheries Act* requires that projects avoid death to fish and harmful alteration, disruption or destruction of fish habitat unless authorized by the Minster. This applies to all fish and fish habitat. DFO requires project proponents to conduct a self-assessment for projects taking place in or near water. The proponent is responsible for:

- Understanding the impacts the project will likely have on fish and fish habitat;
- Taking measures to avoid and mitigate impacts to fish and fish habitat;
- Requesting an Authorization from the Minister and abiding by the conditions of the Authorization when it is not possible to avoid and mitigate project impacts on fish and fish habitat; and
- Ensuring compliance with all statutory instruments, including federal and provincial legislation.

EGE reviewed the species-at-risk and critical habitat mapping provided by DFO for a 1 km radius from the existing crossing location (which incorporates all of the eight alignment options). There is no critical habitat present within the 1 km area; however, two threatened or species of concern listed in the Species at Risk Act (SARA) are identified: Bigmouth Buffalo (fish); and Mapleleaf mussel (mollusc). The information is provided in the Attachment and shown graphically below.



Critical habitat for these species is found within the outlined area:
No critical habitat

Species at risk found (or potentially found) within the outlined area:

Bigmouth Buffalo - Special Concern

Mapleleaf - Threatened

Plate 01: Aquatic species at risk near Newton Force Main Red River Crossing.

Neither construction option (HDD or MT) requires instream or riverbank work; therefore, potential impacts to aquatic species and habitat would be limited to unplanned events related to the accidental release of drilling fluids due to hydraulic fracturing during HDD or an accidental tunnel collapse during MT. Upland construction activities are expected to occur at least 30 m from the high water level (HWL) in the Red River and are also unlikely to cause adverse aquatic impacts.

Based on these determinations, submission of a Request for Review to the Fish and Fish Habitat Protection Program is not formally required, but may be considered as a conservative step to document that there is not a requirement to submit an Application for Authorization and to obtain expert advice on possible mitigation measures that can be implemented during construction.

EGE notes that recent projects on the Red and Assiniboine Rivers in Winnipeg that included either instream work or riverbank stabilization work have required an Authorization from the Minister. Where these sites included the presence of Mapleleaf molluscs, DFO has also issued a Permit under Section 73 of SARA for the capture and relocation of Mapleleaf prior to the construction of riprap, outfalls and intake structures in the river. As noted earlier, since there is no instream, below water or riverbank work proposed, these Authorizations and Permits are not required.

A Request for Review is not an Authorization, which is required only if the project cannot avoid or mitigate HADD or death to fish, as defined above. An Application for Authorization; therefore, is only submitted after a project review has been completed by DFO following the Request for Review application and when that review finds that HADD or death to fish cannot be avoided.

An example of the Request for Review application form, which provides an indication of the information required for DFO to review a project, is included (see Attachments). If submitted, this form would require completion for each of the eight preliminary design options under consideration.

In summary, a Request for Review is not required, but can be completed for all project options, to document that an Authorization is not required, and to obtain specialist review and advice on the proposed environmental protection and mitigation measures included in the project design.

Environment and Climate Change Canada administers the Wastewater Systems Effluent Regulations (SOR/2012-139) under the *Fisheries Act*. These regulations relate to the release of wastewater effluent from the final point of discharge in the wastewater system; therefore, they do not apply directly to the construction and operation of the project. The Regulations also require reporting of CSO flow events per calendar year. This aspect would be applicable to the operation of the project. The CSO review team is responsible for managing the issues related to CSO in the City of Winnipeg.

3.3 Canadian Navigable Waters Protection Act

The *Canadian Navigable Waters Act* (R.S.C., 1985, c. N-22) (*CNWA*) is the result of the 2019 amendments to, and the renaming of, the *Navigation Protection Act* (*NPA*). Transport Canada (TC) has developed the Navigation Protection Program (NPP) to administer and enforce the *CNWA*. The main activities of the NPP are reviewing and authorizing works in navigable waters, managing obstructions in navigable waters and enforcing rules against dewatering or depositing materials into navigable waters.

To assist project proponents, the *CNWA* includes the List of Scheduled Waters (the Schedule), which defines scheduled and non-scheduled navigable waters. The Red River is included in the list of scheduled navigable waterways.

Project proponents who intend to construct, place, alter, rebuild, remove or decommission works that are in, on, over, under, through or across any navigable water may be required to apply for an Approval under the *CNWA*. Before applying for Approval, the proponent must determine if the work is categorized as a major or minor work and whether the work is located on a scheduled water.

Owners in the industry and government sectors who are planning major projects that are likely to have a significant impact on navigable waters are directed to a project review stream. The Major Works Order lists activities that may interfere with navigation and examples of major projects include water control structures, bridges, ferry cables, causeways and aquaculture facilities. The project, including all preliminary design options, does not qualify as a major project.

The Minor Works Order provides a listing of "designated works" under the *CNWA* that may proceed without approval or public notice, as long as they comply with legal requirements. It is the responsibility of the owner to assess the work and ensure it meets the criteria established for its class and that all legal requirements of the Minor Works Order are met. Examples of minor works include docks and aerial cables. Two relevant classes of work to the project are:

- Pipelines buried under the bed of navigable water that are built or placed using a trenched method if the navigable water crossing is less than 50 m; and
- Pipelines and power or communication cables attached to existing works that were approved under the Act.

Based on these classes of work, the MT and HDD options are not incorporated within the Minor Works Order and are not automatically excluded from review under the *CNWA*.

The schedule of waterways is used to identify navigable waters where project proponents may need to apply to TC under the *CNWA*. The owner of a work (other than a major or minor work) in, on, over, under, through or across any navigable water that is listed in the schedule, may proceed if:

- The work, or its construction, placement, alteration, rebuilding, removal or decommissioning would not interfere with navigation; and
- The owner deposits information and publishes a public notice before beginning the construction, placement, alteration, rebuilding, removal or decommissioning of the work.

Based on this guidance, the preliminary design options can be constructed without interfering with navigation and may proceed without applying for an Approval. Submission of an Application for Approval may be considered as a conservative step to formally document that there are no concerns with navigability and to meet the requirement to deposit information and obtain the forms required to provide public notice of the project. The proponent must create an account with the Navigation Protection Program External Submission Site to manage this process.

As noted, none of the eight options require works in the waterway that interfere with navigation and do not place new obstructions in the waterway; therefore, there are no differences in the alignment options with respect to navigation.

3.4 Additional Federal Legislation

The project will also require compliance with the *Species at Risk Act* (SARA) and the *Migratory Birds Convention Act* (MBCA). Compliance with these Acts is generally achieved through environmental assessment and development of suitable mitigation measures in conjunction with either a provincial or federal environmental assessment process. These two Acts do not require stand-alone submissions or approvals prior to construction, but do impose enforcement actions for project proponents that contravene the Acts.

As noted above, SARA listed aquatic species have been identified or are suspected to be present close to the project location and project design should include environmental protection and mitigation measures that protect these species, particularly for any upland works that have the potential to release contaminants, including sediment, into the river and for unplanned releases, including accidental releases due to hydraulic fracturing (HDD), tunnel collapse (MT) or pipe failure after installation.

4.0 SUMMARY

The table below summarizes the environmental approvals and licensing processes that are relevant to the Newton Force Main Red River Crossing.

Summary of Applicable Environmental Legislation and Project Options

Legislation	Kildonan Drive - Scotia Street		Fraser's Grove Chamber- Kildonan Park		Kildonan Drive - Kildonan Park		Fraser's Grove Chamber - Louis Greenburgh Plaza	
	Option 1 MT	Option 2 HDD	Option3 HDD	Option 4 MT	Option 5 MT	Option 6 HDD	Option 7 MT	Option 8 HDD
Provincial								
Manitoba Environment Act	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans	Applicable under existing license - submit plans
Manitoba Public Health Act	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Endangered Species and Ecosystems Act	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)
Federal								
Impact Assessment Act	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Fisheries Act	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review	Applicable (HADD) - consider Request for Review
Canadian Navigable Waters Act	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice	Applicable - submit plans, public notice
Species at Risk Act	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)
Migratory Birds Convention Act	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)	Applicable (general)

As shown in the table above, all of the preliminary design options have the same environmental approvals process under the relevant federal and provincial legislation and there is no significant difference amongst the preliminary design options in the level of effort required to comply with these requirements.

The HDD and MT options also have similar potential for adverse environmental effects. The HDD options have the risk of drilling fluid loss through hydro-fracture, which is not present in the MT options; however, the MT options require more excavation and disturbance near the river bank to install shafts on both sides of the river. Both options would carry the same risk for pipe failure after installation.

Additional site-specific information (likely to become available during preliminary and/or detailed design) and environmental impact assessment would be required to determine with greater certainty which installation method has the lowest overall potential for adverse environmental effects; however, based on this preliminary review, the differences are not expected to be significant. As a general concept, the HDD options are likely to generate a slightly smaller overall environmental impact, as there would be less ancillary disturbance to the upland areas (no shafts required).

The highest risk of accidental release (hydraulic fracture) or adverse environmental impact would be associated with the longest river crossing alignment option and the lowest risk would be associated with the shortest alignment option. The longest alignment is the Option 1/2 alignment between Kildonan Drive and Scotia Street. The shortest alignment is the Option 3/4 alignment between Fraser's Grove Chamber and Kildonan Park. The remaining two alignment options (Options 5/6 and 7/8) have the same river crossing distance and would be rated between the shortest and longest alignment options for the potential of accidental release or adverse environmental effect. The gap between the shortest crossing

(190 m) and longest crossing (218 m) is 28 m; and therefore, the differences between the options are unlikely to be significant.

A ranking of the options from least likely to have an adverse effect and requiring the least effort to obtain environmental approvals (ranked in order of preference from an environmental perspective) to most likely/greatest effort is as follows:

Most preferred

- Horizontal Directional Drilling (Option 3 - Fraser's Grove Chamber -Kildonan Park);
- Microtunnelling (Option 4 - Fraser's Grove Chamber -Kildonan Park);
- Horizontal Directional Drilling (Option 8 - Fraser's Grove Chamber - Louis Greenburgh Plaza)
- Horizontal Directional Drilling (Option 6 - Kildonan Drive-Kildonan Park);
- Microtunnelling (Option 5 - Kildonan Drive-Kildonan Park);
- Microtunnelling (Option 7 - Fraser's Grove Chamber - Louis Greenburgh Plaza);
- Horizontal Directional Drilling (Option 2 - Kildonan Drive-Scotia Street); and
- Microtunnelling (Option 1 - Kildonan Drive-Scotia Street).

Least preferred

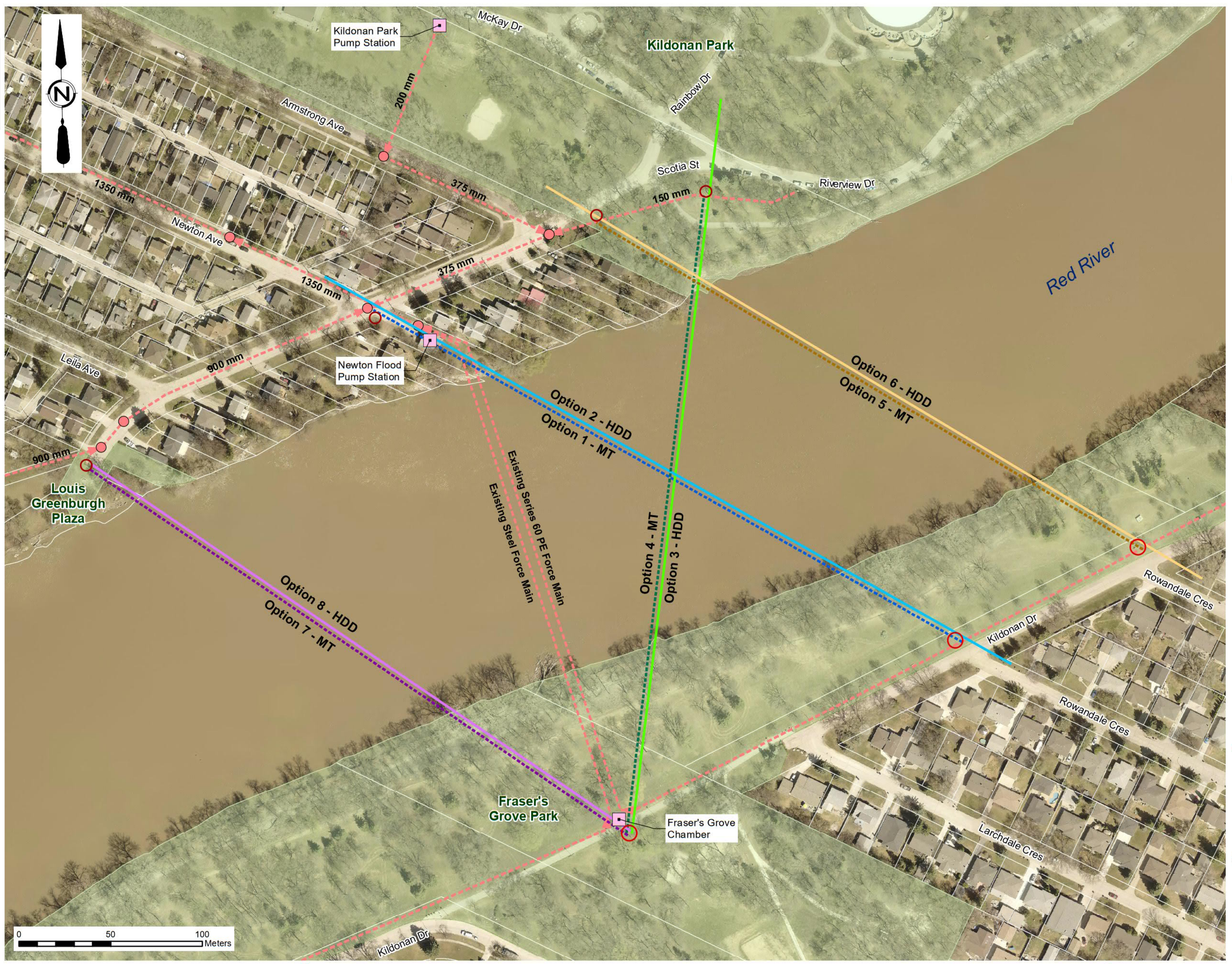
We trust that this meets your needs at this time. Should you have any questions or require any additional information please contact the undersigned at (204) 896-8264.

Sincerely,

EGE ENGINEERING LTD.

David Klassen, P.Geo.
Senior Geoscientist

DRAWINGS



Associated Engineering

BEST MANAGED COMPANIES
Platinum member

LEGEND:

┅	Option 1, MT
━	Option 2, HDD
━	Option 3, HDD
┅	Option 4, MT
┅	Option 5, MT
━	Option 6, HDD
┅	Option 7, MT
━	Option 8, HDD
○	5 m ø Reception Shaft
◯	8 m ø Working Shaft
⇢	Existing Sanitary Main

Winnipeg

FIGURE 1

CITY OF WINNIPEG
NEWTON FORCE MAIN RIVER CROSSING

FORCE MAIN ALIGNMENT OPTIONS

AE PROJECT No.	2021-4589
SCALE	1:2,000
APPROVED	
DATE	2021MAY31
REV	
DESCRIPTION	ISSUED FOR DRAFT

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

IF NOT 25 mm ADJUST SCALES
25 mm

SAVE DATE: 5/31/2021 3:34:01 PM SAVED BY:
DRAWING PATH: W:\edm_infrastructure\resources\GIS\200_Projects\2021\2021_4589_WPG_FM\nfm_fig_1_Overview.mxd
DATA SOURCE: ;

ATTACHMENTS

MANITOBA CONSERVATION DATA CENTRE

DATABASE SEARCH RESULTS

Subject: DR D Klassen EGE 20200609 Newton force main Red R crossing
From: "Murray, Colin (ARD)" <Colin.Murray@gov.mb.ca>
Date: 2021-06-23, 1:17 p.m.
To: David Klassen <david.klassen@mts.net>

Hi David
Thank you for your information request. I completed a search of the Manitoba Conservation Data Centre's (CDC) rare species database for your area of interest. This includes the primary location as defined in the request; and a 250 meter radius buffer from the footprint boundary. I note that the site was digitized manually from a submitted diagram. The imagery used to digitize the site showed what looked like flooding with some trees along the shore appearing submerged.

I am attaching a Microsoft Excel spreadsheet summarizing these occurrences. The spreadsheet includes scientific and common names, the provincial (SRank) rank for each species as well as the Manitoba Endangered Species and Ecosystem Act, and the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Species at Risk Act (SARA) designations. I'm also attaching an ESRI Shapefile depicting the site and 250 meter buffer.

Further information on this ranking system can be found on our website at: http://www.natureserve.org/conservation-tools/conservation-status-assessment.
These designations can be found at:
http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php,
https://www.cosewic.ca/index.php/en-ca/ and
http://www.sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1.

Manitoba's recommended setback distances can be found at:
https://www.gov.mb.ca/sd/pubs/conservation-data-centre/mbcdc_bird_setbacks.pdf.

The information provided in this letter is based on existing data known to the Manitoba Conservation Data Centre of the Wildlife and Fisheries Branch at the time of the request. These data are dependent on the research and observations of CDC staff and others who have shared their data, and reflect our current state of knowledge. An absence of data does not confirm the absence of any rare or endangered species. Many areas of the province have never been thoroughly surveyed, therefore, the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The information should not be regarded as a final statement on the occurrence of any species of concern, nor should it substitute for on-site surveys for species or environmental assessments. Also, because our Biotics database is continually updated and because information requests are evaluated by type of action, any given response is only appropriate for its respective request.

Please contact the Manitoba CDC for an update on this natural heritage information if more than six months passes before it is utilized.

Third party requests for products wholly or partially derived from our Biotics database must be approved by the Manitoba CDC before information is released. Once approved, the primary user will identify the Manitoba CDC as data contributors on any map or publication using data from our database, as the Manitoba Conservation Data Centre; Wildlife and Fisheries Branch, Manitoba Sustainable Development.

This letter is for information purposes only - it does not constitute consent or approval of the proposed project or activity, nor does it negate the need for any permits or approvals required by the Province of Manitoba.

We would be interested in receiving a copy of the results of any field surveys that you may undertake, to update our database with the most current knowledge of the area.

If you have any questions or require further information contact me directly at (204) 945-7760.

Colin

Reference screen clip:

Colin Murray
Information Manager- Manitoba Conservation Data Centre
Wildlife, Fisheries, and Resource Enforcement Branch
Manitoba Agriculture and Resource Development
200 Saulteaux Crescent, Winnipeg, MB R3J3W3
Colin.Murray@gov.mb.ca
T: 204-945-7760 F: 204-945-3077
Visit our website: Mhttps://www.manitoba.ca/fish-wildlife/cdc/index.html
Follow us on Twitter: twitter.com/MBGovAg
View our videos on YouTube: youtube.com/ManitobaAgriculture

-----Original Message-----
From: +WPG969 - Form Submissions (CEN) <noreply@gov.mb.ca>
Sent: June 9, 2021 8:22 AM
To: Murray, Colin (ARD) <Colin.Murray@gov.mb.ca>
Subject: WWW Form Submission

Below is the result of your feedback form. It was submitted by CDC Information Request () on Wednesday, June 9, 2021 at 08:21:41

DocumentID: Manitoba_Sustainable_Development

Project Title: Newton Force Main Red River Crossing

Date Needed: 2021/06/17

Name: David Klassen

Company/Organization: EGE Engineering Ltd.

Address: 100-399 Pembina Hwy

City: Winnipeg

Province/State: Manitoba

Phone: 204-896-8264

Email: david.klassen@mts.net

Project Description: Environmental review of alignment options for proposed wastewater (force main) crossing of the Red River. Environmental constraints will be used as input to feasibility study and selection of of a preferred alignment.

Information Requested: Species at risk - information related to rare, threatened or endangered species and species at risk, their habitat and status rank.

Please include the stretch of Red River shown plus the associated riparian areas along the river bank and any upland areas within 250 m of the river.

Format Requested: Word document, Excel spreadsheet, map as appropriate.

Please send via email.

Location: Project location is the Red River between Mossdale Avenue at the south limit and Hawthorne Avenue at the north limit.

The centre of the project location is:
14 U 636177E 5533647N

A site plan will be provided via email to Colin Murray.

action: Submit

Attachments:

DR D Klassen EGE 20200609 Newton force main Red R crossing.xlsx	14.3 KB
Newton force main Red R crossing area and b250m.zip	13.8 KB

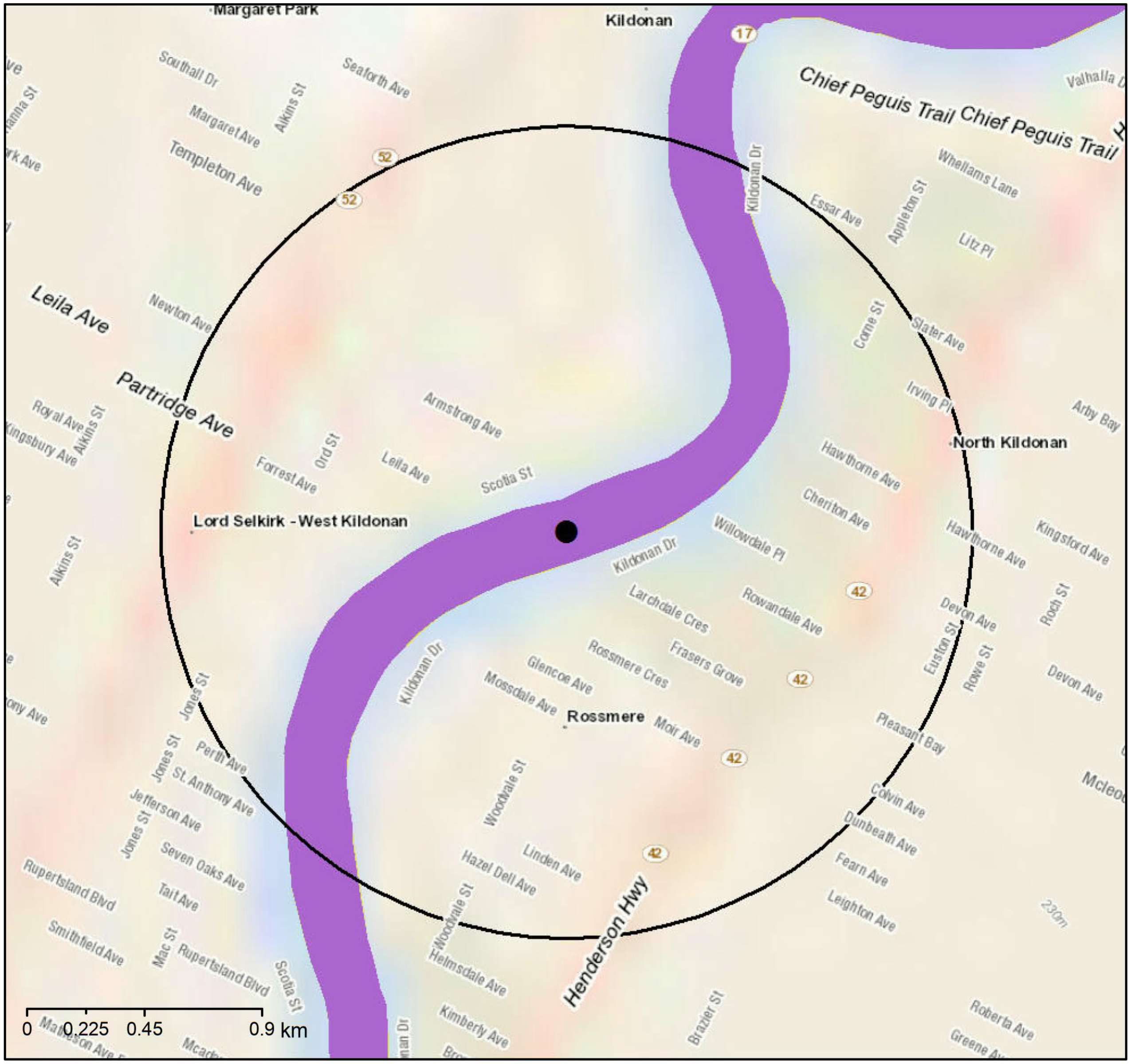
SEARCH CRITERIA	SITE	SCINAME	COMNAME	S_RANK	ESEA	SARA	COSEWIC	FIRSTOBS	LASTOBS	EO_RANK	REPACC
Within	Site	Ichthyomyzon unicuspis	Silver Lamprey	SU			Special Concern	1960-61Wtr	1974-06-14	H? - Possibly historical	Low
Within	Site	Ichthyomyzon castaneus	Chestnut Lamprey	S3		Special Concern		1933-06-06	1974-10-24	H? - Possibly historical	Low
Within	Site	Coturnicops noveboracensis	Yellow Rail	S3B		Special Concern	Special Concern	1945-09-02	1945-09-02	H - Historical	Low
Within	Site	Melanerpes erythrocephalus	Red-headed Woodpecker	S3B	Threatened	Threatened	Endangered	1986-07-19	2011-05-31	E - Verified extant (viability not assessed)	Medium
Within	Site	Danaus plexippus	Monarch	S3S4B		Special Concern	Endangered	1986-09-02	2015-05-22	E - Verified extant (viability not assessed)	Low
Within	Site	Bombus terricola	Yellow-banded Bumble Bee	S3S5		Special Concern	Special Concern	1922-04-28	2018-07-26	E - Verified extant (viability not assessed)	Low
Within	Site	Quadrula quadrula	Mapleleaf Mussel	S1	Endangered	Threatened	Threatened	1991-09-28	2017-07-21	BC - Good or fair estimated viability	High
Within 250m radius of site boundary	Site	Ichthyomyzon unicuspis	Silver Lamprey	SU			Special Concern	1960-61Wtr	1974-06-14	H? - Possibly historical	Low
Within 250m radius of site boundary	Site	Ichthyomyzon castaneus	Chestnut Lamprey	S3		Special Concern		1933-06-06	1974-10-24	H? - Possibly historical	Low
Within 250m radius of site boundary	Site	Coturnicops noveboracensis	Yellow Rail	S3B		Special Concern	Special Concern	1945-09-02	1945-09-02	H - Historical	Low
Within 250m radius of site boundary	Site	Accipiter cooperii	Cooper's Hawk	S4S5B				1997-07-08	1997-07-24	B - Good estimated viability	
Within 250m radius of site boundary	Site	Melanerpes erythrocephalus	Red-headed Woodpecker	S3B	Threatened	Threatened	Endangered	1986-07-19	2011-05-31	E - Verified extant (viability not assessed)	Medium
Within 250m radius of site boundary	Site	Strix varia	Barred Owl	S3S4						E - Verified extant (viability not assessed)	Medium
Within 250m radius of site boundary	Site	Danaus plexippus	Monarch	S3S4B		Special Concern	Endangered	1986-09-02	2015-05-22	E - Verified extant (viability not assessed)	Low
Within 250m radius of site boundary	Site	Bombus terricola	Yellow-banded Bumble Bee	S3S5		Special Concern	Special Concern	1922-04-28	2018-07-26	E - Verified extant (viability not assessed)	Low
Within 250m radius of site boundary	Site	Quadrula quadrula	Mapleleaf Mussel	S1	Endangered	Threatened	Threatened	1991-09-28	2017-07-21	BC - Good or fair estimated viability	High
Records in general area	Site	Anisota manitobensis	Manitoba Oakworm Moth	S2			Special Concern	Jul-54	Jul-54	H - Historical	Very Low
Records in general area	Site	Athene cunicularia	Burrowing Owl	S1B	Endangered	Endangered	Endangered	1926-07-31	1926-07-31	H - Historical	Low
Records in general area	Site	Bombus bohemicus	Gypsy Cuckoo Bumble Bee	S1		Endangered	Endangered	1925-06-13	1988-06-06	H - Historical	Very Low
Records in general area	Site	Chaetura pelagica	Chimney Swift	S2B	Threatened	Threatened	Threatened	1921-06-26	2015-07-15	BC - Good or fair estimated viability	High
Records in general area	Site	Contopus virens	Eastern Wood-pewee	S3B		Special Concern	Special Concern	2015-06-07	2015-06-07	E - Verified extant (viability not assessed)	Medium
Records in general area	Site	Riparia riparia	Bank Swallow	S4B		Threatened	Threatened	2010-07-01	2010-07-01	BC - Good or fair estimated viability	Medium

DFO SPECIES AT RISK AND CRITICAL HABITAT MAPPING

Fisheries and Oceans Canada / Pêches et Océans Canada

Aquatic Species at Risk Report

Canada



One or more aquatic species listed under the Species at Risk Act are found (or potentially found) within the coloured areas.

- 🟥 Critical Habitat
- 🟪 Extirpated, Endangered, or Threatened
- 🟨 Special Concern

How to use this information:

1. The map and species list are intended to provide a general overview of aquatic species at risk and their critical habitat that may occur within the mapped area.

2. To assess your project go to: www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html

If you encounter an aquatic species at risk in an area that is not currently mapped, please notify your regional Fisheries Protection Program office to ensure that you are compliant with the Species at Risk Act.
The official source of information for species at risk is the Species at Risk Public Registry www.sararegistry.gc.ca

To protect fish and fish habitat, including aquatic species at risk, their residences, and their critical habitat, efforts should be made to avoid, mitigate and/or offset harm. Following the measures to avoid harm will help you comply with the Fisheries Act and the Species at Risk Act.

Critical habitat for these species is found within the outlined area

Critical habitat is identified in recovery strategies or action plans for species listed under Schedule 1 of the Species at Risk Act as extirpated, endangered or threatened.

Name	Where Found	Species Status
	No critical habitat	

Species found (or potentially found) within the outlined area

Name	Where Found	Species Status
Bigmouth Buffalo - Saskatchewan - Nelson River	Assiniboine River (Rivière)	Special Concern
Mapleleaf - Saskatchewan - Nelson	Red River/Rivière Rouge	Threatened

DFO REQUEST FOR REVIEW FORM

Request for Review

Please note that Guidance on Submitting a Request for Review is available at the end of this form. This guidance explains the requirements for a Request for Review by DFO under the fish and fish habitat protection provisions of the *Fisheries Act*. All information requested must be provided. If you attach documents to your application with additional information, you must still provide appropriate summaries in the spaces provided on the application document or your application will be considered incomplete.

A) Contact information

Name of Business/Company:	Select additional contact: Contractor/Agency/Consultant *(if applicable):*
Name of Proponent:	
Mailing address:	Mailing address:
City/Town:	City/Town:
Province/Territory:	Province/Territory:
Postal Code:	Postal Code:
Tel. No. :	Tel. No. :
Fax No.:	Fax No.:
Email:	Email:

Is the Proponent the main/primary contact? ○ Yes ○ No

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

If no, please enter information for the primary contact or any additional contact.

B) Description of Project

If your project has a title, please provide it.

Is the project in response to an emergency circumstance*? ○ Yes ○ No

Does your project involve work in water? ○ Yes ○ No

If yes, is the work below the High Water Mark*? ○ Yes ○ No

What are you planning to do? Briefly describe all project components you are proposing in or near water.

How are you planning to do it? Briefly describe the construction materials, methods and equipment that you plan to use.

Include a site plan (figure/drawing) showing all project components in and near water.

Are details attached? ○ Yes ○ No

Identify which work categories apply to your project.

- ☐ Aquaculture Operations
- ☐ Aquatic Vegetation Removal
- ☐ Beaches
- ☐ Berms
- ☐ Blasting / Explosives
- ☐ Boat Houses
- ☐ Boat Launches / Ramps
- ☐ Breakwaters
- ☐ Bridges
- ☐ Cable Crossings
- ☐ Causeways
- ☐ Culverts
- ☐ Dams
- ☐ Dewatering / Pumping
- ☐ Docks
- ☐ Dredging / Excavation
- ☐ Dykes
- ☐ Log Handling / Dumps
- ☐ Log Removal
- ☐ Moorings
- ☐ Open Water Disposal
- ☐ Piers
- ☐ Riparian Vegetation Removal
- ☐ Seismic Work
- ☐ Shoreline Protection
- ☐ Stormwater Management Facilities
- ☐ Surface Water Taking
- ☐ Tailings Impoundment Areas
- ☐ Temporary Structures
- ☐ Turbines
- ☐ Water Control Structures
- ☐ Water Intakes / Fish Screens
- ☐ Water Outfalls
- ☐ Watercourse Realignment

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

☐ Fishways / Ladders
☐ Flow Modification (hydro)
☐ Groundwater Extraction
☐ Groynes
☐ Habitat Restoration
☐ Ice Bridges
☐ Weirs
☐ Wharves
☐ Wind Power Structures
☐ Other   Please Specify

Was your project submitted for review to another federal or provincial department or agency? ○ Yes ○ No

If yes, indicate to whom and associated file number(s).

C) Location of the Project

Coordinates of the proposed project   Latitude ______ N   Longitude ______ W

OR   UTM zone ______ ; ______ Easting

______ Northing

Include a map clearly indicating the location of the project as well as surrounding features.

Name of Nearest Community (City, Town, Village):

Municipality, District, Township, County, Province:

Name of watershed (if applicable):

Name of watercourse(s) or waterbody(ies) near the proposed project:

Provide detailed directions to access the project site:

D) Description of the Aquatic Environment

Identify the predominant type of aquatic habitat where the project will take place.

○ Estuary (Estuarine)
○ Lake (Lacustrine)
○ On the bank/shore at the interface between land and water (Riparian)
○ River or stream (Riverine)
○ Salt water (Marine)
○ Wetlands (Palustrine)

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

Provide a detailed description of biological and physical characteristics of the proposed project site. This description should include information on aquatic species at risk* (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html), their residence* and critical habitat* if found in the area. An overview of the distribution of aquatic species at risk and the presence of their critical habitat within Canadian waters can be found here http://dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html

Include representative photos of affected area (including upstream and downstream area) and clearly identify the location of the project.

E) Potential Effects of the Proposed Project

Have you reviewed the Pathways of Effects (PoE) diagrams (http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html) that describe the type of cause-effect relationships that apply to your project?

○ Yes ○ No

If yes, select the PoEs that apply to your project.

☐ Addition or removal of aquatic vegetation
☐ Change in timing, duration and frequency of flow
☐ Cleaning or maintenance of bridges or other structures
☐ Dredging
☐ Excavation
☐ Fish passage issues
☐ Grading
☐ Marine seismic surveys
☐ Organic debris management
☐ Placement of marine finfish aquaculture site
☐ Placement of material or structures in water
☐ Riparian Planting
☐ Streamside livestock grazing
☐ Structure removal
☐ Use of explosives
☐ Use of industrial equipment
☐ Vegetation Clearing
☐ Wastewater management
☐ Water extraction

Will there be changes (i.e., alteration) in the fish habitat*? ○ Yes ○ No ○ Unknown

If yes, provide a description.

Is there likely to be a harmful alteration, disruption or destruction of habitat used by fish? ○ Yes ○ No ○ Unknown

Is there likely to be destruction or loss of habitat used by fish? ○ Yes ○ No ○ Unknown

What is the footprint (area in square meters) of your project that will take place below the high water mark*?

Is your project likely to change water flows or water levels? ○ Yes ○ No ○ Unknown

If your project includes withdrawing water, provide source, volume, rate and duration.

If your project includes a water control structure, provide the % of flow reduction.

*All definitions are provided in Section G of the Guidance on Submitting a Request for Review

If your project includes discharge of water, provide source, volume and rate.

Will your project cause death of fish? ○ Yes ○ No ○ Unknown

If yes, how many fish will be killed (for multi-year project, provide average)? What species and lifestages?

What is the time frame of your project?

The construction will start on MM/DD/YYYY and end by MM/DD/YYYY

If applicable, the operation will start on MM/DD/YYYY and end by MM/DD/YYYY

If applicable, provide schedule for the maintenance

If applicable, provide schedule for decommissioning

Are there additional effects to fish and fish habitat that will occur outside of the time periods identified above? ○ Yes ○ No

(If yes, provide details)

Can you follow appropriate Timing Windows (http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/index-eng.html) for all your project activities below the High Water Mark*? ○ Yes ○ No

(If no, provide explanations.)

Have you considered and incorporated all options for redesigning and relocating your project to avoid negative effects to fish and fish habitat?

○ Yes ○ No

If yes, describe.

Have you consulted DFO's Fish and Fish Habitat Protection Measures Habitat (https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html) to determine which measures apply to your project? ○ Yes ○ No

Will you be incorporating applicable measures into your project? ○ Yes ○ No

If yes, identify which ones. If No, identify which ones and provide reasons.

Have you considered whether DFO standards and codes of practice apply to your project? ○ No ○ Yes

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

If Yes, include a list.

Have you considered other avoidance and mitigation measures? ○ No ○ Yes

If Yes, include a list.

Are there any relevant measures that you are unable to incorporate? ○ Yes ○ No

(If yes, identify which ones.)

What harmful effects to fish and fish habitat do you foresee after taking into account the avoidance and mitigation measures described above?

Do these include effects on aquatic species at risk*? ○ Yes ○ No

If yes, please describe, including how many individuals will be harmed, harassed, or otherwise affected by the project, and how?

Do these include effects on areas identified as their residence or critical habitat? ○ Yes ○ No

If yes, please describe

Are there any aquatic invasive species in the vicinity of your project area? ○ Yes ○ No

(If yes, identify which ones.)

Does your project aim to, or will it be likely to, effect any of these aquatic invasive species? ○ Yes ○ No

If yes, how?

All definitions are provided in Section G of the Guidance on Submitting a Request for Review

F) Signature

I, ☐ (print name) certify that the information given on this form is to the best of my knowledge, correct and completed.

Signature

MM/DD/YYYY
Date

Information about the above-noted proposed work or undertaking is collected by DFO under the authority of the *Fisheries Act* for the purpose of administering the Fish and Fish Habitat protection provisions of the *Fisheries Act*. Personal information will be protected under the provisions of the *Privacy Act* and will be stored in the Personal Information Bank DFO-PPU-680. Under the *Privacy Act*, Individuals have a right to, and on request shall be given access to any personal information about them contained in a personal information bank. Instructions for obtaining personal information are contained in the Government of Canada's Info Source publications available at www.infosource.gc.ca or in Government of Canada offices. Information other than "personal" information may be accessible or protected as required by the provision of the *Access to Information Act*.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

Guidance on Submitting a Request for Review

This document explains the requirements for a Request for Review by DFO under the fish and fish habitat protection provisions of the *Fisheries Act*. To determine whether you should request a review, visit DFO's Projects Near Water webpage (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).

Incomplete Requests for Review will be returned to the applicant without review by DFO. All information requested must be provided. If you attach documents to your application with additional information, you must still provide appropriate summaries in the spaces provided on the application document or your application will be considered incomplete.

Section A: Contact Information

Provide the full legal name of the proponent and primary mailing address for the proponent. When the proponent is a company, identify the full legal registered name of the company.

If applicable, also provide the contact information of the duly authorized representative of the proponent. Please note that a copy of correspondence to Contractor/Agency/Consultant will also be sent to the Proponent.

Section B: Description of Project

This information is meant to provide background about the proposed project. All components of the proposed project in or near water, must be described.

Proponents should provide information about all appropriate phases of the project, i.e., the construction, operation, maintenance and closure phases for the proposed project.

All details about the construction methods to be used, associated infrastructure, permanent and temporary structure, structure type (e.g. corrugated steel pipe vs box culvert), structures dimension, building materials to be used, machinery and equipment to be used must also be provided. For example, the construction of p**ermanent structures** may require the construction of temporary structures such as temporary dikes, in conjunction with other associated activities like the withdrawal of water, land clearing, excavation, grading, infilling, blasting, dredging, installing structures, draining or removing debris from water. Similarly, the equipment and materials to be used may include hand tools, backhoes, gravel, blocks or armor stone (provide the average diameter), concrete (indicate if pre-cast or poured in-water), steel beams or wood.

When physical structures in or near water are proposed, provide the plan and specifications of those works which would require a review.

Section C: Location of the Project

The purpose for this information is to describe and illustrate the location of the proposed project, and to provide geographical and spatial context. The information should also facilitate an understanding of how the project will be situated in relation to existing structures.

The details to be provided must include:

- ➢ Coordinates of the project (e.g., Latitude and Longitude or Universal Transverse Mercator Grid coordinates);
- ➢ A map(s), site plan, or diagrams indicating the high water mark and the location, size and nature of proposed and existing structures (e.g., floating or fixed), landmarks and proposed activities. In a marine setting, it may be helpful to depict the approximate location of the proposed development on a nautical chart or showing the relation of the site to sea marks or other navigational aids. These plans, maps or diagrams should be at an appropriate scale to help determine the relative size of the proposed structures and activities, the proximity to the watercourse or waterbody and the distance from existing structures;
- ➢ The community nearest to the location of the proposal as means to provide a general reference point. When possible, proponents should use geographical names recognized by the Geographical Names Board of Canada (http://www.nrcan.gc.ca/earth-sciences/geography-boundary/geographical-name/11680).
- ➢ If available, provide aerial photographs or satellite imagery of the water source(s) and waterbody(ies);
- ➢ Names of the watershed(s), water source(s) and/or waterbody(ies) likely to be affected by the proposal; and
- ➢ Brief directions to access the proposed project site.

Section D: Description of the Aquatic Environment

Proponents must describe the environmental context and aquatic resources present at the proposed site. The information must identify the current state of the fish and fish habitat prior to the carrying on of the project.

It is important to include information about the fish species present, the biological, chemical, physical features present (habitat characteristics), and the fish life-cycle functions (fish characteristics).

The spatial scope for assessing fish and fish habitat should encompass the direct physical footprint of the project, and the upstream and downstream areas affected.

As an example, the following is a non-exhaustive and non-prescriptive list of some common attributes which may characterize the aquatic environment:

- Type of water source or watercourse (groundwater, river, lake, marine, estuary, etc.);
- Characteristics of the water source or waterbody could include:
  - Substrate characterization - describe the types of substrate (e.g., bedrock, boulder, cobble, gravel etc.), identify the predominant substrate type (e.g., 80% cobble, 20% gravel etc.) and provide maps of the substrate;
  - Aquatic and riparian vegetation characterization - identify the prevalent types of vegetation (e.g. rooted, submerged, emergent, etc.), identify the relative abundance of the vegetation (e.g., 10% cattails, 80% grass, 10% sedge) , indicate the predominant vegetation (e.g., by species or types) and identify the vegetation densities (e.g., type of vegetation/ area);
  - Flow characterization - specify if the flow is controlled or if it is natural, identify if the flow is permanent or intermittent, identify the current and tide (marine environment) etc.;
  - Physical waterbody characterization - identify the average depth of water for water bodies, identify bathymetry of water bodies, provide bathymetric maps where available, channel width (determine the width of the channel from the high water mark), slope ;
  - Water quality characterization - (e.g., annual or average pH, salinity, alkalinity, total dissolved solids, turbidity, temperature etc.);
  - Biological water quality characterization - (e.g., benthic macro-invertebrates, zooplankton, phytoplankton, etc.)
- Fish species characterization - identify the fish species (including molluscs, crustaceans, etc.) known or suspected to be in the area, predator prey relationships etc. Identify what source of information was used to determine the presence of fish in that area; and
- Estimate the fish abundance - estimate the number of fish present, estimate the year class for each species etc.

There are many different methods and attributes available to characterize fish and fish habitat. Proponents must describe all sources of information used, all fish and environment sampling techniques used, all modelling techniques used and all other approaches used to define the fish and fish habitat. Proponents are encouraged to use recognized fisheries inventory methods such as those approved by DFO or provinces and territories, and/or scientifically defensible methodologies and techniques whenever possible.

Whenever possible, proponents should support descriptions of the aquatic environment with the use of detailed drawings, such as plans or maps and photographs of the habitat features. In an offshore marine setting, photos may not be useful to depict the proposed development site. Instead describe and/or sketch the specific features of the sea floor which may include the presence of submarine features such as canyons, cliffs, caverns, etc.

Section E: Potential Effects of the Proposed Project

The objective of this section is to identify all anticipated effects on fish and fish habitat likely to be caused by the project. Proponents should consider all mitigation or avoidance techniques.

The description must include qualitative and/or quantitative information about the predicted/potential effects to fish species and fish habitat. Some examples of likely effects may include mortality to fish, area of habitat loss, change to flow, changes to habitat function, reduction in prey availability etc.

The spatial scope of the aquatic effects assessment would include the direct physical "footprint" of the proposed project, and any areas indirectly affected, such as downstream or upstream areas. The footprint of each component of the project below the higher water mark should be provided individually. This may also include areas in or on the water, on the shoreline, coast or bank(s) (i.e., in the riparian zone).

The assessment must include the following attributes:

- Identification of all fish species affected by the proposed project as well as their life stages (e.g., juvenile, yearling, adult, etc.);
- Identification of the type of fish habitat affected (e.g., spawning habitat - gravel and cobble, feeding and rearing areas - side channel slough, small tributaries, etc.), estimate of the affected area (e.g., square meters or hectares);
- Description of the effect (e.g., mortality to fish from entrapment, delayed migration of spawning adults, reduction in prey availability, etc.)
- Probability of the effect - this is the likelihood of the effect occurring (e.g., probability of fish strike from turbines for specific fish sizes, probability of sediment plume within a distance from source, etc., or qualitative assessment: low, medium, high)
- Magnitude of the effect - this is the intensity or severity of the effect (e.g., total number of fish affected, or qualitatively assessment: low, medium, high).
- Geographic extent of the effect - this is the spatial range of the effect (e.g., localized to 100m from the work, channel reach or lake region, entire watershed etc.); and
- Duration of the effect - this is the temporal period for which the effect will persist (e.g., duration of delay to fish migration in hours, days, months or years).

The information to be provided must also describe the methods and techniques used to conduct the assessment. As much as possible, methods and techniques used should be scientifically defensible.

The schedule should, at minimum, identify the proposed start and end dates for carrying out each proposed activity, and where applicable, identify the respective phase of the proposal; i.e., the construction, operation, maintenance and closure phases. In some cases, in order to provide additional context, it may be relevant to identify other information such as the expected life span of permanent and temporary structures.

Proponents must provide comprehensive information about all available measures that are proposed to avoid or mitigate potential harmful alteration, disruption or destruction of fish habitat, or death of fish (e.g., in standards or codes of practice).

Residual harmful impacts that remain after the application of such measures.

It is important to clearly describe and quantify harmful impacts because DFO will use this information as part of its decision making on whether harmful alteration, disruption or destruction of fish habitat or death of fish is likely and an authorization is required under subsection 35(2)(*b*) or 34.4(2)(b) of the *Fisheries Act*.

Section F: Submission and Signature

The proponent must sign their application. A signed original of the Request for Review must be provided to the regional DFO office (http://www.dfo-mpo.gc.ca/pnw-ppe/contact-eng.html), even if an electronic copy was sent by email. Should the review of your project indicate that harmful alteration, disruption or destruction of fish habitat or death of fish is likely, the information provided in the Request for Review document can be referred to in the subsequent application for an authorization under Paragraphs 35(2)(*b*) or 34.4 of the *Fisheries Act*.

Section G: Definitions

Aquatic Species at Risk: an extirpated, endangered, threatened species, or a species of special concern. A non-exhaustive list of aquatic species at risk found in Canadian waters can be found here (http://www.dfo-mpo.gc.ca/species-especes/sara-lep/identify-eng.html).

Aquatic Species at Risk Critical Habitat
the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species critical habitat in the recovery strategy or in an action plan for the species.

Aquatic Species at Risk Residence: the specific dwelling place, such as a den, nest or other similar area or a place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating.

Aquatic invasive species: are fish, invertebrate or plant species that have been introduced into a new aquatic environment, outside of their natural range. Once introduced, aquatic invasive species populations can grow quickly because they don't have natural predators in their new environment. As a result, they can outcompete and harm native species. They can even alter habitats to make them inhospitable for the native species. A non-exhaustive list of aquatic invasive species can be found here (http://www.dfo-mpo.gc.ca/species-especes/ais-eae/identify-eng.html).

Emergency circumstance: If your project must be conducted in response to an emergency, you may apply for an Emergency Authorization. The emergency situations are:

- The project is required as a matter of national security
- The project is being conducted in response to a national emergency where special temporary measures are being taken under the federal *Emergencies Act*
- The project is required to address an emergency that poses a risk to public health or safety or to the environment or property.

Fish habitat: means habitat that can directly or indirectly support life processes. This includes but is not limited to: spawning grounds, nursery, rearing, food supply and migration areas.

Harmful alteration, disruption or destruction means any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat's capacity to support one or more life processes of fish.

High Water Mark: The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to leave a mark on the land.

**All definitions are provided in Section G of the Guidance on Submitting a Request for Review*

APPENDIX D - WORKSHOP ATTENDEES

SIGN-IN SHEET

Project Name: Newton Force Main Red River Crossing – Preliminary Design

Project No.: 2021-4589

Meeting Name: Preliminary Design Workshops

Meeting Dates: June 16, 2021
June 22, 2021

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*Absent from the June 22, 2021 workshop.

APPENDIX E - GEOTECHNICAL INVESTIGATION REPORT

KGS
GROUP

ASSOCIATED ENGINEERING LTD.

Newton Ave Forcemain Red River Crossing 2021 Preliminary Geotechnical Investigation Report

Final:
0

KGS Group Project:
21-3913-001

Date:
October 28, 2021

Prepared by:

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STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This report has been prepared for Associated Engineering Ltd. in accordance with the agreement between KGS Group and Associated Engineering Ltd. (the “Agreement”). This report represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by Associated Engineering Ltd. and unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group’s work.

Third Party Use of Report

Any use a third party makes of this report or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at the site at the time of drilling. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

1.0 INTRODUCTION

Associated Engineering (AE) was retained by the City of Winnipeg to complete the preliminary design for the Newton Ave Force Main Red River crossing replacement. KGS Group provided the geotechnical engineering support for the work.

The overall objective of the project is to complete the preliminary engineering required to create and evaluate options for the replacement of the dual 350 mm force main crossing between Fraser's Grove Park and Newton Avenue / Scotia Street. The geotechnical investigation program was designed to determine the riverbank stratigraphy and evaluate the competency of the underlying bedrock including strength, hardness, extent of fracture, water bearing potential and rock quality designation index. This approach will assist in evaluating the remedial alternatives and suitability of the bedrock for the horizontal directional drilling (HDD) and microtunneling options to facilitate the preliminary design of crossing.

2.0 REGIONAL GEOLOGICAL SETTING

The geology in Winnipeg generally consists of carbonate sedimentary bedrock overlaying Precambrian era granite and gneiss. The sedimentary rock consists of alternating layers of limestone, and dolomite and to a lesser extent shale. The proposed pipeline is located within the limestone Selkirk member of the Red River Formation.

The surface of the bedrock is usually highly fractured and disturbed, often mixed with gravels and sands. Geological maps for Winnipeg indicate karst topography caused from dissolution of the soluble rock, and a heavily fractured upper bedrock layer. The karst topography is typically infilled with mixtures of silt, sand and gravel till soils.

During the last glacial advance and retreat, Winnipeg’s glacial till was deposited by ice masses. Glaciolacustrine deposits suspended in glacial lakes confined by ice masses settled to overlie the tills. Additional information on the regional geology can be found in the Geological Engineering Report for Urban Development of Winnipeg, University of Manitoba.

3.0 2021 FIELD INVESTIGATION PROGRAM

The geotechnical field investigation program was developed to meet the objectives stated in Section 1.0 of this report.

3.1 Test Hole Drilling and Soil Sampling

The test hole drilling and sampling program was completed by KGS Group from August 4 to 12, 2021. A total of four (4) test holes were advanced into bedrock to investigate the subsurface stratigraphic conditions and evaluate the suitability of the bedrock for Horizontal Directional Drilling (HDD), one (1) on the west side of the Red River, one (1) within the river and two (2) on the east side of the Red River. The locations of the test holes are shown on Figure 1. The information obtained from the drilling investigation in conjunction with the seismic refraction surveys was used to developed profile to facilitate the preliminary design of the river crossing.

Maple Leaf Drilling of Winnipeg, Manitoba provided the drilling services using a track mounted drill rig. Soil samples were collected at intervals of 1.5 m (5 ft.) or at any changes in soil strata encountered during drilling. The soil samples were visually inspected for material type and classified according to the Modified Unified Soil Classification System (USCS).

Clay samples were tested with a field Torvane to evaluate consistency and estimate undrained shear strengths of cohesive soils. Standard Penetration Tests (SPTs) were completed in the till to estimate the in-situ density. Upon completion of drilling, the test holes were examined for indications of sloughing and seepage, and then backfilled. Test hole log summary reports incorporating field observations, and field test results are provided in Appendix A. Photographs of the soil samples are included in Appendix B.

3.2 Laboratory Testing

Laboratory testing is being performed on select bedrock samples for use in the characterization of the subsurface. Laboratory testing on the bedrock samples was completed to determine the following parameters:

- Shear Modulus (G)
- Unconfined Compressive Strength
- Youngs Modulus (E)

These mechanical properties of the bedrock are required to adequately evaluate potential construction risks, tooling, and costs for horizontal directional drilling and microtunneling options.

The testing was performed at a Canadian Council of Independent Laboratories (CCIL) certified laboratory in general accordance with ASTM International standards.

3.3 Groundwater Monitoring

A total of two (2) standpipes were installed at the site, one (1) in the till and one (1) in the bedrock. Details of the standpipe piezometer installations are included on the test hole logs in Appendix A.

3.4 Geophysical Investigation

KGS Group retained the services of Frontier Geoscience Inc. to complete seismic refraction surveys along the two (2) preferred alignments on August 10 and 11, 2021. The primary objective of the geophysical survey was to obtain estimates of the depth to till and bedrock along the preferred alignments. The locations of the seismic lines are shown on Figure 1. The results of the seismic refraction survey are included in the Seismic Refraction Survey Report included in Appendix C.

FIGURE 1: TEST HOLE AND SEISMIC REFRACTION SURVEY LOCATIONS

4.0 FIELD INVESTIGATION RESULTS

4.1 Subsurface Characterization

The stratigraphy at the site is described in this section and is based on the exploratory test holes, seismic refraction surveys and our understanding of the general site geology.

The approximate stratigraphic boundaries shown on the test hole logs were inferred from soil observed during the drilling. The engineering characteristics of the subsurface materials are described in the following sub-sections. The soil classification is based on visual examination.

In general, the stratigraphy consists of alluvium soils over lacustrine clay, glacial silt till and limestone bedrock. The following sections describe the soil and the bedrock encountered during the geotechnical drilling investigation.

4.1.1 TOPSOIL

Topsoil was encountered at ground surface in test holes TH21-01, TH21-03 and TH21-04 and was generally less than 300mm thick. The topsoil was black in colour and dry at the time of drilling

4.1.2 FILL

Silty sand fill was observed in test hole TH21-01 from elevation 228.1 to 227.7 m. The silty sand fill was brown in colour, dry, loose in density, and contained medium to coarse grained sand.

4.1.3 ALLUVIUM SOILS

Alluvium soils ranging from sandy clay to sand was observed in test holes TH21-01, TH21-03 and TH21-04 at elevations ranging from 226.8 to 227.7 m and extending to elevations ranging from 211.6 to 219.0 m.

Silty sand was observed in test hole TH21-03 from elevation 226.8 to 225.6 m and in test hole TH21-04 from elevation 227.1 to 226.4 m. The silty sand was brown in colour, dry, loose in density, and contained some silt.

Sandy clay was observed in test hole TH21-01, TH21-03 and TH21-04 from elevations 214.7 to 226.7 m. The sandy clay was brown in color, damp, soft to stiff in consistency, of low to intermediate plasticity. The torvanes within the sandy clay ranged from 10 to 100 kPa and generally decreased with depth.

Clayey sand was encountered in test hole TH21-01, TH21-03 and TH21-04 from elevations 213.4 to 224.4 m. The clayey sand was brown in colour, moist to wet, loose in density and contained fine grained sand. It was noted that there was interlayered sand and clay throughout the layer.

Sandy silt was encountered in test hole TH21-04 from elevation 226.4 to 225.7 m. The sandy silt was brown in colour, damp, of low plasticity, and contained some fine grained sand lens.

Sand was encountered in test hole TH21-01 from elevation 220.6 to 219.0 m and in test hole TH21-03 from elevation 222.3 to 221.5 m. The sand was brown to grey in colour, moist to wet, compact in density, and contained trace silt.

Alluvial clay (CI to CL) was encountered in test holes TH21-03 and TH21-04 from elevation 219.0 to 217.7 m, and 216.5 to 214.9 m respectively. The clay was grey in colour, moist, soft to firm in consistency, of low to intermediate plasticity, and contained trace sand. The torvanes in the clay ranged from 10 to 45 kPa.

Silt was observed at the base of the Red River in the test hole drilled in the river, TH21-02. The silt was grey, wet, very soft in consistency, and contained fine grained gravel. The silt was observed from elevation 217.7 to 216.6 m.

A sand and gravel layer was encountered in test hole TH21-04 from elevation 213.4 to 211.5 m. The sand and gravel was grey in colour, moist to wet and dense.

4.1.4 LACUSTRINE CLAY

Lacustrine clay was encountered in test holes TH21-01, to TH21-03 overlying the silt till at elevations ranging from 213.6 to 219.0 m. The clay ranged in thickness from 0.6 to 6.1 m. The clay was typically brown to grey in colour, damp to moist, firm to stiff in consistency and of high plasticity. In general, the consistency of the clay decreased with depth. The material contained trace to some silt nodules. Fine to coarse grained gravel and boulders were encountered in the grey clay near the till interface. The undrained shear strength of the clay deposit, as determined using a field Torvane on disturbed samples, ranged from 30 to 80 kPa, generally decreasing with depth.

4.1.5 GLACIAL SILT TILL

Glacial silt till was encountered below the clay and sand with gravel at elevations ranging from 211.6 to 212.9 m in the test holes. The glacial till ranged in thickness from 3.1 to 5.8 m. The silt till was brown in colour, damp to moist, compact to very dense and contained some fine to coarse grained gravel and some fine to coarse grained sand.

The uncorrected Standard Penetration Test blow counts ranged from 17 to greater than 50 m, classifying the material as compact to very dense.

Boulders and cobbles are commonly found within till and should be anticipated within the deposits at the project site.

Cobbles and Boulders

In KGS Group’s experience, sporadic irregular zones or cobbles and/or boulders have been encountered within the till deposits such as those at this site. These zones can cause difficulties during construction.

4.1.6 BEDROCK

The limestone bedrock in the area of the project site is Selkirk member of the Red River Formation. The Selkirk member typically is medium strength with compressive strengths that vary from 30 to 40 MPa. The Young’s modulus (E) generally ranges from 15 to 25 GPa (University of Manitoba, 1983). The bulk modulus (k) typically ranges from 40 to 50 GPa, and the shear modulus ranges from 5 to 10 GPa.

Based on the borehole drilling, bedrock was encountered below the silt till at elevations ranging from 207.1 to 209.7 m. However, the seismic refraction survey suggest that top of bedrock may be lower on the east side of the river, at an elevation of approximately El. 198 m along the proposed alignment. The core samples retrieved from the borehole and the seismic survey indicate that the quality of the bedrock is generally better on the east side of the river compared to the west especially near the upper section above elevation El. 202 m. The estimated bulk compressive wave velocity (Vp)for the upper bedrock is 4100 m/s and 3200 m/s on the east side and west side, respectively. These estimated velocities suggest that the bedrock is more fractured on the west side as indicated by the RQD values presented in Figure 2.

The bedrock consists of limestone and mottled limestone. Dolomite was observed in test hole TH21-01 from elevation 208.0 to 209.7 m. The measured RQD of the bedrock with elevation is shown Figure 2 below, and a historgram with he RQD distribution is shown on Figure 3.

FIGURE 2: BEDROCK RQD WITH ELEVATION

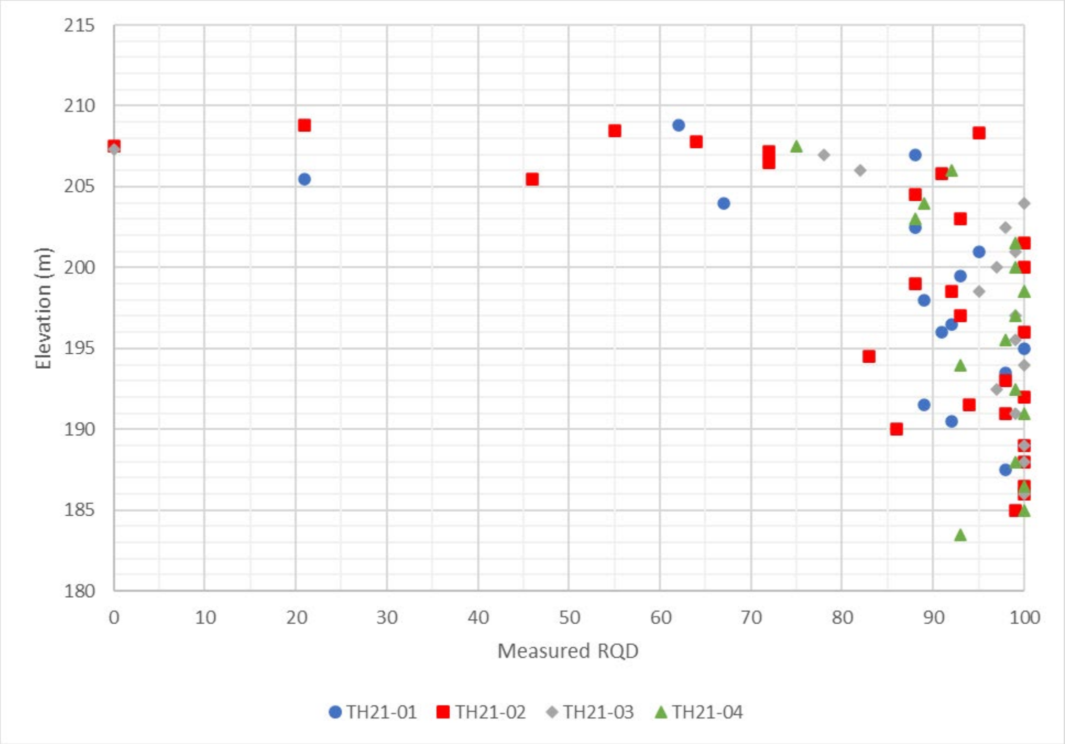
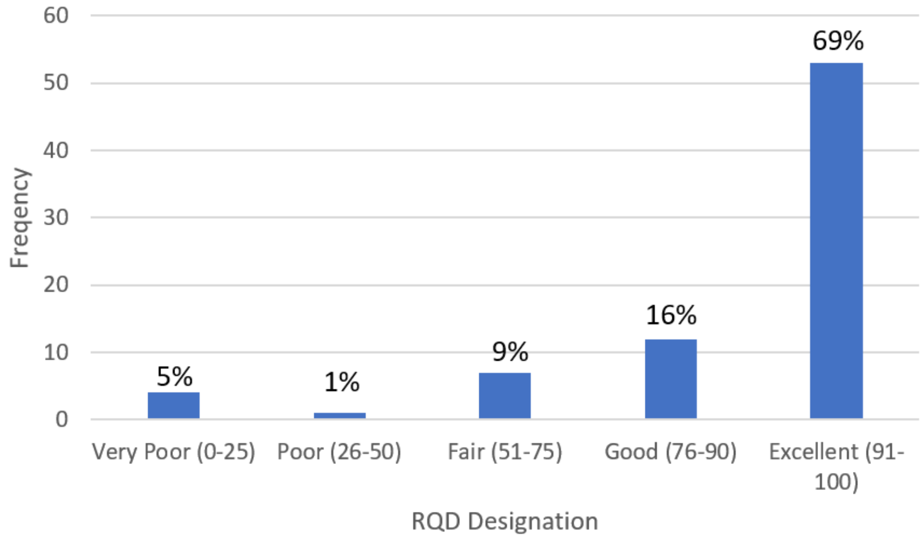


FIGURE 3: HISTOGRAM OF DISTRIBUTION OF RQD WITHIN TEST HOLES



The dolomite was brown in colour, and fine grained. Weaker fractured rock with closely spaced joints was generally observed above elevation 208 m. Shale was observed at elevation 208.0 m. The rock quality designation (RQD) of the dolomite was 62, classifying the rock as fair.

Limestone was generally encountered below elevations of 208.0. The limestone was white to grey colour, and medium grained. A soft clay seam 50 mm thick was observed in test hole TH21-01 at elevation 207.0 m. In some sections of the core, multiple closely spaced breaks were observed along the bedding planes. Three (3) open joints were observed in test hole TH21-02 at elevations ranging from 208.6 to 207.5 m. The RQD of the limestone ranged from 21 to 91. In general, the RQD was greater than 80 below elevation 205 m, classifying the rock as good to excellent.

Mottled limestone was encountered in all of the test holes at elevations ranging from 203.7 to 207.9 m and extending to the end of the test holes. The mottled limestone was mottled white, brown and grey in colour, medium grained and strong. The jointing was moderate to wide spaced. Weak zones of soft clay seams up to 50 mm were noted within the mottled limestone in test hole TH21-01 from elevation 203.3 to 197 m. The RQD of the mottled limestone ranged from 75 to 100, generally increasing with depth. In general, the RQD was greater than 90 below elevation 197 m, classifying the bedrock as excellent.

Laboratory testing was completed on two (2) mottled limestone bedrock samples from test hole TH21-01, at elevations 200.5 and 202.7 m. The compressive strength was measured to be 14.4 and 28.4 MPa, the Young's Modulus was measured to be 12.0 and 19.3 GPa and the Shear Modulus was calculated to be 5.4 and 12.2 GPa in the upper and lower samples respectively.

The origin of the opening in limestone rock, which has apparently become infilled with alluvial clay from the river, could be the result of erosion of rock material which might have been sheared and weakened (from faulting) or a zone containing erodible material. Once the weaker rock has been eroded, the opening could become filled with alluvium (clay) washed in by fluvial processes over time.

4.2 Groundwater Monitoring

Two (2) standpipe piezometers were installed as part of the 2021 geotechnical investigation. The installation details for the standpipes are included on the test hole logs included in Appendix A. Since installation, groundwater monitoring has been completed twice. The measured groundwater levels are listed below in Table 1.

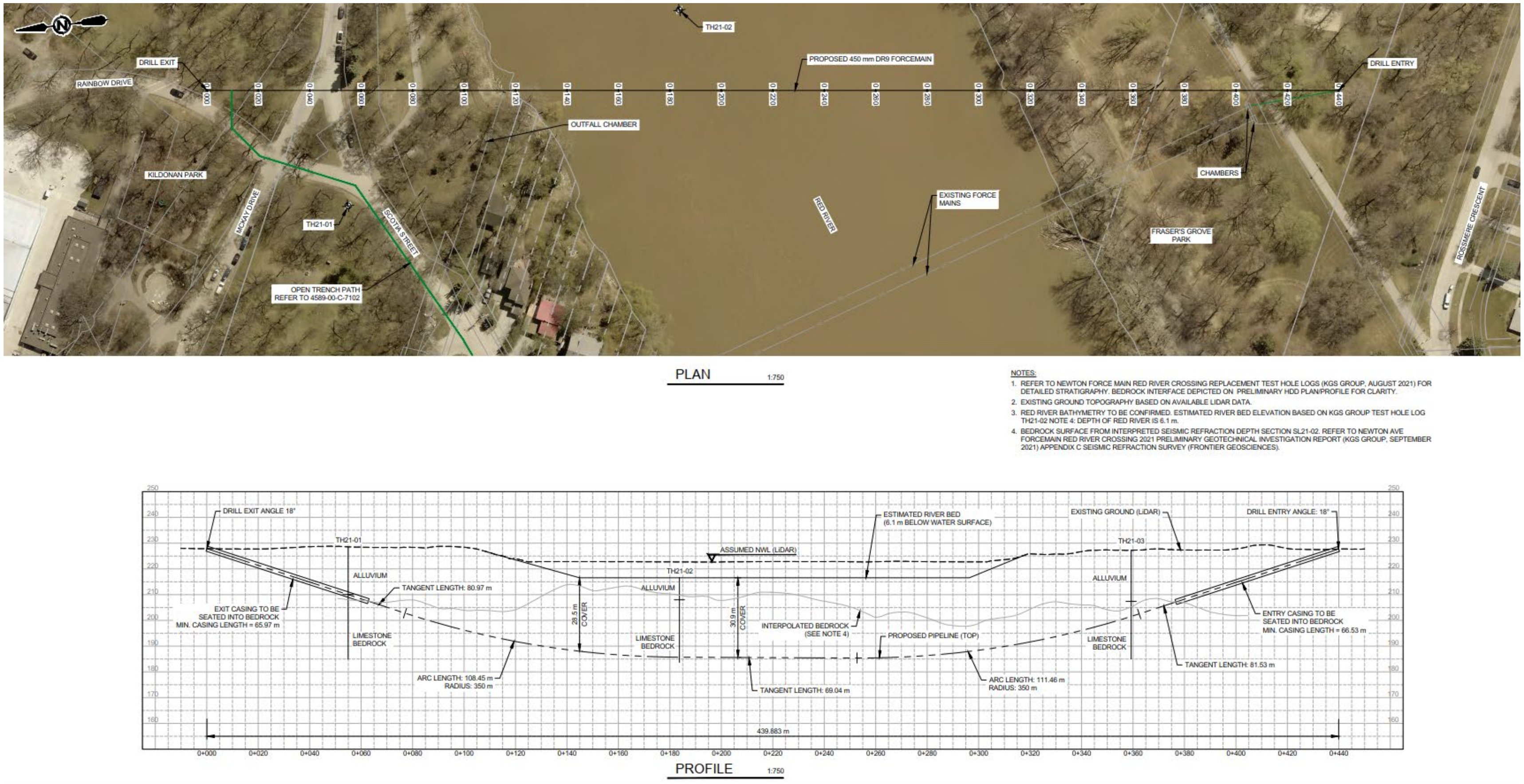
TABLE 1: GROUNDWATER MONITORING RESULTS

Test Hole ID	TH21-01	TH21-03
Ground Elevation (m)	228.19	227.14
Piezometer Type	Standpipe	Standpipe
Tip Elevation (m)	211.4	205.74
Monitoring Zone	Glacial Till	Bedrock
Date		
9/10/2021	222.3	222.7
10/28/2021	223.4	223.2

5.0 PROPOSED PIPE BOREPATH

Figure 4 shows preliminary borepath for the proposed pipeline. The drill entry will be east of Kildonan Drive in Fraser's Grove Park, and the exit will be located west of the intersection of Rainbow Drive and Scotia Street in Kildonan Park. The borepath will enter and exit at an angle of 18 degrees, with a minimum elevation of approximately 185 m.

FIGURE 4: CONCEPT LEVEL BOREPATH



NOTES:

1. REFER TO NEWTON FORCE MAIN RED RIVER CROSSING REPLACEMENT TEST HOLE LOGS (KGS GROUP, AUGUST 2021) FOR DETAILED STRATIGRAPHY. BEDROCK INTERFACE DEPICTED ON PRELIMINARY HDD PLAN/PROFILE FOR CLARITY.
2. EXISTING GROUND TOPOGRAPHY BASED ON AVAILABLE LIDAR DATA.
3. RED RIVER BATHYMETRY TO BE CONFIRMED. ESTIMATED RIVER BED ELEVATION BASED ON KGS GROUP TEST HOLE LOG TH21-02 NOTE 4: DEPTH OF RED RIVER IS 6.1 m.
4. BEDROCK SURFACE FROM INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL21-02. REFER TO NEWTON AVE FORCEMAIN RED RIVER CROSSING 2021 PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT (KGS GROUP, SEPTEMBER 2021) APPENDIX C SEISMIC REFRACTION SURVEY (FRONTIER GEOSCIENCES).

6.0 PRELIMINARY RIVERBANK SLOPE STABILITY

6.1 Visual Inspection

As part of the field investigation, a visual inspection of the riverbank was completed for the east and west riverbanks. The site is located at the start of a gradual bend in the river, with the west side of the river being on the inside of the bend and the east side on the outside as shown on Figure 4. Erosion is typically observed on the outside bend of rivers.

FIGURE 5: SITE LOCATION

The east side of the riverbank is approximately 8 m high with benches at approximately elevations 222.5 and 225.9 m. These elevations generally coincide with approximate average summer river level and ordinary high water level (2-year flood level), respectively. The slope of the riverbank at the top of bank above the upper bench at EL. 225.9 m was approximately 3H:1V, from the upper bench to lower bench the slope was approximately 3.5H:1V and below the lower bench to the bottom of channel the slope was approximately 8H:1V. The benching and shallow slope of the riverbank suggests historical erosion along this segment of the river.

At the time of the site inspection there were no visual signs of deep-seated slope movement including slumps, sloughing, headscraps, or tension cracking. The downstream slope was vegetated with tall grass and shrubs and mature trees at the top of the bank. Photos of east bank are shown below.

PHOTO 1: EAST RIVERBANK LOOKING SOUTH

PHOTO 2: EAST RIVERBANK LOOKING SOUTH

The west side of the riverbank is approximately 10 m high with a bench at approximate the normal summer water level (El. 222.5 m). The slope of the riverbank above to the bench was at a slope of approximately 4H:1V and the lower slope to the channel was approximately 5H:1V. The riverbank slope flattens downstream of the site. An existing headscrap was observed downstream of the outfall pipe during the site inspection. At the time of the site inspection, no additional visual signs of deep seated slope instability such as slumps, sloughing, headscraps, or tension cracking with exception of the historical headscrap downstream were noted. The downstream slope was vegetated with tall grass and shrubs and mature trees at the top of the bank. Photos of the west bank are shown below.

PHOTO 3: WEST RIVERBANK LOOKING WEST

PHOTO 4: WEST RIVERBANK LOOKING SOUTH (UPSTREAM OF OUTLET)

PHOTO 5: WEST RIVERBANK LOOKING NORTH
NOTE HISTORICAL HEADSCRAP

6.2 Preliminary Slope Stability Analysis

KGS Group completed limit equilibrium (LE) slope stability analyses to determine the current stability of the riverbank on both sides of the proposed crossing. The slope stability analysis approach incorporates LE techniques based on two-dimensional slope stability analysis using SLOPE/W software by Geo-Slope International Ltd. The Morgenstern-Price method of analysis was employed for the slope stability assessment using the LE method. This method considers both shear and normal interslice forces, and it satisfies both moment and force equilibrium.

The estimated target factor of safety generally reflects the uncertainty in the input parameters used in the slope stability analysis and the potential impacts that the failure of the riverbank may have on adjoining infrastructure. In general, riverbanks with a minimum factor of safety greater than 1.3 are considered to be relatively stable, however movements are possible. Riverbanks with a minimum factor of safety greater than 1.5 are unlikely to experience ground movements.

6.2.1 REPRESENTATIVE STRATIGRAPHIC SECTIONS

Two (2) cross-sections were analyzed, one (1) on the east side and one (1) on the west side of the Red River at the proposed crossing to evaluate the stability of the riverbanks. The riverbank geometry was obtained from LiDAR data provided by the City of Winnipeg and the soil stratigraphy was developed from the test hole drilling and seismic refraction survey results. The cross sections for the slope stability analysis are shown in Figures 6 and 7 below.

FIGURE 6: EAST RIVERBANK SIMPLIFIED STRATIGRAPHY

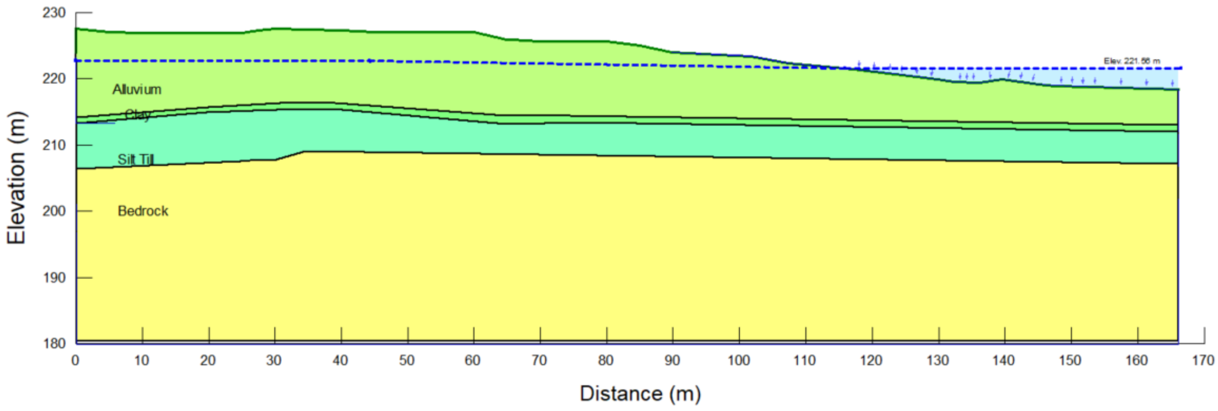
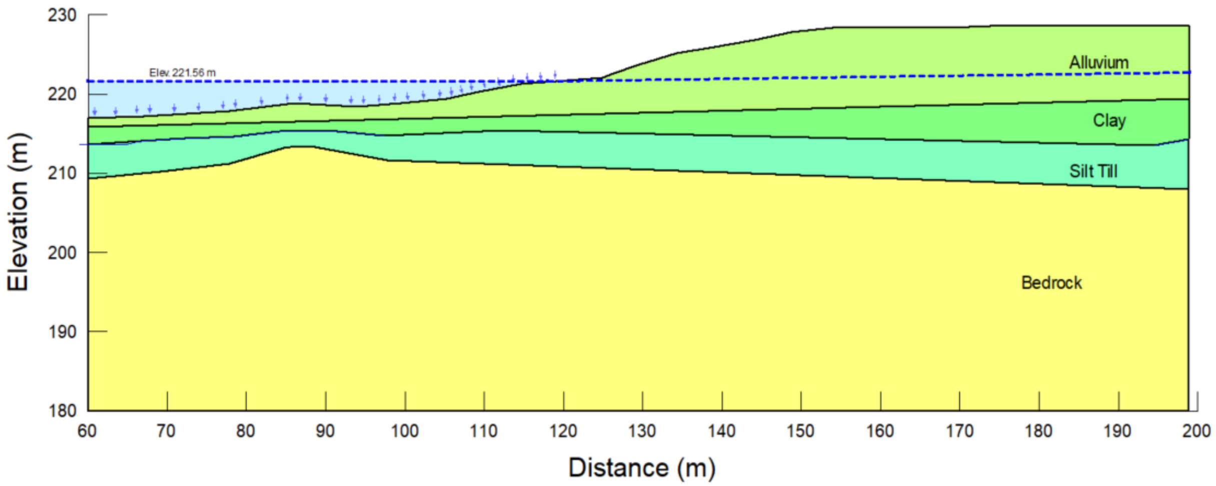


FIGURE 7: WEST RIVERBANK SIMPLIFIED STRATIGRAPHY



6.2.2 SOIL MATERIAL PARAMETERS

The soil strength parameters for the subsurface soils in these analyses were based on the observations from the field investigation and our experience with the native soils in the area. The average soil strength parameters assigned to the various materials for the slope stability analyses are summarized in Table 2. The shear strength parameters used for the alluvium soils have been reduced from typical strengths for this material in Winnipeg to account for the weaker and lower strength zones present within the deposits. The shear strength parameters used for the alluvium soils are considered to be representative of the average strength of the layer.

TABLE 2: SLOPE STABILITY ANALYSIS MATERIAL PARAMETERS

Soil Type	Unit Weight (kN/m^3)	Effective / Apparent Cohesion (kPa)	Friction Angle (°)
Alluvium soils	18	2	20
Clay	18	5	14
Till	20	2	30
Bedrock	Impenetrable		

6.2.3 GROUND WATER AND RIVER LEVELS

The groundwater levels adopted for the stability analysis model were based on the recorded groundwater levels obtained from the newly installed standpipe piezometers and the river water levels are typical levels for the Red River outlined below:

- Average Winter River Level = 221.56 m

- Average Summer River Level = 222.57 m
- Ordinary high-water level (2 year flood) = 225.92 m

The reported river levels consider average summer and winter flows over the last 20 years. The ordinary high-water level is estimated based on a two year flood on the Red and Assiniboine River.

Two (2) groundwater and river level combinations were analyzed in the slope stability models:

Case 1: Long-Term Condition – The groundwater level was assumed to be at elevation 223.4 m and the river level was assumed to be at the average winter level.

Case 2: Short-Term Condition – The groundwater level was assumed to coincide with the ordinary high-water level and the river level was the average winter river level.

6.3 Slope Stability Results

The stability analysis was completed on both sides of the Red River along the proposed pipe alignment to determine the minimum factor of safety (FOS = 1.5). The analysis indicated the in general the estimated factor of safety for the riverbanks is equal to or greater than 1.5. The typical potential slip surfaces for the riverbanks are shown on the figures below. The proposed entry and exit location for the new forcemain will be located beyond the potential slip surfaces shown below.

Based on the visual inspection, the east riverbank has benching and shallow slopes which suggests historical erosion along this segment of the river. Additionally, it is located on an outside bend which are known to be susceptible to erosion. No erosion protection was observed along the east shoreline during the visual inspection. It is recommended that a riprap blanket be placed in the lower bank area within the normal summer river level range to minimize the potential for toe erosion which will result in a reduction in the stability over time. The riprap blanket should extend a minimum of 1.5 m above and below the normal summer river level.

FIGURE 8: EAST RIVERBANK TYPICAL SLIP SURFACE

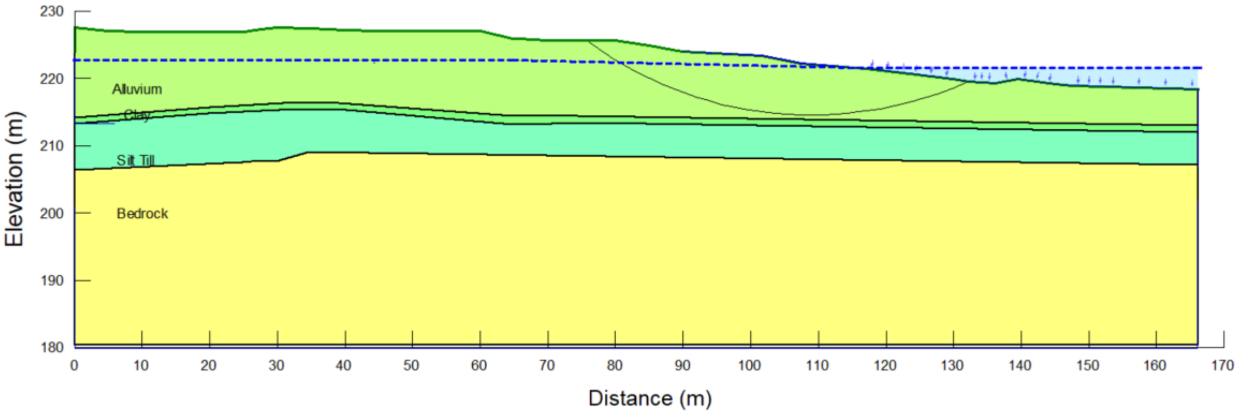
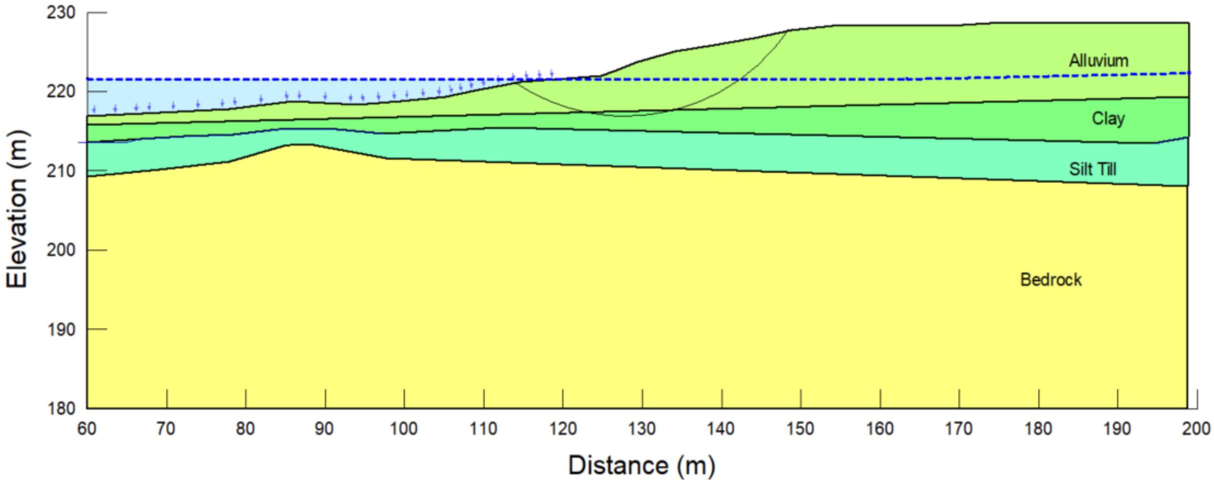


FIGURE 9: WEST RIVERBANK TYPICAL SLIP SURFACE



7.0 CONSTRUCTION CONSIDERATIONS

7.1 Bedrock Quality and Trenchless Pipe Installation

Rock Quality Designation (RQD) of the limestone bedrock is generally between 75% and 100% indicating typically good rock quality. The limestone bedrock joints/fractures can result in migration of drilling fluid (loss of circulation) and instability of the borehole. The possible occurrence of cobbles and boulders within glacial till soils above the bedrock is another fissure that could provide paths for fluid to migrate out of the borepath. However, this risk may be mitigated by using drilling additives to consolidate and reduce the permeability of joints and fractures.

Karst openings are commonly encountered in limestone and dolomite formations around Winnipeg; these features are results of bedrock solution processes and can also be a source of loss of circulation and mud control problems. However, no extensive karst features that would be of concern were observed in any of the boreholes that were drilled at the site.

Both horizontal directional drilling and microtunneling are feasible trenchless installation methods at the site based on the strength, hardness and quality of the bedrock.

7.2 Temporary Excavations

Temporary excavations will be required for the construction of the proposed pipeline and associated infrastructure. All excavation work will be required to be performed in accordance with the Workplace Safety and Health Act and Manitoba Workplace Safety and Health Regulation.

Excavations adjacent to existing infrastructure including structures, roads and utilities will require temporary shoring or bracing to minimize ground movement. Excavations deeper than 1.5 m are required to be designed and approved prior to construction by an experienced Professional Engineer with expertise in Geotechnical Engineering.

For design purposes the soils may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 3.

TABLE 3: LATERAL EARTH PRESSURE COEFFICIENTS

Material	Unit Weight (kN/m^3)	ϕ'	K_a	K_o	K_p
Alluvium soils	18	20	0.49	0.66	2.04
Clay	18	14	0.61	0.75	1.63
Till	20	30	0.33	0.50	3.00
Well Graded Compacted Granular Fill	18	35°	0.27	0.43	3.70

7.3 Impacts on Existing Infrastructure

Some degree of movement, settlement, heave and lateral movement, will be expected during the construction of the pipeline and the associated structures. The Contractor shall be required to undertake the work in a manner which maintains movements around the perimeter of the excavation and of utilities, roadways, and buildings within the established acceptable limits to be determined during the detailed design.

All excavation and shoring system should be designed by a professional engineer with extensive relevant experienced and the works must be inspected and certified by the same professional engineer to verify that the temporary structure has been installed according to the design.

7.4 Impact of Groundwater and Dewatering

The groundwater level in the till and bedrock was observed to be at approximate elevations 223.4 and 223.2 m respectively. These levels are expected to fluctuate with the river level. In KGS Group's experience, zones of cobbles, boulders and/or granular layers are known to exist within till deposits. These zones should be expected to be water bearing, which may cause difficulties with open cut excavation for vertical shafts.

8.0 CLOSURE

The geotechnical investigation conducted by KGS Group describes the overburden deposits and bedrock stratigraphy along the proposed alignment based on the information from the test holes and seismic refraction survey. This report presented the geotechnical engineer’s best judgement of the subsurface and ground conditions anticipated to be encountered across the project site. While the actual conditions encountered in the field are expected to be within the range of the conditions discussed in this document, the spatial variability of subsurface conditions that could be encountered may be more complex than the simplified interpretation presented in this report.

It is recommended that a geotechnical baseline report (GBR) be prepared as part of the detailed design phase of work. The GBR will be used to establish the geotechnical conditions anticipated to be encountered during construction and set the basis of tender assumptions during bidding for the work.

9.0 REFERENCES

Department of geological Engineering, The University of Manitoba, Geological Engineering Report for Urban Development of Winnipeg, February 1983.

APPENDIX A

Test Hole Logs

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-01

SHEET 1 of 4

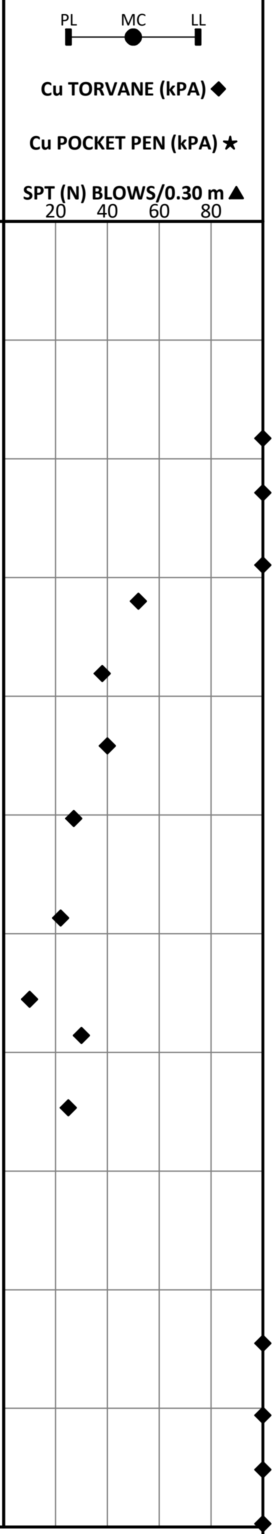
CLIENT	**ASSOCIATED ENGINEERING ALBERTA LTD.**	**PROJECT NO.**	21-3913-001
PROJECT	**Newton Force Main Red River Crossing Replacement**	**SURFACE ELEV.**	228.19 m
LOCATION	Winnipeg, MB	**TOC STICK-UP / ELEV.**	-0.10 m / 228.09 m (Standpipe)
DESCRIPTION	Scotia Street at Rainbow Drive (Kildonan Park)	**DATE DRILLED**	8-9-2021
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,533,809 E 636,141
METHOD(S)	0.0 m to 16.6 m: 100 mm ø SSA - switched due to encountering dense till 16.6 m to 43.2 m: Triple Tube, HQ Core		

ELEVATION (m) | **DEPTH (m) (ft)** | **GRAPHICS** | **DESCRIPTION AND CLASSIFICATION** | **WATER LEVEL** | **LOG OF INSTALLS: DIAGRAM, DEPTH (m)** | **SAMPLE TYPE** | **NUMBER / RUN** | **RECOVERY %** | **RQD (JOINTS/RUN)** | **BLOWS/0.15 m** | **N-VALUE**

DESCRIPTION AND CLASSIFICATION	ELEV (m)
TOPSOIL - Black, dry.	228.1
SILTY SAND FILL (SM) - Brown, dry, loose, fine grained, with silt, some medium to coarse grained sand.	227.7
POORLY GRADED SAND (SP) - Light brown, dry, loose, fine grained, trace medium grained sand.	227.4
SILTY SAND (SM) - Brown, dry, loose, fine grained, with silt, trace rootlets.	226.7
SANDY CLAY (CL) - Brown, damp, stiff, low plasticity, minor oxidation , trace gypsum, trace oxidation. - Intermediate plasticity below 2.4 m. - Trace black organic pockets/lenses below 2.7 m. - Damp to moist, high plasticity, no gypsum, no oxidation below 3.0 m. - Firm below 3.4 m.	223.6
CLAYEY SAND (SC) - Brown, moist to wet, loose, fine grained, interlayered sand/clay throughout.	220.6
POORLY GRADED SAND (SP) - Grey, moist to wet, compact, fine to medium grained, trace silt, trace shells. - Medium to coarse grained sand below 8.5 m.	219.0
CLAY (CH) - Grey, moist, stiff, high plasticity, trace medium to coarse grained sand, trace fine grained gravel. - No sand or gravel below 10.1 m.	

Log of installs depth (m): 0.3, 1.5

Samples: S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13



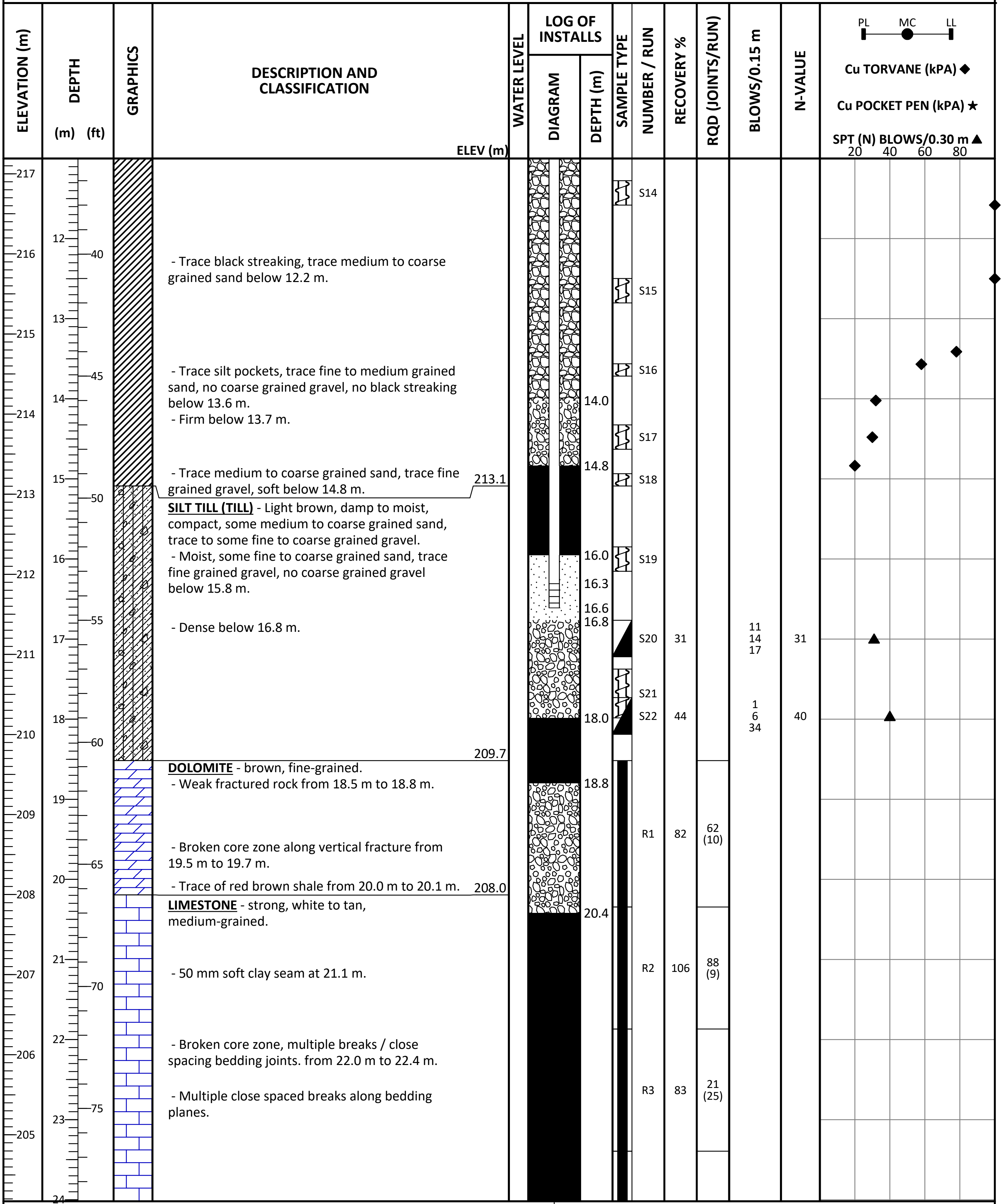
WATER LEVELS	▽ **During Drilling**	4.57 m on 8-9-2021 During Drilling
	▼ **Remeasured/Static** During Drilling	5.49 m on 8-13-2021 CS Standpipe

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021



DESCRIPTION AND CLASSIFICATION — ELEV (m)

- Trace black streaking, trace medium to coarse grained sand below 12.2 m.

- Trace silt pockets, trace fine to medium grained sand, no coarse grained gravel, no black streaking below 13.6 m.
- Firm below 13.7 m.

- Trace medium to coarse grained sand, trace fine grained gravel, soft below 14.8 m.

213.1

SILT TILL (TILL) - Light brown, damp to moist, compact, some medium to coarse grained sand, trace to some fine to coarse grained gravel.
- Moist, some fine to coarse grained sand, trace fine grained gravel, no coarse grained gravel below 15.8 m.

- Dense below 16.8 m.

209.7

DOLOMITE - brown, fine-grained.
- Weak fractured rock from 18.5 m to 18.8 m.

- Broken core zone along vertical fracture from 19.5 m to 19.7 m.

- Trace of red brown shale from 20.0 m to 20.1 m.

208.0

LIMESTONE - strong, white to tan, medium-grained.

- 50 mm soft clay seam at 21.1 m.

- Broken core zone, multiple breaks / close spacing bedding joints. from 22.0 m to 22.4 m.

- Multiple close spaced breaks along bedding planes.

Log of installs depth (m): 14.0, 14.8, 16.0, 16.3, 16.6, 16.8, 18.0, 18.8, 20.4

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
S14				
S15				
S16				
S17				
S18				
S19				
S20	31		11 14 17	31
S21				
S22	44		1 6 34	40
R1	82	62 (10)		
R2	106	88 (9)		
R3	83	21 (25)		

WATER LEVELS
∇ **During Drilling** 4.57 m on 8-9-2021 During Drilling
▼ **Remeasured/Static** During Drilling 5.49 m on 8-13-2021 CS Standpipe

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-01

SHEET 3 of 4

ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | ELEV (m) | WATER LEVEL | LOG OF INSTALLS: DIAGRAM, DEPTH (m) | SAMPLE TYPE | NUMBER / RUN | RECOVERY % | RQD (JOINTS/RUN) | BLOWS/0.15 m | N-VALUE | PL MC LL | Cu TORVANE (kPA) ◆ | Cu POCKET PEN (kPA) ★ | SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

Elevation (m): 204, 203, 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192

Depth (m): 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37

Depth (ft): 80, 85, 90, 95, 100, 105, 110, 115, 120

203.7

MOTTLED LIMESTONE - strong, mottled brown, white and grey, medium-grained.
- trace nodules from 24.5 m to 25.2 m.
- 25 mm open joint at 24.8 m.
- Compressive strength is 14.4 MPa, Young's Modulus is 12.0 GPa and Poisson's ratio is 0.13 at 25.2 m.
- Compressive strength is 28.4 MPa, Young's Modulus is 19.3 GPa and Poisson's ratio is 0.16 at 27.6 m.
- 50 mm soft clay seam at 29.5 m.
- 7 mm clay seam at 31.1 m.
- Moderate to wide space joints, trace vugs below 31.2 m.

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
R4	98	67 (18)
R5	93	88 (8)
R6	95	95 (11)
R7	100	93 (10)
R8	100	89 (6)
R9	100	92 (7)
R10	100	100 (6)
R11	98	98 (2)
R12	100	89 (11)

WATER LEVELS ▽ **During Drilling** 4.57 m on 8-9-2021 During Drilling
▼ **Remeasured/Static** During Drilling 5.49 m on 8-13-2021 CS Standpipe

CONTRACTOR **Maple Leaf Drilling Ltd.**
INSPECTOR **C. FRIESEN**
APPROVED J. MACLENNAN
DATE 10-25-2021

TEST HOLE LOG

HOLE NO.
TH21-01

SHEET 4 of 4

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS DEPTH (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL / Cu TORVANE (kPA) ◆ / Cu POCKET PEN (kPA) ★ / SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
191													
190	38	125						R13	100	92 (7)			
189	39	130						R14	100	100 (1)			
188	40												
187	41	135						R15	100	98 (5)			
186	42	140						R16	95	91 (2)			
185	43			185.0		43.2							
184	44	145											
183	45												
182	46	150											
181	47	155											
180	48												
179	49	160											
	50												

Notes:
1. End of test hole at 43.2 m.
2. Auger refusal encountered in till at a depth of 16.6 m.
3. Test hole caved to 13.7 m upon completion of drilling.
4. Flush mount installed at surface.

WATER LEVELS
- ▽ **During Drilling** 4.57 m on 8-9-2021 During Drilling
- ▼ **Remeasured/Static** During Drilling 5.49 m on 8-13-2021 CS Standpipe

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-02

SHEET 1 of 3

CLIENT	**ASSOCIATED ENGINEERING ALBERTA LTD.**	**PROJECT NO.**	21-3913-001
PROJECT	**Newton Force Main Red River Crossing Replacement**	**SURFACE ELEV.**	217.70 m
LOCATION	Winnipeg, MB	**DATE DRILLED**	8-4-2021
DESCRIPTION	Center of Red River	**UTM (m)**	N 5,533,672 E 636,201
DRILL RIG / HAMMER	B20 Portable Drill Rig with Winch Drop Hammer		
METHOD(S)	0.0 m to 8.6 m: Water Rotary - switched due to encountering bedrock 8.6 m to 33.8 m: Triple Tube, NQ Core		

DESCRIPTION AND CLASSIFICATION — ELEV (m)

SILT (ML) - Dark grey, wet, very loose, non-plastic, with fine grained gravel, trace organic odour.

216.6

CLAY (CI) - Grey, wet, very soft, intermediate plasticity, trace silt, trace shells.

213.6

SILT TILL (TILL) - Light brown, wet, compact, trace fine to coarse grained sand, trace fine to coarse grained gravel.

- Harder drilling below 5.5 m.
- Dense below 5.7 m.

- Fine to coarse grained gravel in SPT sampler at 7.2 m.
- Very dense below 7.2 m.

209.1

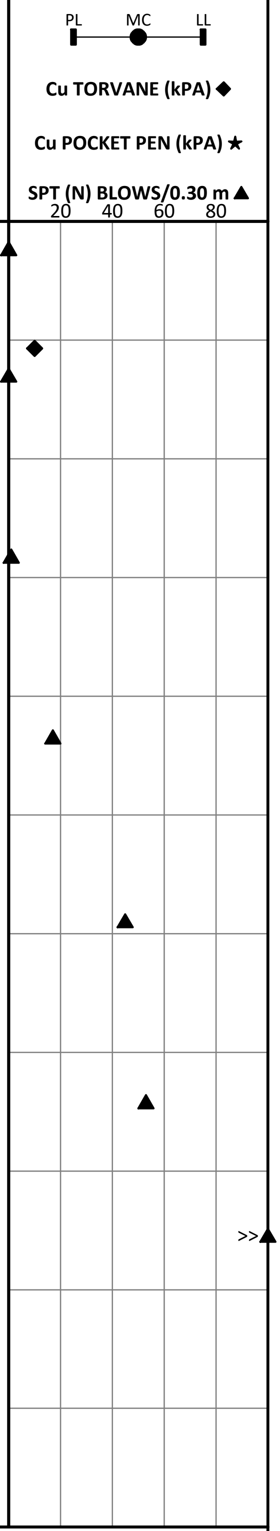
LIMESTONE - strong, white to grey, massive.

- Weak altered zone from 8.6 m to 9.4 m.

- Close spaced fractures from 9.4 m to 10.3 m.

- Close to moderate spaced joints, three open joints observed from 10.3 m to 12.5 m.

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
S1	33		2 0 0	0
S2	22		1 0 0	0
	0		1 0 1	1
S3	44		10 6 11	17
S4	6		22 26 19	45
S5	11		26 26 27	53
S6	100		60/ 90mm	+100
R1	67	21 (2)		
R2	77	55 (1)		
R3	95	95 (1)		
R4	100	64 (2)		
R5	100	0 (1)		
R6	100	72 (10)		



WATER LEVELS

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **G. BAKER/C. FRIESEN**
APPROVED J. MACLENNAN	DATE 10-25-2021

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-02

SHEET 2 of 3

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL Cu TORVANE (kPA) ◆ Cu POCKET PEN (kPA) ★ SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
						R7	100	72 (8)			
						R8	100	91 (2)			
			- Weak fracture at 12.2 m.	205.2		R9	100	46 (6)			
			MOTTLED LIMESTONE - strong, mottled white to grey, moderate to wide spaced joints, trace vugs. - Occasional nodules from 12.5 m to 14.5 m.			R10	100	88 (8)			
						R11	100	93 (6)			
						R12	100	100 (4)			
						R13	100	100 (2)			
						R14	100	88 (2)			
						R15	100	92 (7)			
						R16	93	93 (5)			
						R17	100	100 (3)			
						R18	83	83 (1)			

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
G. BAKER/C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-02

SHEET 3 of 3

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL / Cu TORVANE (kPA) ◆ / Cu POCKET PEN (kPA) ★ / SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
						R19	100	98 (4)			
						R20	100	100 (3)			
						R21	94	94 (1)			
						R22	98	98 (3)			
						R23	86	86 (1)			
						R24	100	100 (2)			
						R25	100	100 (1)			
						R26	100	100 (1)			
						R27	100	99 (1)			
						R28	100	100 (0)			
						R29	99	99 (1)			
				183.9							

Elevation (m): 193, 192, 191, 190, 189, 188, 187, 186, 185, 184, 183, 182, 181

Depth (m): 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37

Depth (ft): 80, 85, 90, 95, 100, 105, 110, 115, 120

Notes:
1. End of test hole at 33.8 m.
2. Test hole backfilled with grout.
3. Grout mix consisted of 1 part cement, 0.75 part bentonite, 5.7 part water.
4. Depth of Red River is 6.1m.

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
G. BAKER/C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

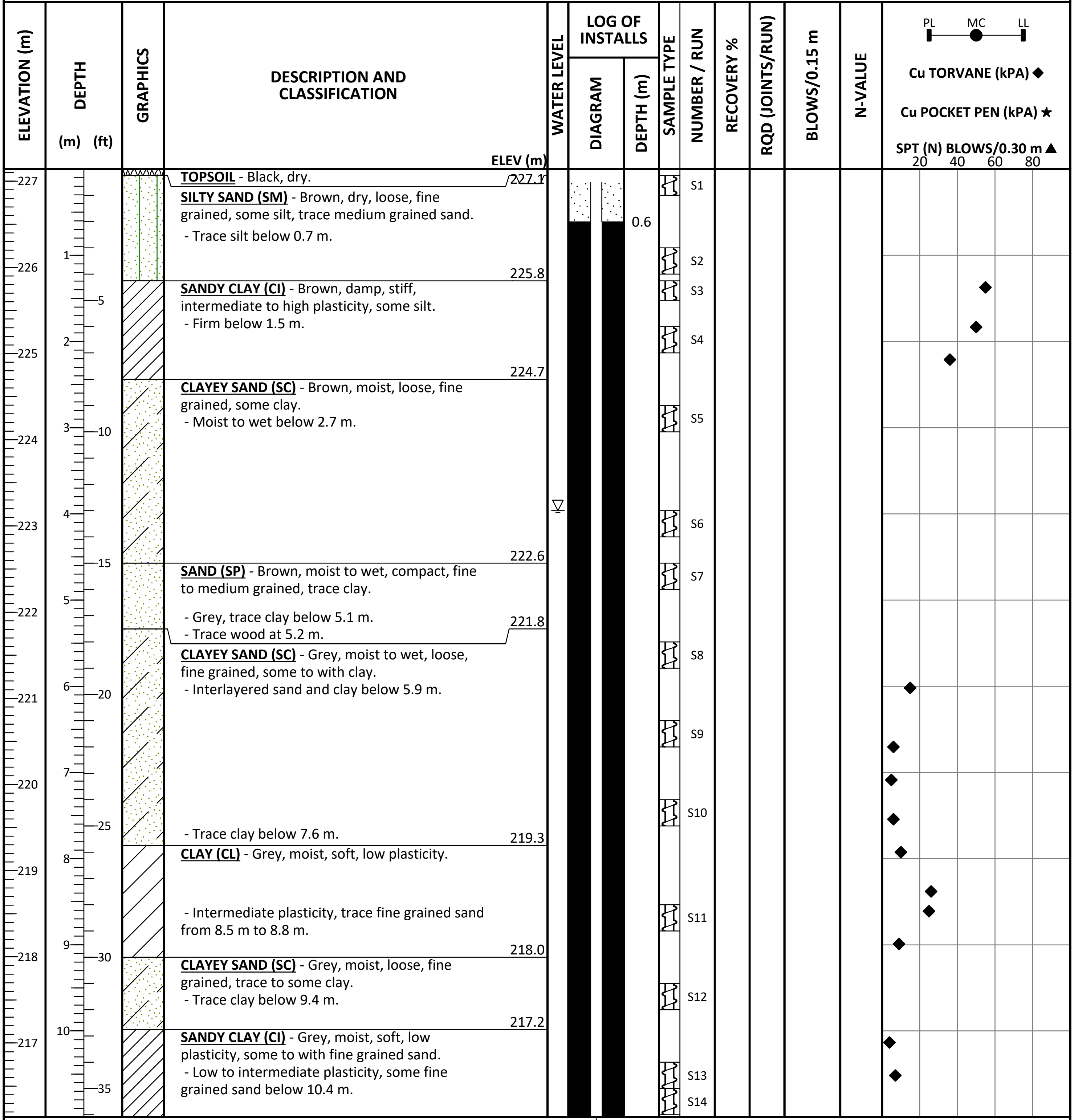
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-03

SHEET 1 of 4

CLIENT	**ASSOCIATED ENGINEERING ALBERTA LTD.**	**PROJECT NO.**	21-3913-001
PROJECT	**Newton Force Main Red River Crossing Replacement**	**SURFACE ELEV.**	227.14 m
LOCATION	Winnipeg, MB	**TOC STICK-UP / ELEV.**	-0.10 m / 227.04 m (Standpipe)
DESCRIPTION	Kildonan Drive at Larchdale Crescent (Fraser's Grove Park)	**DATE DRILLED**	8-12-2021
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,533,496 E 636,194
METHOD(S)	0.0 m to 18.3 m: 125 mm ø SSA - switched due to sloughing 18.3 m to 41.7 m: Triple Tube, HQ Core		



DESCRIPTION AND CLASSIFICATION	ELEV (m)
TOPSOIL - Black, dry.	227.1
SILTY SAND (SM) - Brown, dry, loose, fine grained, some silt, trace medium grained sand. - Trace silt below 0.7 m.	225.8
SANDY CLAY (CI) - Brown, damp, stiff, intermediate to high plasticity, some silt. - Firm below 1.5 m.	224.7
CLAYEY SAND (SC) - Brown, moist, loose, fine grained, some clay. - Moist to wet below 2.7 m.	222.6
SAND (SP) - Brown, moist to wet, compact, fine to medium grained, trace clay. - Grey, trace clay below 5.1 m. - Trace wood at 5.2 m.	221.8
CLAYEY SAND (SC) - Grey, moist to wet, loose, fine grained, some to with clay. - Interlayered sand and clay below 5.9 m. - Trace clay below 7.6 m.	219.3
CLAY (CL) - Grey, moist, soft, low plasticity. - Intermediate plasticity, trace fine grained sand from 8.5 m to 8.8 m.	218.0
CLAYEY SAND (SC) - Grey, moist, loose, fine grained, trace to some clay. - Trace clay below 9.4 m.	217.2
SANDY CLAY (CI) - Grey, moist, soft, low plasticity, some to with fine grained sand. - Low to intermediate plasticity, some fine grained sand below 10.4 m.	

WATER LEVELS ▽ **During Drilling** 3.96 m on 8-12-2021 During Drilling
During Drilling

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **C. FRIESEN**
APPROVED J. MACLENNAN	DATE 10-25-2021

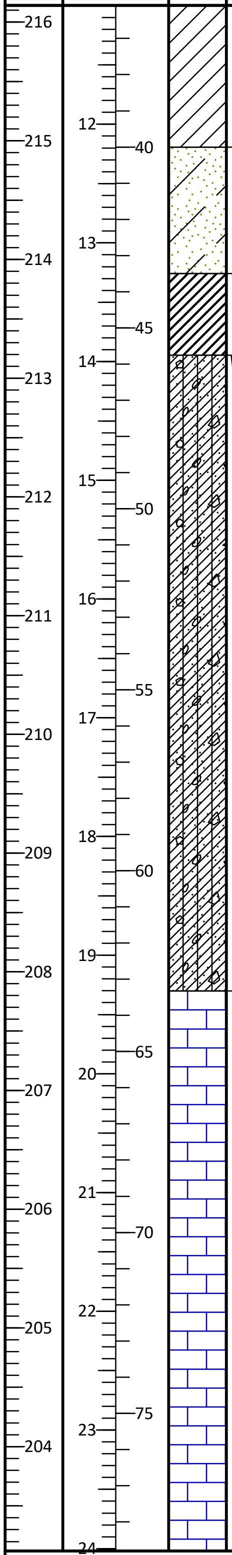
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-03

SHEET 2 of 4

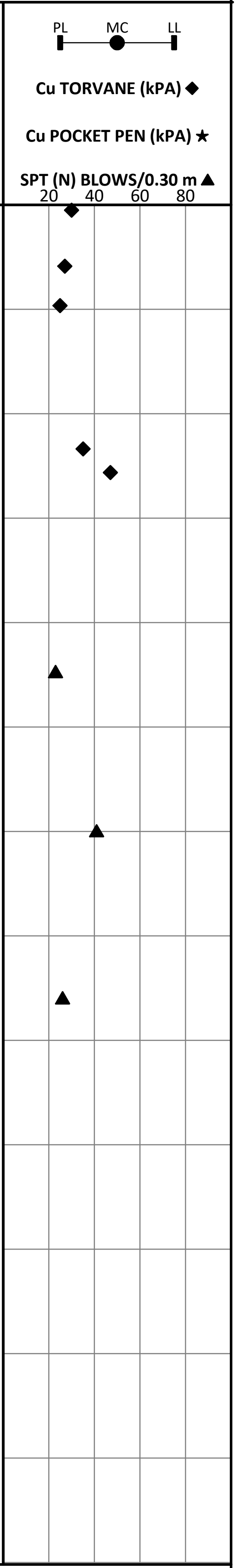
Depth (m)	Description and Classification	ELEV (m)
11.0–12.2	- Intermediate to high plasticity, firm below 11.0 m. - Trace to some fine grained sand below 11.3 m.	214.9
12.2–13.2	**CLAYEY SAND (SC)** - Grey, moist, loose, fine to medium grained, some clay.	213.9
13.2–13.9	**CLAY (CH)** - Greyish brown, moist, firm, high plasticity, trace silt nodules, some fine to medium grained sand. - Trace coarse grained sand, trace fine grained gravel below 13.9 m.	213.2
13.9–18.3	**SILT TILL (TILL)** - Light brown, moist, compact, some fine to coarse grained sand, trace fine to coarse grained gravel. - With coarse grained sand below 14.6 m. - Broken gravel in SPT sampler at 16.8 m. - Some fine to coarse grained gravel below 16.8 m.	207.8
18.3–24	**MOTTLED LIMESTONE** - grey to light yellow brown, Moderate to wide spaced joints. - Highly fractured limestone from 19.3 m to 19.9 m. - Vugs from 22.9 m to 23.8 m. - Softer to 23.4 m. - Softer at 23.8 m.	



LOG OF INSTALLS

DEPTH (m)
12.2
18.1
20.8
21.1
21.4
22.6

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
S15				
S16				
S17				
S18				
S19				
S20	72		8 10 13	23
S21				
S22	42		44 29 12	41
S23				
S24	42		14 13 13 13	26
R1	48	0		
R2	100	78 (3)		
R3	97	82 (11)		
R4	100	100 (4)		



WATER LEVELS ⊻ **During Drilling** 3.96 m on 8-12-2021 During Drilling
During Drilling

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **C. FRIESEN**
APPROVED J. MACLENNAN	DATE 10-25-2021

GROUP

TEST HOLE LOG

HOLE NO.
TH21-03

SHEET 3 of 4

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION ELEV (m)	WATER LEVEL	LOG OF INSTALLS DIAGRAM	LOG OF INSTALLS DEPTH (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL Cu TORVANE (kPA) ◆ Cu POCKET PEN (kPA) ★ SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
203	80							R5	100	98 (4)			
202	25							R6	100	99 (7)			
201	26 85												
200	27 90							R7	97	97 (0)			
199	28							R8	100	95 (5)			
198	29 95												
197	30 100							R9	100	99 (3)			
196	31		- Grey to white, moderate to wide spaced joints. from 31.5 m to 41.7 m.					R10	99	99 (3)			
195	32 105		- Mottled grey to brown below 32.4 m.										
194	33 110							R11	100	100 (1)			
193	34		- Trace vugs from 34.1 m to 36.3 m.					R12	99	97 (3)			
192	35 115												
191	36 120							R13	100	99 (3)			
	37												

WATER LEVELS ⊻ **During Drilling** 3.96 m on 8-12-2021 During Drilling
During Drilling

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

KGS
GROUP

TEST HOLE LOG

HOLE NO.
TH21-03

SHEET 4 of 4

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	LOG OF INSTALLS DEPTH (m)	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
190 – 185.4	37.1 – 41.7	122 – 137				R14	100	100 (3)
						R15	100	100 (1)
				185.4	41.7	R16	100	100 (3)

Column headings also printed: GRAPHICS, WATER LEVEL, DIAGRAM, SAMPLE TYPE, BLOWS/0.15 m, N-VALUE, PL MC LL, Cu TORVANE (kPA) ◆, Cu POCKET PEN (kPA) ★, SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

Notes:
1. End of test hole at 41.7 m.
2. Test hole caved to 12.2 m upon completion of drilling.
3. Flush mount installed at surface.

WATER LEVELS ∇ **During Drilling** 3.96 m on 8-12-2021 During Drilling
During Drilling

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

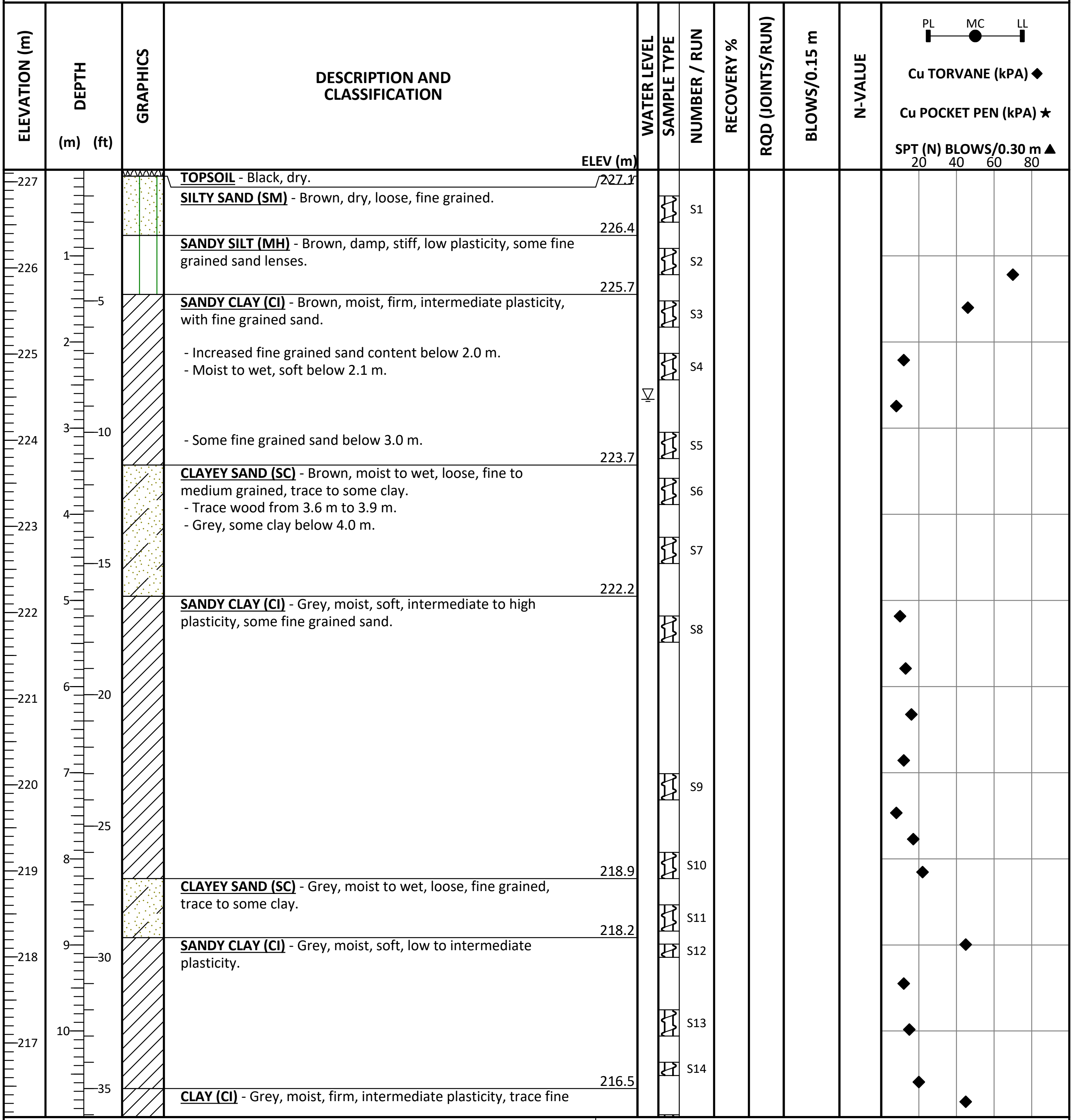
KGS
GROUP

TEST HOLE LOG

HOLE NO.
TH21-04

SHEET 1 of 4

CLIENT	**ASSOCIATED ENGINEERING ALBERTA LTD.**	**PROJECT NO.**	21-3913-001
PROJECT	**Newton Force Main Red River Crossing Replacement**	**SURFACE ELEV.**	227.14 m
LOCATION	Winnipeg, MB	**DATE DRILLED**	8-11-2021
DESCRIPTION	Kildonan Drive at Rowandale Crescent (Fraser's Grove Park)	**UTM (m)**	N 5,533,587 E 636,371
DRILL RIG / HAMMER	Acker Renegade Track Mounted Drill Rig with Auto-Hammer		
METHOD(S)	0.0 m to 18.3 m: 125 mm ø SSA - switched due to sloughing 18.3 m to 44.7 m: Triple Tube, HQ Core		

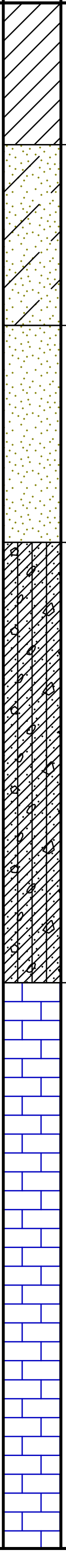


DESCRIPTION AND CLASSIFICATION	ELEV (m)
TOPSOIL - Black, dry.	227.1
SILTY SAND (SM) - Brown, dry, loose, fine grained.	226.4
SANDY SILT (MH) - Brown, damp, stiff, low plasticity, some fine grained sand lenses.	225.7
SANDY CLAY (CI) - Brown, moist, firm, intermediate plasticity, with fine grained sand. - Increased fine grained sand content below 2.0 m. - Moist to wet, soft below 2.1 m. - Some fine grained sand below 3.0 m.	223.7
CLAYEY SAND (SC) - Brown, moist to wet, loose, fine to medium grained, trace to some clay. - Trace wood from 3.6 m to 3.9 m. - Grey, some clay below 4.0 m.	222.2
SANDY CLAY (CI) - Grey, moist, soft, intermediate to high plasticity, some fine grained sand.	218.9
CLAYEY SAND (SC) - Grey, moist to wet, loose, fine grained, trace to some clay.	218.2
SANDY CLAY (CI) - Grey, moist, soft, low to intermediate plasticity.	216.5
CLAY (CI) - Grey, moist, firm, intermediate plasticity, trace fine	

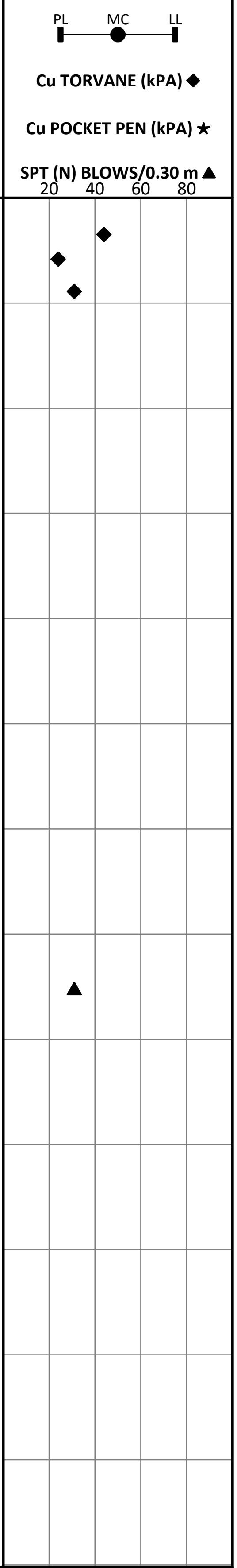
WATER LEVELS ⊻ **During Drilling** 2.67 m on 8-11-2021 During Drilling
During Drilling

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **C. FRIESEN**
APPROVED J. MACLENNAN	DATE 10-25-2021

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)
216 – 214.9	– 12.3	– 40	grained sand. - Trace wood from 11.3 m to 11.4 m. - Soft, some to with fine grained sand from 11.4 m to 11.6 m.	214.9
214.9 – 213.4	12.3 – 13.8	40 – 45	**CLAYEY SAND (SC)** - Grey, moist, compact, medium grained, trace shells. - Some clay, trace fine to coarse grained gravel below 12.5 m. - Medium to coarse grained sand, some fine grained sand, trace clay below 13.1 m. - Trace coarse grained sand from 13.3 m to 13.4 m.	213.4
213.4 – 211.6	13.8 – 15.6	45 – 51	**POORLY GRADED SAND WITH GRAVEL (SP)** - Grey, moist to wet, dense, medium to coarse grained, some fine grained sand, some fine to coarse grained gravel, trace shells. - Trace cobbles at 15.2 m. - With clay, trace silt pockets below 15.2 m.	211.6
211.6 – 207.9	15.6 – 19.3	51 – 63	**SILT TILL (TILL)** - Light brown, moist, compact, some medium to coarse grained sand, some fine to coarse grained gravel. - Dense below 18.6 m.	207.9
207.9 –	19.3 – 24	63 –	**MOTTLED LIMESTONE** - strong, mottled white to grey, very few joints. - Trace of rusty oxidation from 19.3 m to 19.4 m. - Some vugs from 22.6 m to 23.5 m. - Broken core zone, likely from drilling from 23.5 m to 23.6 m.	



NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
S15				
S16				
S17				
S18				
S19				
S20				
S21				
S22				
S23	25		25 17 14	31
R1	100	75 (7)		
R2	100	92 (7)		
R3	100	89 (10)		



WATER LEVELS ⊻ **During Drilling** 2.67 m on 8-11-2021 During Drilling
During Drilling

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL Cu TORVANE (kPA) ◆ Cu POCKET PEN (kPA) ★ SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
203		80						R4	100	88 (3)			
202	25							R5	99	99 (5)			
201	26	85						R6	99	99 (4)			
200	27	90											
199	28							R7	100	100 (4)			
198	29	95		- Finer grained section from 29.6 m to 31.7 m.									
197	30	100						R8	100	99 (5)			
196	31												
195	32	105		- Mottled brown, medium grained, trace of vugs with no alterations associated in the vuggy areas from 31.7 m to 44.7 m.				R9	99	98 (6)			
194	33	110						R10	100	93 (7)			
193	34												
192	35	115						R11	99	99 (2)			
191	36	120						R12	100	100 (1)			
	37												

WATER LEVELS ∇ **During Drilling** 2.67 m on 8-11-2021 During Drilling
During Drilling

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

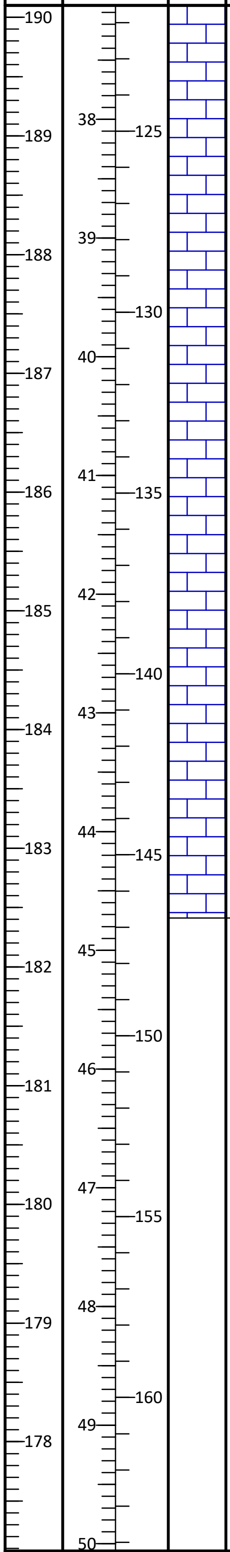
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH21-04

SHEET 4 of 4

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL Cu TORVANE (kPA) ◆ Cu POCKET PEN (kPA) ★ SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
							R13	100	100 (2)			
			- Large piece of coral at 39.1 m.				R14	99	99 (2)			
							R15	100	100 (2)			
							R16	100	100 (1)			
				182.4			R17	100	93 (4)			



Notes:
1. End of test hole at 44.7 m.
2. Test hole backfilled with grout.
3. Grout mix consisted of 1 part cement, 0.4 part bentonite, 3.3 part water.
4. Backfilled testhole with bentonite grout mixture to 1.8m.
5. Grout level dropped to 2.9m overnight. Topped up hole with bentonite chips to grade.

WATER LEVELS ▽ **During Drilling** 2.67 m on 8-11-2021 During Drilling
During Drilling

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
C. FRIESEN

APPROVED
J. MACLENNAN

DATE
10-25-2021

APPENDIX B

Photographs

Photo 1: TH21-01, Depth: 60’9” to 71’4.5”

Photo 2: TH21-01, Depth: 71’4.5” to 81’9”

Photo 3: TH21-01, Depth: 81’9” to 91’9”

Photo 4: TH21-01, Depth: 91’9” to 101’9”

Photo 5: TH21-01, Depth: 101’9” to 116’9”

Photo 6: TH21-01, Depth: 111’6.5” to 126’8”

Photo 7: TH21-01, Depth: 120'2.5" to 136'9"

Photo 8: TH21-01, Depth: 129'1" to 141'9" (End of Hole)

Photo 1: TH21-02, Depth: 28’2” to 40’10”

Photo 2: TH21-02, Depth: 40’10” to 55’9”

Photo 3: TH21-02, Depth: 55’9” to 70’9”

Photo 4: TH21-02, Depth: 70’9” to 82’2”

Photo 5: TH21-02, Depth: 82’2” to 95’11”

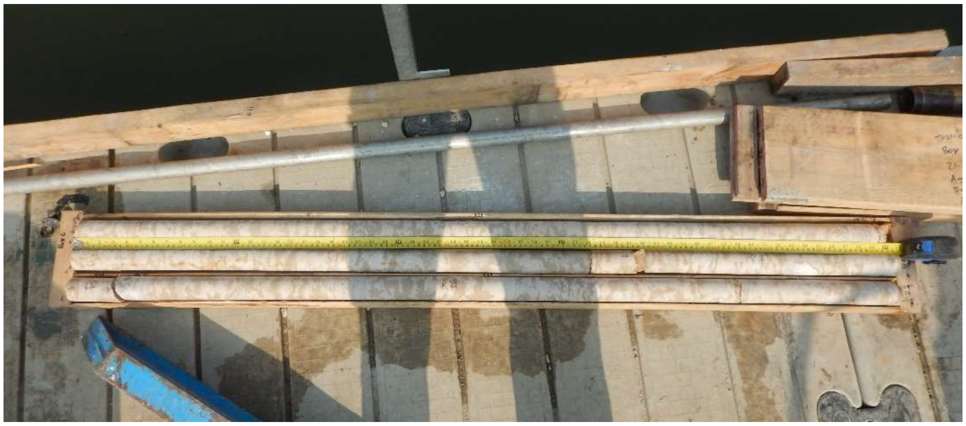


Photo 6: TH21-02, Depth: 95’11” to 110’9” (End of Hole)

Photo 1: TH21-03, Depth: 63’4” to 81’11”

Photo 2: TH21-03, Depth: 73’10.75” to 96’10”

Photo 3: TH21-03, Depth: 92’10.5” to 111’11”

Photo 4: TH21-03, Depth: 111’11” to 121’10”

Photo 5: TH21-03, Depth: 121’10” to 131’8”

Photo 6: TH21-03, Depth: 131’8” to 136’10” (End of Hole)

Photo 1: TH21-04, Depth: 63’2” to 81’10”

Photo 2: TH21-04, Depth: 72’9” to 91’10”

Photo 3: TH21-04, Depth: 91’10” to 106’11”

Photo 4: TH21-04, Depth: 101’6.25” to 116’11”

Photo 5: TH21-04, Depth: 110’11” to 126’11”

Photo 6: TH21-04, Depth: 120’9.5” to 136’9”

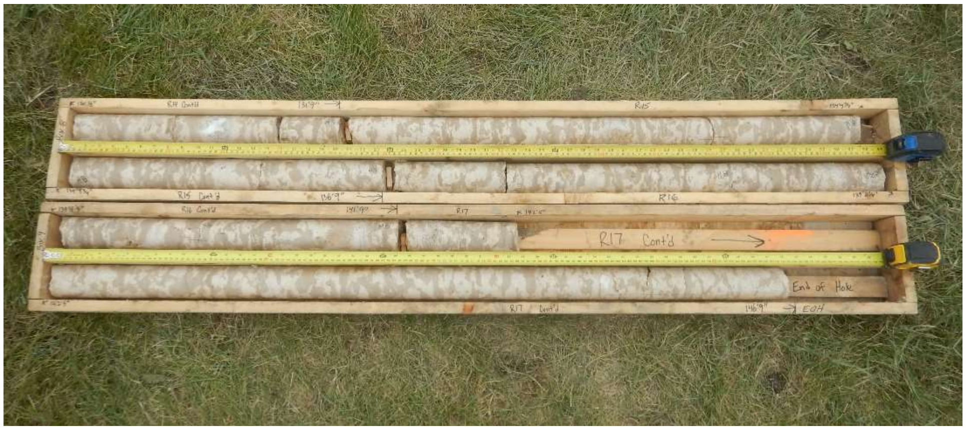


Photo 7: TH21-04, Depth: 130’0.5” to 146’9” (End of Hole)

APPENDIX C

Seismic Refraction Survey

FRONTIER GEOSCIENCES INC.

SEISMIC REFRACTION
SURVEY REPORT
NEWTON FORCE MAIN RED RIVER CROSSING
WINNIPEG, MB

Submitted to:
KGS Group
October 26, 2021

Authors:
Sean Henry, B.Sc.
Caitlin Gugins, P.Geo.

Project: FGI-1743

237 St. Georges Ave.
North Vancouver, B.C.
V7L 4T4

604 987 3037

CHANGE LOG

Version	Date of Issue	Changes
Draft	Sept. 6, 2021	Draft Report for Review
Final	Oct. 26, 2021	Final Report – updated Figures 3 and 4, discussion updated

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1. Introduction 1

2. Seismic Refraction Survey 2

  2.1 Terrestrial Refraction Survey 2

    2.1.1 Survey Equipment 2

    2.1.2 Survey Procedure 2

  2.2 Overwater Refraction Survey 3

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    2.2.2 Survey Procedure 3

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4. Limitations 6

Illustrations

		Location
Figure 1	Survey Location Plan	Appendix
Figure 2	Site Plan	Appendix
Figure 3	Interpreted Seismic Refraction Depth Section SL21-01	Appendix
Figure 4	Interpreted Seismic Refraction Depth Section SL21-02	Appendix

1. Introduction

During the period of August 10 and 11, 2021, Frontier Geosciences Inc. carried out a seismic refraction investigation for KGS Group, in Winnipeg, MB. The survey area is located across the Red River, near Newton Ave. A Survey Location Plan of the area is shown at a scale of 1:50,0000 in Figure 1 in the Appendix.

The purpose of the geophysical survey was to obtain overburden and bedrock compressional wave velocity information, in support of the Newton Force Main Red River Crossing Replacement project. A total of 705 metres of seismic refraction data was collected along two separate seismic lines. A Site Plan showing the locations of the lines is presented at a 1:2,000 scale in Figure 2, in the Appendix.

Example of Survey Setup at the River's Edge

2. Seismic Refraction Survey

2.1 Terrestrial Refraction Survey

2.1.1 Survey Equipment

The seismic refraction investigation was carried out using a Geometric Geode, 24 channel, signal enhancement seismograph and Oyo Geospace 10 Hz geophones. Geophone intervals along the multicored seismic cable were maintained at 5 metres, in order to ensure high resolution data of subsurface layering. Seismic energy was provided from a Buffalo gun, shotgun source firing 8 gauge, blank, shotgun shells into hand-excavated shotholes. Shot initiation or zero time was established by metal to metal contact of a striking hammer contacting the firing pin of the shotgun.

2.1.2 Survey Procedure

For each spread, the seismic cable was stretched out in a straight line and the geophones implanted in the soil. Up to seven separate 'shots' were then initiated: one at either end of the geophone array, up to three at intermediate locations along the seismic cable, and two off each end of the line, to ensure adequate coverage of the subsurface. The shots were triggered individually and arrival times for each geophone were recorded digitally in the seismograph. For quality assurance, field inspection of raw data after each shot was carried out, with additional shots recorded if first arrivals were unclear.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features. Relative elevations along the seismic lines were recorded by chain and inclinometer and referenced to handheld GPS measurements.

2.2 Overwater Refraction Survey

2.2.1 Survey Equipment

The overwater seismic refraction surveying was carried out with two, land-based, Geode seismographs and up to twenty-four geophones, together with a waterborne airgun energy source. A small Bolt airgun was used which released 10 cubic inches of compressed air into the river. A Gisco seismic radio trigger in the survey boat was used to initiate recordings at the two, shore-based seismographs.

2.2.2 Survey Procedure

In operation, the ‘shooting’ boat was manoeuvred in-line with the recording stations and the seismic source was lowered to just above the river bottom then initiated. The recording stations were automatically triggered by a radio link between the shooting vessel and recording seismographs. Accurate positioning of the shooting vessel was determined with a handheld GPS receiver. With numerous shot locations spanning the breadth of the lake, detailed travel time data was established similar to land-based operations. Water depths were recorded at each ‘shooting’ station.

2.3 Seismic Refraction Interpretive Method

The final interpretation of the seismic data was arrived at using the method of differences technique. This method utilizes the time taken to travel to a geophone from shotpoints located to either side of the geophone. Velocities are calculated as the slope of first break pick times and geophone distances. When there is a significant change in slope a new velocity is calculated and assigned to the new layer. Basal velocities are calculated by the arrivals of off-end shots, where picked arrivals are refracted from the basal layer. Each geophone is assigned a velocity and time for each layer. Using the total time, a small vertical time is computed which represents the time taken to travel from the refractor up to the ground surface. This time is then multiplied by the velocity of each overburden layer to obtain the thickness of each layer at that point. The thicknesses are splined along the seismic line to create a continuous boundary between layers.

3. Geophysical Results

3.1 General

The interpreted results of the seismic refraction lines are illustrated in profile in Figures 3 and 4, at a scale of 1:500, in the Appendix. The seismic velocity layer interfaces are marked on the seismic profiles in blue, purple and red. The interface line colours are not a specific velocity contour, but rather the interpreted discrete boundary above which velocities are defined within a certain range and below which velocities are within a significantly increased velocity range.

Seismic Shotgun Operation on Terrestrial Lines

3.2 Discussion

The results of the seismic refraction survey indicate the area is underlain by up to four distinct velocity layers. The two seismic profiles display a surficial layer with a range of compressional wave velocities between 360 m/s and 450 m/s. This velocity range is indicative of unconsolidated materials such as loose, dry to damp sands, silts and clays. This layer averages approximately 3.8 metres in thickness and reaches a maximum of approximately 6.2 metres along line SL21-02 near station 338N. This surficial layer is absent across the river.

Underlying the surficial layer is an upper intermediate layer with an interpreted compressional wave velocity range between 1000 m/s and 1400 m/s, consistent with drillhole intersections of moist to wet, sands and clays. Layer thicknesses vary significantly across the survey lines, from a minimum of around 2.7 metres surrounding station 188N on line SL21-02, while reaching a maximum of over 15 metres near station 90NW on line SL21-01.

Underlying the upper intermediate layer is a lower intermediate velocity layer with a narrow compressional wave velocity range of 1600 m/s to 1750 m/s. These velocities are consistent with a more compact material, such as the silt till layer encountered in the drillholes. The greatest calculated thicknesses for this layer is approximately 11 m occurring at the beginning of line SL21-02, and thinning to 1.5 metres near station 264N on line SL21-02. While identifiable over the terrestrial portions this layer was not as apparent over the coarser cross river portions of the lines, likely due to it's thickness relative to depth. As a result, the depth for this layer was interpolated along the river bottom, and therefore it's thickness has a higher level of uncertainty underneath the river.

The basal layer with compressional wave velocities of 3250 m/s to 4100 m/s is the interpreted competent bedrock surface. These high velocities are consistent with nearby borehole logs encountering limestone, with higher velocities in this range indicative of a lesser degree of weathering and/or fracturing. Depths to the interpreted bedrock surface range from around 5.5 metres underlying the river near station 240N on line SL21-02 to a maximum of 26 metres at station 100NW on line SL21-01.

4. Limitations

The depths to subsurface boundaries derived from seismic refraction surveys are generally accepted as accurate to within ten percent of the true depths to the boundaries, below 10 metres. Above 10 metres, the accuracy of seismic refraction data is approximately +/- 1.5 metres due mainly to the greater statistical error in determining the upper velocity layers from fewer data points. In some cases, unusual geological conditions may produce false or misleading data points with the result that computed depths to subsurface boundaries may be less accurate. In seismic refraction surveying difficulties with a 'hidden layer' or a velocity inversion may produce erroneous depths. The first condition is caused by the inability to detect the existence of a layer because of insufficient velocity contrasts or layer thicknesses. A velocity inversion exists when an underlying layer has a lower velocity than the layer directly above it. The interpreted depths shown on drawings are to the closest interface location, which may not be vertically below the measurement point if the refractor dip direction departs significantly from the survey line location. Structural discontinuities occurring on a scale less than the geophone spacing or isolated boulders would go undetected in the interpretation of the data. The seismic refraction method may not detect a narrow canyon-like feature incised into bedrock, if the canyon width is narrow relative to the depth of burial of the feature.

Due to the method constraints of the overwater seismic refraction surveying, there is limited data on the velocities and depths of the overburden materials on the overwater profile. As a result, overburden velocities and bedrock depth errors may be greater than fifteen percent on the overwater segments of refraction lines.

The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the seismic refraction method.

For: Frontier Geosciences Inc.

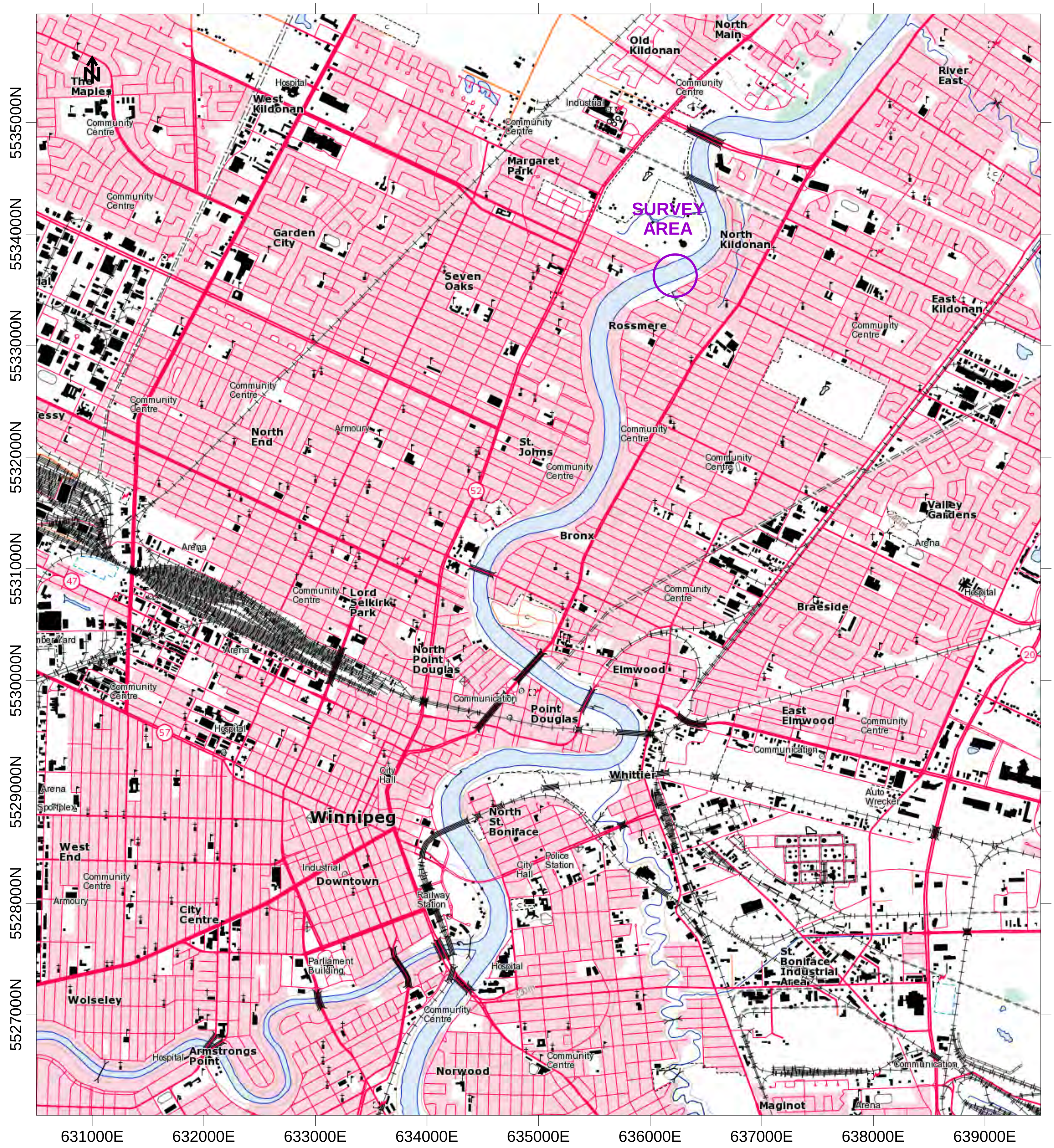
Sean Henry, B.Sc.

Caitlin Gugins, P.Geo.

PROVINCE OF MANITOBA
C.M.
GUGINS
Member
46920G
REGISTERED PROFESSIONAL GEOSCIENTIST

Oct 26, 2021

APPENDIX



KGS GROUP

NEWTON FORCE MAIN
RED RIVER CROSSING REPLACEMENT

SEISMIC REFRACTION SURVEY

SURVEY LOCATION PLAN

FRONTIER GEOSCIENCES INC.

DATE: AUG. 2021	SCALE 1:50,000	FIG. 1

NATURAL RESOURCES CANADA
TOPORAMA MAPSHEET 62H14
UTM NAD83 ZONE 14

GOVERNMENT OF MANITOBA IMAGERY
UTM NAD83 ZONE 14

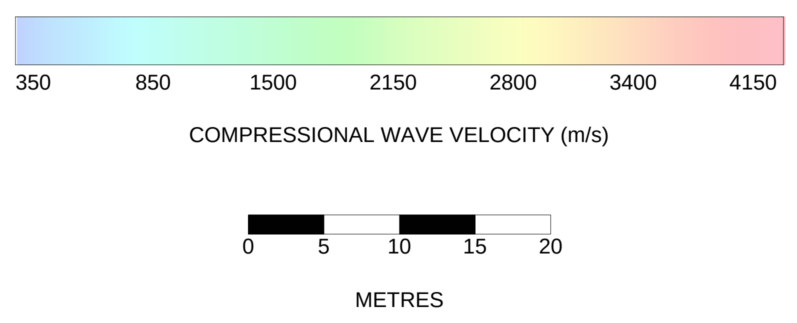
KGS GROUP
NEWTON FORCE MAIN
RED RIVER CROSSING REPLACEMENT

SEISMIC REFRACTION SURVEY

SITE PLAN

FRONTIER GEOSCIENCES INC.

DATE: AUG. 2021	SCALE 1:2,000	FIG. 2



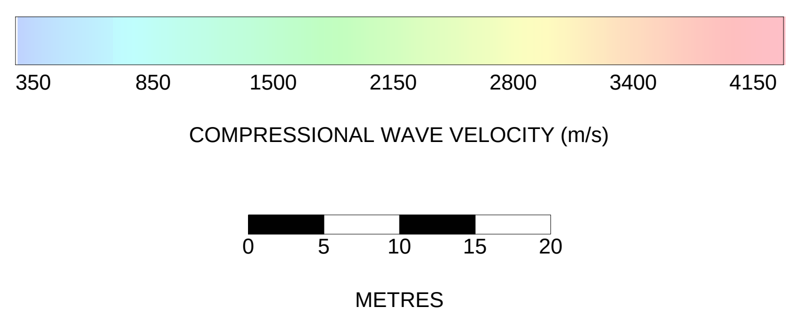
KGS GROUP
NEWTON FORCE MAIN
RED RIVER CROSSING REPLACEMENT

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL21-01

FRONTIER GEOSCIENCES INC.

DATE: AUG. 2021	SCALE 1:500	FIG. 3



KGS GROUP

NEWTON FORCE MAIN
RED RIVER CROSSING REPLACEMENT

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL21-02

FRONTIER GEOSCIENCES INC.

DATE: AUG. 2021	SCALE 1:500	FIG. 4

KGS
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Experience in Action

APPENDIX F - BASIS OF ESTIMATION

Basis of Estimate Summary

Investment Title	Newton Force Main Red River Crossing Replacement
Investment Description	The replacement of the High Density Polyethylene Newton Force Main which crosses the Red River from the Fraser Grove Park to the Scotia Street and Newton Ave. This is required due to the degraded condition of the existing force main pipe.
Department	Water and Waste
Date	27-Aug-21
BoE Author	Christopher Lamont (Associated Engineering)
BoE Estimating Team	Christopher Lamont, Jason Lueke (Associated Engineering)
BoE Reviewed by	
Business Case ID	

Investment Capital Cost Summary

CAPITAL COSTS ($000's)	
Construction/Equipment	$3,187
Consultant	$478
Utility	
Other	
Contingencies	$956
Administration	$243
Interest	

Investment Operating Cost Summary

NET OPERATING IMPACT ($000's)	2020	2021	2022	2023	2024	2025
Operating Costs						
Debt & Finance Charges						
Total Direct Costs	-	-	-	-	-	-
Less: Incremental Revenue/Recovery	-	-	-	-	-	-
Net Cost/(Benefit)	-	-	-	-	-	-
Incremental Full Time Equivalent Positions						

Estimate Classification	Class 3
Assumptions	Class 3 as required by the project scope
Risks and Opportunities	
Reference Documents	Newton Force Main Red River Crossing, Preliminary Design - Decision Support Report (Associated Engineering, 2021)

Document Control

Major Changes from Previous Estimate	

Version #	Date	Author	Rationale

Basis of Estimate Capital Cost Detail

Investment Title	Newton Force Main Red River Crossing Replacement
BC ID	0
Is this a Major Capital project?	No
Estimate Date	August 27, 2021
In Service Year	2022
Class of Estimate	Class 3

ESTIMATE DETAIL

Cost Escalation / Capital Inflation			3%	3%	3%	3%	3%	3%	
		Estimate Year	Year Project Work Undertaken						
		2021	2022	2023					Total
Construction/Equipment Costs	% of Const.	($000's)							
Mobilization and Demobilization, TAS, and Temp Facilities	10%	$300	$309	$0	$0	$0	$0	$0	$309
Site Preparation and Restoration	3%	$100	$103	$0	$0	$0	$0	$0	$103
Supply and Install 450mm DR9 HDPE Force Main by Horizontal Directional Drilling	71%	$2,200	$2,266	$0	$0	$0	$0	$0	$2,266
Connection to Existing Force Main	6%	$200	$206	$0	$0	$0	$0	$0	$206
Abandon Existing Force Main (Drain and Cap)	1%	$25	$26	$0	$0	$0	$0	$0	$26
Supply and Install 375mm Sewer on Scotia Street	8%	$240	$248	$0	$0	$0	$0	$0	$248
Supply and Install 375mm in Frasers Grove Park	1%	$28	$29	$0	$0	$0	$0	$0	$29
Construction Costs Sub-total	100%	$3,093	$3,187	$0	$0	$0	$0	$0	$3,187
Consultant Costs (Internal & External)	% of Const	($000's)							
Design and Construction Services	15%	$464	$478	$0	$0	$0	$0	$0	$478
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
Consultant Costs Sub-total	15%	$464	$478	$0	$0	$0	$0	$0	$478
Construction & Consultant Sub-total		$3,557	$3,665	$0	$0	$0	$0	$0	$3,665
Utility Costs	% C&C	($000's)							
Hydro	0%		$0	$0	$0	$0	$0	$0	$0
Communication - MTS	0%		$0	$0	$0	$0	$0	$0	$0
Communication - Shaw	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
Utility Costs Sub-total	0%	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	% C&C	($000's)							
Land Acquisition	0%		$0	$0	$0	$0	$0	$0	$0
Insurance	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
Other Costs Sub-total	0%	$0	$0	$0	$0	$0	$0	$0	$0
Project Costs before Contingencies Sub-total		$3,557	$3,665	$0	$0	$0	$0	$0	$3,665
Contingencies Costs	% Proj Cost	($000's)							
	26%	$928	$956	$0	$0	$0	$0	$0	$956
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
	0%		$0	$0	$0	$0	$0	$0	$0
Contingencies Costs Sub-total	26%	$928	$956	$0	$0	$0	$0	$0	$956
Project Sub-total before Administrative Charges Subtotal		$4,485	$4,621	$0	$0	$0	$0	$0	$4,621
								% increase from base	103%
Administrative Charges Detail									
Administrative Charges (*consult department Finance*)									
Departmental Staff	2.00%	$90	$93	$0	$0	$0	$0	$0	$93
Corporate Admin (max $100,000)	1.25%	$56	$58	$0	$0	$0	$0	$0	$58
Municipal Accommodations charges (if delivering the project)	0.00%	$0	$0	$0	$0	$0	$0	$0	$0
Research (SMIR) (Construction Only, only applies to Public Works)	0.00%	$0	$0	$0	$0	$0	$0	$0	$0
Corporate Interest	2.00%	$90	$93	$0	$0	$0	$0	$0	$93
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
Administrative Charges Sub-total	-	$235	$243	$0	$0	$0	$0	$0	$243
Project Sub-total before Interest Charges Sub-total		$4,720	$4,864	$0	$0	$0	$0	$0	$4,864
TOTAL CAPITAL PROJECT COST		$4,720	$4,864	$0	$0	$0	$0	$0	$4,864

	% of Project Work Undertaken						Check
	2022	2023	0	0	0	0	Total %
Mobilization and Demobilization, TAS, and Temp Facilities	100%						100%
Site Preparation and Restoration	100%						100%
Supply and Install 450mm DR9 HDPE Force Main by Horizontal Directional Drilling	100%						100%
Connection to Existing Force Main	100%						100%
Abandon Existing Force Main (Drain and Cap)	100%						100%
Supply and Install 375mm Sewer on Scotia Street	100%						100%
Supply and Install 375mm in Frasers Grove Park	100%						100%
Design and Construction Services	100%						100%
							0%
							0%
							0%
							0%
Hydro							0%
Communication - MTS							0%
Communication - Shaw							0%
							0%
							0%
							0%
Land Acquisition							0%
Insurance							0%
							0%
							0%
Contingencies Costs	100%						100%
							0%
							0%
							0%
							0%
							0%

Basis of Estimate Operating Cost Detail

Investment	Newton Force Main Red River Crossing Replacement
BC ID	0

Operating Budget Impact Detail Table

IN SERVICE YEAR - Please note that interest is charged to the project until the asset is in service at which time interest is then charged to the operating budget.

	Estimate Year	Year of Operating Impact					
NET OPERATING IMPACT ($000's)	2019	2020	2021	2022	2023	2024	2025
Operating Costs		$0	$0	$0	$0	$0	$0
Debt & Finance Charges		$0	$0	$0	$0	$0	$0
Total Direct Costs		$0	$0	$0	$0	$0	$0
Less: Incremental Revenue/Recovery							
Net Cost/(Benefit)		$0	$0	$0	$0	$0	$0
Incremental Full Time Equivalent Positions							

Cost Escalation / Operating Budget Inflation		2%	2%	2%	2%	2%	2%

Budget Impact Detail

OPERATING COSTS

Salaries and Benefits (consult finance/HR)	($000's)	Enter in current dollars in yellow highlighted cells. Inflation will be automatically calculated.						EXPLANATION/ASSUMPTIONS
Position #1								
Position #2								
Position #3								
Position #4								
Sub-total		$0	$0	$0	$0	$0	$0	
Sub-total with Inflation		$0	$0	$0	$0	$0	$0	

Operation & Maintenance Costs (consult operations)	($000's)							EXPLANATION/ASSUMPTIONS
Services								
Materials, Parts & Supplies								
Assets & Purchases								
Other								
Sub-total		$0	$0	$0	$0	$0	$0	
Sub-total with Inflation		$0	$0	$0	$0	$0	$0	

DEBT & FINANCING CHARGES

Debt & Finance Charges (consult finance)	($000's)							EXPLANATION/ASSUMPTIONS
Interest								
Principle	2.10%							
Sub-total		$0	$0	$0	$0	$0	$0	
Sub-total with Inflation		$0	$0	$0	$0	$0	$0	

Class of Estimate

Investment Title	Newton Force Main Red River Crossing Replacement	Estimate Date	August 27, 2021
Description	The replacement of the High Density Polyethylene Newton Force Main which crosses the Red River from the Fraser Grove Park to the Scotia Street and Newton Ave. This is required due to the degraded condition of the existing force main pipe.	Business Case ID	

Table 1 - Classification of Estimate [1]

	Characteristic	Class 5	Class 4	Class 3	Class 2	Class 1
1	Project Definition/Design % Complete	~1%*	~10%*	~30%*	~60%*	~99%*
2	End Usage - *typical purpose of estimate*	Concept	Feasibility	Budget Authorization	Detailed Design*	Tender Documents*
3	Methodology - *typical estimating method*	parametric models, judgment, or analogy	parametric models, assembly driven models	semi-detailed unit costs with assembly level line items	detailed unit cost with forced detailed take-off	detailed unit cost with forced detailed take-off
	Buildings and General Construction:	SF or m2 factoring				
	Process:	capacity factored	equipment factored			
	Pipeline, Transportation:	cost/length factors	cost/length factored			
4	Accuracy of Cost Estimate*	High: +100% Low: -50%	High: +50%* Low: -30%	High: +30% Low: -20%	High: +20% Low: -15%*	High: +15%* Low: -10%*

[1] Based on using the AACE International Recommended Practice(s): 17R-97, 18R-97, 56R-08, 97R-18, 98R-18.

* City of Winnipeg Customization

Table 2 - Estimate Input Checklist and Maturity Matrix[2]

The following table is a checklist of general project data and design deliverables found in common practise in the specific industry selected.

Select the Investment Industry from the drop down list below: [2]		Assess Overall Class Estimate:
Pipeline Industry	Based on AACE 97R-18 Recommended Practice Cost Estimate Classification System – as applied in Pipeline Transportation Infrastructure Projects (rev. August 2019) Reprinted with the permission of AACE International, 1265 Suncrest Towne Centre Dr., Morgantown, WV 26505 USA. Phone 304-296-8444. Internet: http://web.aacei.org E-mail: info@aacei.org Copyright © 2019 by AACE International; all rights reserved.	Class 3

Basis of Estimate Author's Legend:

n/a: *Not applicable. The deliverable does not apply to the project.*

🟩 *Basis of Estimate Author's determination of highlighted selection (fill shading in green) the deliverables status characteristics in Table 2 (Class 5 to Class 1 or n/a)*

General Project Data Deliverables Legend:

Not Required (NR): *May not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.*
Preliminary: *Project definition has begun and progressed to at least an intermediate level of completion. Review and approvals for its current status has occurred.*
Defined: *Project definition is advanced and reviews have been conducted. Development may be near completion with the exception of final approvals.*

Design Deliverables Legend:

Not Required (NR): *Deliverable may not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.*
Started (S): *Work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.*
Preliminary (P): *Work on the deliverable is advanced. Interim, cross functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.*

S/P: *Between started and preliminary status.*
Complete (C): *The deliverable has been reviewed and approved as appropriate.*

-		Class 5	Class 4	Class 3	Class 2	Class 1	Not Applicable	Comments:
-	Key Deliverable Target Status:	- Pipeline throughput capacity, general design concepts and routing alternatives agreed by business stakeholders.	- Preliminary hydraulic design, routing corridors defined with optimization underway, with preliminary crossing and major valve identification and assumed geotechnical conditions.	- Completed hydraulic study, route conditions confirmed by survey; pipe, coatings, valves and crossings defined; long lead pipe quoted for order, all ROW title holders identified ; major permit, license applications, and environmental impacts prepared and execution plans agreed.*	- Specific route conditions surveyed, specific crossing designs; most ROW, permits, and licenses obtained; and supply and installation contracts issued.	- All deliverables in maturity matrix complete.	Shade 'n/a' cell green if specific deliverable is not applicable to project.	Add relevant details to support the rationale for selecting the deliverable maturity level. Also indicate the location of specific document or drawing related to the deliverable, in order to validate maturity level.
-	General Project Data Deliverables:							
1	Project Scope Description	Preliminary	Preliminary	Defined	Defined	Defined	n/a	
2	Commodity Characteristics and Capacity	Preliminary	Preliminary	Defined	Defined	Defined	n/a	
3	Station, Terminal and Tie-in Locations	Preliminary	Preliminary	Defined	Defined	Defined	n/a	
4	Right-of Way (ROW) Strategy	Not Required	Preliminary	Defined	Defined	Defined	n/a	
5	Soils, Hydrology, Subsea	Not Required	Preliminary	Defined	Defined	Defined	n/a	
6	Integrated Project Plan	Not Required	Preliminary	Defined	Defined	Defined	n/a	
7	Stakeholder Management Plan	Not Required	Preliminary	Defined	Defined	Defined	n/a	
8	Stakeholder Consultation/Requirements	Not Required	Preliminary	Defined	Defined	Defined	n/a	
9	Project Master Schedule	Not Required	Preliminary	Defined	Defined	Defined	n/a	
10	Escalation Strategy	Not Required	Preliminary	Defined	Defined	Defined	n/a	
11	Work Breakdown Structure	Not Required	Preliminary	Defined	Defined	Defined	n/a	
12	Project Code of Accounts	Not Required	Preliminary	Defined	Defined	Defined	n/a	
13	Procurement/Contracting Strategy	Not Required	Preliminary	Defined	Defined	Defined	n/a	
-	Design Deliverables:	Class 5	Class 4	Class 3	Class 2	Class 1	Not Applicable	Comments:
14	Hydraulic Design	S	P	C	C	C	n/a	
15	Route Mapping/ Survey/ Topography/ Alignment Sheets	S/P	P/C	C	C	C	n/a	
16	Land/ROW Title Negotiation	NR	S/P	P/C	C	C	n/a	
17	Piping/Mechanical Discipline Drawings (including valving and pigging)	S	P	P	C	C	n/a	
18	Instrumentation/Control & Monitoring/ SCADA System Discipline Drawings	NR	S/P	P	C	C	n/a	
19	Civil/Site Preparation/Structural Discipline Drawings	NR	S/P	P	C	C	n/a	
20	Crossings and Borings Designs and Drawings	NR	S/P	P	C	C	n/a	
21	Station/Terminal Interface Design	NR	S/P	P	C	C	n/a	
22	Specifications and Datasheets	NR	S	P	C	C	n/a	
	* City of Winnipeg Customization							

Newton Force Main Replacement
Option 3:
HDD from Fraser's Grove Park to Kildonan Park - Single Pipe

Client:
City of Winnipeg

Subject:
Concept Cost Comparison

Item	Description	Unit	Quantity	Unit Price	Extension
1.0	Mobilization and Demobilization, TAS, and Temp Facilities	LS	1	$ 300,000	$ 300,000
2.0	Site Preparation and Restoration	LS	1	$ 100,000	$ 100,000
3.0	Supply and Install 450mm DR9 HDPE Force Main by Horizontal Directional Drilling	l.m.	440	$ 5,000	$ 2,200,000
4.0	Connection to Existing Force Main	Ea.	2	$ 100,000	$ 200,000
5.0	Abandon Existing Force Main (Drain and Cap)	LS	1	$ 25,000	$ 25,000
6.0	Supply and Install 375mm Sewer on Scotia Street	l.m.	240	$ 1,000	$ 240,000
7.0	Supply and Install 375mm Sewer in Frasers Grove Park	l.m.	35	$ 800	$ 28,000

Assumptions:
- New alignment along Scotia Ave

Class 3 Estimate

SUBTOTAL	**$ 3,093,000**
Engineering (15%)	$ 463,950
Contingency (30%)	$ 927,900
TOTAL	**$ 4,484,850**