Groat Road Bridges Rehabilitation Project: Groat Road Bridge over the North Saskatchewan River (B059), Groat Road Bridge over Victoria Park Road (B060) and Emily Murphy Park Road Bridge over Groat Road (B099) Environmental Impact Assessment

Final Report

Prepared for:

City of Edmonton Transportation Planning & Design and Transportation Infrastructure Delivery
Edmonton, Alberta

Prepared by:

Spencer Environmental
Management Services Ltd.
Edmonton, Alberta

Under contract to:

DIALOG
Edmonton, Alberta

Project Number EP 667

August 2017

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Network Integration, City Planning
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Edmonton Tower, 7th Floor
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Edmonton, AB T5J 0J4

30 August 2017
EP 667

Dear Mr. Adhikari,

Re: Groat Road Bridges Rehabilitation Project: Groat Road Bridge over the North Saskatchewan River (B059), Groat Road Bridge over Victoria Park Road (B060) and Emily Murphy Park Road Bridge over Groat Road (B099) – Final Environmental Impact Assessment (EIA)

As requested, please find enclosed a pdf copy of the above-mentioned final Environmental Impact Assessment (EIA) for your files. The final EIA includes a concordance table, outlining City of Edmonton reviewer comments and the project team's responses.

Please contact either of the undersigned if you require additional information.

Sincerely,

Spencer Environmental
Management Services Ltd.

Kesia Miyashita

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Neil Robson, DIALOG

AA17:06: Environmental Impact Assessment for Groat Road Bridges Rehabilitation Project: Groat Road Bridge over the North Saskatchewan River (B0559), Groat Road Bridge over Victoria Park Road (B060) and Emily Murphy Park Road Bridge over Groat Road (B099)

Concordance Table - Response to Comments Received: 15 May 2017

August 2017

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
1. BIODIVERSITY + RIVER VALLEY PLANNING UNIT, URBAN ANALYSIS (Achyut Adhikari, 15 May 2017)		
The Biodiversity and River Valley Planning Unit, Urban Analysis has completed our review and circulation of the above mentioned report and has the following comments from our River Valley reviewing agencies.	N/A	**N/A**
It looks like the access road construction will result significant river bank instability and potential loss of riparian habitat. Please consider Best Management Practices considering geotechnical recommendation to ensure that the access road will be restored and no residual impacts will results in permanent habitat loss and potential sedimentation issue.	As stated in *Section 2.3.3.1* of the draft EIA, the proposed access road will be situated instream along the toe of the river bank and will likely be built from Class 1 riprap. The instream section will be approximately 190 m long and 5-6 m wide. Some vegetation clearing and placement of fill will be required to access the instream road from a previously disturbed area adjacent to an existing outfall upstream of the bridge that offers a shallower point-of-entry for construction equipment from the nearby SUP. That bank area will be reclaimed post-construction. Mitigation for potential impacts resulting from the instream access road at the toe of the slope will follow DFO requirements.	**Section 2.3.3.1**
Does this study examine an alternative plan considering access road route selection?	Access to the river from the north river bank is challenging due to steep and high (approximately	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
	12 m) slopes in the vicinity of Pier 1. Alternative access points down the river bank to the river are not described in the draft EIA: the proposed access ramp location immediately downstream of the outfall was determined in the field during a site visit with City of Edmonton Transportation Planning & Design, DIALOG and Spencer Environmental. That location was preferred because it does not require cuts into the steep river bank adjacent to River Valley Road. Rather, the proposed access ramp to the instream access route will utilize an existing area of shallower slopes and previous disturbance near the existing outfall upstream of the bridge.	
If the project consider installation of street/bridge light, due consideration should to in place to avoid direct impact to the aquatic and terrestrial wildlife movement if applicable.	As stated in *Sections 2.3.3.1* and *5.1.4.2* of the draft EIA, bridge street lighting will remain consistent with the current condition (streetlights along bridge median). Proposed enhanced lighting would comprise lights directed upwards from the girders to the underside of the cantilevered slab on both sides of the bridge and low level pedestrian lighting over the sidewalk on one side of the bridge. If enhanced lighting is installed, it will be controlled/shielded to prevent light pollution into the river valley (including aquatic and terrestrial wildlife habitats), consistent with Dark Sky protection best practices and strategic actions listed in *The Way We Green*.	**Sections 2.3.3.1 and 5.1.4.2**
DRAINAGE SERVICES, CITY OPERATIONS		
Drainage Services, City Operations reviewed attached report and we have following comments/concerns	N/A	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
Height of the berm will be 600 mm above seasonal (?) water level – this has been determined on average seasonal water level for NSR? What is the plan if water level gets above this – 600 mm. Please explain how this was decided?	Please see comment below regarding DFO review.	**N/A**
Stormwater detention on the site (during construction)?	Please see comment below regarding DFO review	**N/A**
Stage 4 of the berm – following are DFO requirements for instream work: • Protect the natural stream conditions and structure to promote stability of bank and bed structures, and retain riparian vegetation. • Provide the instream conditions required for unhindered fish passage upstream and downstream. • Prevent introduction of pollutants and deleterious substances by controlling construction activities and site conditions. • Prevent generation of sediment, impacting fish and aquatic habitat, by utilizing the proper instream construction technique and supervision. All of the above will be impossible with staging the berm the way presented in the report? Comments?	Please see comment below regarding DFO review	**N/A**
As long as DFO/EC approves this methodology (berm transfer and other) please disregard above comments – all of them.	A Request for Review was submitted to DFO on 21 April 2017 and is pending results of their review.	**N/A**
Prevent pollution and continually improve environmental performance – City of Edmonton Environmental Policy is one of the policies that this project will follow in its design and construction – Hydrology, surface water and drainage section needs to address bridge surface water management design including additional surface of the bridge (and additional runoff) and how is new design addressing above statement.	As stated in *Section 2.3.4* of the draft EIA, proposed bridge repairs will include deck replacement and a two-stage deck drainage system. Deck drainpipe orifices will be positioned so that they are 50 mm above the road surface, allowing water to run from the crest near the middle of the bridge, past the drainpipes, toward the abutments and into underground oil	**Section 2.3.4**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
	grit separators situated near the abutments. Separators will remove pollutants and the treated runoff will then discharge into the existing stormwater management system. During extreme storms, deck water level will rise above the drain orifices, enter the drainpipes and overflow to the river. During those events, runoff pollutants will be diluted.	
PARKS AND ROADS SERVICES, CIVIC EVENTS AND PARTNERSHIPS SECTION (Nicole Fraser)		
I have no objection with this project moving forward and no comments on the environmental review.	N/A	**N/A**
I did want to mention that each year, Parks places raised planters in the intersections and along the roadway in the Groat Road Interchanges, Emily Murphy Park interchanges, and Hawrelak Park entrance area including near the bridges. The beautification effort is associated with the ITU Triathlon route that occurs in this area, as well as for events in Hawrelak Park. Parks also has hanging flower basket brackets attached to the light poles in these areas. Will this area (within the boundaries of the study area illustrated in the report) be unsuitable for placement of flower planters (on the ground) and hanging baskets (on poles) from 2018-2020?	Once a contractor is on board and the proposed schedule and staging for the project is known, the Project team will share with Parks and Civic Events the specifics of the work and will include a detailed map with locations where we would not be able to facilitate the raised planters and hanging flower brackets within our project limits due to inaccessibility and disturbance potential during some of the construction period. There may be locations where we cannot facilitate either of these beautification efforts for the entire duration, and there may be areas where we cannot facilitate these planters and baskets for only a portion of time.	**N/A**
Maintenance for these planters involves Parks water trucks often hopping the curb in these interchanges or stopping on the road for watering and care of flowers. If the construction and traffic will impact these areas significantly, not allowing for placement/watering/care of the plant material, then we would likely remove planters and hanging baskets from these areas	We will outline where planters and baskets cannot be facilitated from a maintenance perspective once the contractor has submitted a detailed schedule and staging plan.	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
for the next few years starting in 2018. In 2017 these planters and baskets will be delivered starting in June.		
If any hanging basket brackets are needed to be removed from street light poles in or near the construction area prior to construction please contact Nicole Fraser and Amber Brant, Beautification and Greening Initiatives, Parks and Roads Services, City Operations	It is anticipated that once the contractor has provided a schedule and staging plan, the project team will be able to provide Parks and Road Services, City Operations with a map and date and list of the locations where these hanging baskets will need to be removed.	**N/A**
RIVER VALLEY PARKS AND FACILITIES (Juanita Spence)		
General statement – both Parks and Golf Courses would like to understand what further engagement is planned with City stakeholders. It is referenced on page that ongoing consultation will be taking place, however not indicated when or in what format.	The City project team will be meeting with the City stakeholders during the detailed design phase, after the tendering of the project, and again prior to and throughout the project as details of the construction are confirmed including construction schedule details and staging. As specific roadways, pedestrian facilities, and parks are impacted this information will be shared at the first available opportunity.	**N/A**
Emily Murphy Park • Details required as to what extent the contractor will maintain the road during construction – where does it start and end? Will the road be closed, and if so what does the closure mechanism look like to deter access?	As stated in *Sections 2.3.11* and *5.2.1.1* of the draft EIA, the contractor will maintain the internal park roadway throughout construction. That roadway will be reconstructed at the end of the bridge project. During construction, access will be shared between recreationalists and construction vehicles and public park access will be maintained throughout construction.	**Sections 2.3.11 and 5.2.1.1**
Government House Park • The extent of use of the multi-use trail needs to be included in Figure 2.6 • The trail will need to be restored to City of Edmonton	The current construction plan is for the trail to remain open except where shown in Figure 2.6 of the draft EIA. The contractor and project will be responsible for restoring any sections of trail,	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
standards through the construction area • The parking lot is anticipated to require re-surfacing, particular if heavy equipment is moving through to support berm and access road construction. • These trails are important bicycle commuter routes, and popular for fitness/recreational use. Detours will be challenging, particularly if the road/interchange work goes through. Please contact Jody Virr to discuss pedestrian/cycling routes to ensure adequate detours can be accommodated.	road and parking damaged by construction. The use of Government House Park, complete with accompanying trail and parking lot impacts has been arrived at in consultation with Parks (Jody Virr) to minimize the impacts to users. Any additional or modifications would not be permitted unless discussed and agreed upon with Parks.	
Hawrelak Park • The temporary road to allow SB access to Hawrelak Park is critical, particularly to support major events in the park.	As indicated on Figure 2.6 of the draft EIA, the temporary road is intended to maintain southbound traffic access to the University Area, Hawrelak Park and Mayfair Golf Club when the contractor is working on the west half of the bridge.	**Figure 2.6**
Victoria Golf Course • The "study area" in one of the diagrams encompasses hole #5 and #6 in the mapping which seems inconsistent with the other plans. Please confirm that this plan was just for the EIA and not representative of the construction zone.	Confirmed. As stated in *Section 1.3* of the draft EIA, the study area presented in Figure 1.1 and used in subsequent figures was developed for the EIA to encompass direct and indirect impacts and does not represent the construction zone. Anticipated construction and staging areas are shown on Figure 5.1 (hatched areas).	**N/A**
• Ensure project prepares communication plans for disruptions to golf course access and to manage traffic and/or transportation detour signage accordingly.	It is not anticipated that access to Victoria Golf course will be impacted as part of the bridge work. Any traffic disruptions will be communicated to stakeholders in advance with alternates/detours provided where possible. The project will work with Traffic Operations on signing all roadway and pedestrian impacts	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
	accordingly and in advance of changes. This project will also issue Traffic New Disruptions through media as the project progresses and changes occur to traffic patterns.	
PARKS AND ROADS SERVICES, CITY OPERATION (Mark Walz)		
Conditional requirement: Commitment and sign-off of approved access/egress of proposed staging/laydown areas – Project personnel (Prime Contractor and Sub-trades) shall conditionally adhere to designated approved areas outlined (fenced off) based off approved documents or plans. No additional open park-space areas are to be used temporarily for staging locations without the permitted consent of Parks. • 2.3.11 Construction Laydown Areas and Access	Comment noted. Aside from the areas previously identified for construction laydown, should additional area be needed or the area identified not be suitable, permission will be sought from Parks.	**N/A**
Additions: See corrections (in bold italics, below) to add in the EIA report.	N/A	**N/A**
2.4.3.8 Corporate Tree Management Policy C456***A*** All ornamental trees and natural treed areas on City-owned property are the responsibility of ***City of Edmonton, implemented by*** Edmonton Facility and Landscape Infrastructure (including procurement, maintenance, protection and preservation) pursuant to the City of Edmonton's Corporate Tree Management Policy (C456***A***). That policy states that where damage to or loss of City trees or shrubs occurs, ***as a result of not complying with the City Guidelines,*** equitable compensation for that loss will be recovered from the entity causing the damage or loss and applied to future tree (canopy) replacement. Compensation amounts are dependent on the type of plant species lost or damaged and are calculated using set formula or, in some cases, negotiations between City departments.	The text in *Section 2.4.3.8* of the draft EIA has been revised accordingly.	**Section 2.4.3.8**
Below is our General Conditional requirements:	N/A	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
• A tree protection plan shall be provided prior to startup of construction and implemented throughout all phases of construction.	Tree protection requirements will be included in the contract documents.	**N/A**
• Prior to construction, all City of Edmonton trees within 5 meters of the construction area shall be protected (hoarded) and designated outside the appointed construction zone. If a tree cannot be designated outside this zone, protection requirements still apply and a City of Edmonton Urban Forester must be contacted prior to occupying this space for construction. If tree damage occurs, compensation or value will be enforced and shall be covered by the proponent asper the Corporate Tree Management Policy (C456A).	Comment noted. City of Edmonton Transportation Planning & Design will continue to work with City of Edmonton Urban Forestry to ensure trees are sufficiently protected.	**N/A**
• During construction and/or installation, <u>no</u> vehicles, equipment, construction supplies, or debris shall be placed within 5.0 meters of any tree situated on the City of Edmonton Road Right-Of-Way, Boulevard, Green space/buffer, or Parkland area without the approval of a City of Edmonton Urban Forester. Any soil damage or compaction compromising that trees critical and structural root system shall be corrected by and at cost to the proponent/project. This corrective soil activity or action shall be directed by the Urban Forester. Please be advised that all costs associated with the removal, pruning, replacement, transplanting of trees, and tree protection shall be covered by the proponent as per the Corporate Tree Management Policy (C456A).	Comment noted. City of Edmonton Transportation Planning & Design will continue to work with Urban Forestry to ensure trees are sufficiently protected.	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
OPEN SPACE PLANNING UNIT, CITY PLANNING (Jim Mackie)		
Page 23 – Victoria Bridge/Emily Murphy Bridge – As part of the rehabilitation of these bridges, why can't oil grit separators be installed at this time?	As stated in *Section 2.3.4* of the draft EIA, surface water management at Victoria Bridge and Emily Murphy Bridge will remain unchanged from the existing condition, as the work being undertaken is centered around rehabilitation and maintenance of other elements of the bridges, which do not include the collection systems.	**Section 2.3.4**
Page 25 – Reclamation Phase – Weed infestations are becoming an on-going problem and this is of special concern in River Valley areas. The reclamation of the areas disturbed by construction must include a commitment to a long term plan for weed control and eradication.	As stated in *Section 6.4* of the draft EIA, post-construction monitoring of revegetated areas will be required until desired vegetation becomes established. Where warranted, weed control measures, as prescribed in the contractor's ECO Plan will be implemented. The contractor will be responsible for all weed control during construction.	**Section 6.4**
ENGINEERING SERVICES, INTEGRATED INFRASTRUCTURE SERVICES (Shawn McArthur)		
Engineering Services has reviewed the information provided for the proposed Groat Road Bridges Rehabilitation Project. This information included a Draft Environmental Impact Assessment (EIA), prepared by Spencer, Project Number EP 667, dated April 2017. The EIA included a project- and site-specific geotechnical report prepared by Thurber Engineering Ltd. (Thurber), File 10298, dated July 22, 2016.	N/A	**N/A**
The EIA included a description of site-specific geotechnical information summarized from the appended Thurber geotechnical report. The EIA identified potential impacts that may arise from the geotechnical conditions associated with the proposed development and provided recommended measures to mitigate those impacts.	N/A	**N/A**
The Thurber geotechnical report appended to the EIA appeared	N/A	**N/A**

Review Comment (Verbatim)	Response Approach	EIA Report Section Reference(s)
to be a comprehensive report that included the requisite information to facilitate the design and construction of the proposed development. The Thurber report provided recommendations to be implemented during the design works including verifying the integrity of the pier footing base conditions and the integrity of the concrete. Engineering Services concurs with these recommendations. The Thurber report also provided recommendations to be implemented during construction including inspection by qualified geotechnical personnel during construction. Engineering Services would also concur with this recommendation.		
Based on the information provided, it appears that geotechnical information provided is adequate to facilitate design and construction of the proposed development, and that geotechnical risk associated with this project can be mitigated through the ongoing involvement of the geotechnical engineering consultant. Provided that the recommendations included in the EIA and appended geotechnical report are adhered to and that the geotechnical engineering consultant is involved in future phases of the development, it would appear that the geotechnical aspects of the project will be addressed accordingly. As such, we would have no issues with the project proceeding.	N/A	**N/A**

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1.0 INTRODUCTION

1.1 Background

The City of Edmonton proposes to undertake bridge rehabilitation work for three bridges in the vicinity of Groat Road in Edmonton (collectively referred to as Groat Road Bridges): Groat Road Bridge over the North Saskatchewan River (Groat Road Bridge) (B059), Groat Road Bridge over Victoria Park Road (Victoria Bridge) (B060) and Emily Murphy Park Road Bridge over Groat Road (Emily Murphy Bridge) (B099) (Figure 1.1). In combination, Groat Road, Victoria Park Road, River Valley Road and Emily Murphy Park Road form an important commuter and recreation network in the North Saskatchewan River Valley. That network is well used by all transportation modes (e.g., cyclists, pedestrians and vehicles) and provides access to downtown Edmonton to the east, the University of Alberta to the south, and numerous parks and recreation amenities along the river.

1.1.1 Groat Road Bridge (B059)

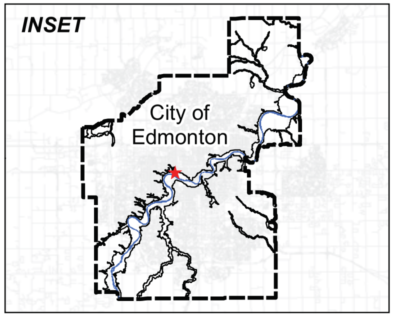
The Groat Road Bridge over the North Saskatchewan River (B059) was constructed in 1955 and is a 289.56 m, 7-span, cast-in-place concrete girder bridge with a composite concrete deck supported on six piers; piers one and six are located on the river bank and the remaining four are located within the main river channel (City of Edmonton 2015) (Plate 1.1). A major rehabilitation was completed on the bridge in 1989-1990 in which longitudinal post-tensioning was added, the deck was widened to provide a wider sidewalk, the two previously separate decks were joined, and other miscellaneous repairs were completed. The bridge carries two lanes of traffic northbound and southbound, respectively, separated by a concrete median, over the North Saskatchewan River and has a sidewalk on the east side of the structure. Street lighting is located in the median. This bridge is not located on a designated truck route.

Plate 1.1. Groat Road Bridge over the North Saskatchewan River – view to south (08 June 2016)

Figure 1.1
Setting and Location
Groat Road Bridges
Rehabilitation

Legend

- ● Outfall
- ☐ Study Area
- ■ Bridge Location
- 🟩 City of Edmonton River Valley Natural Areas (2010)
- ☐ Bylaw 7188 Boundary



Date Map Created: 28 March 2017
Aerial Photograph Date: May 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

DIALOG completed a condition assessment and preliminary rehabilitation strategy report for Groat Road Bridge in 2014 (DIALOG 2017). While they concluded that the bridge was overall in fair to good condition, they did find several deficiencies including: the structural capacity of the girders was not adequate to carry CL-800 truck loading, girder shear strength was inadequate, the expansion joints were in poor condition, the deck concrete and epoxy wearing surface on the deck were in poor to fair condition, the condition of the structural steel members in the pier shafts needed further investigation, the abutment roof slabs had large areas of severe efflorescence and corrosion staining, the sidewalk on the east side was too narrow by current standards and the drainage slopes for the deck were minimal. A review of alternatives for rehabilitation of Groat Road Bridge assessed maintainability, constructability, aesthetics, added functionality, project schedule and environmental impact. Based on this review, the City decided to that rehabilitation of Groat Road Bridge will comprise superstructure replacement at Groat Road Bridge (DIALOG 2017).

The proposed superstructure replacement work will extend the service life of the bridge by at least 75 years with only a deck overlay and regular maintenance performed over that time period. Overall bridge rehabilitation activities also will ensure that the bridge meets the current Canadian Highway Bridge Design Code (CSA S6-14) (DIALOG 2017).

1.1.2 Victoria Park Road Bridge (B060)

Victoria Park Road Bridge (Victoria Bridge) was constructed in 1954 and is a 32.62 m, 3-span, concrete haunched T-girder bridge (City of Edmonton 2015). The bridge carries two lanes of traffic northbound and one southbound, separated by a concrete median, over Victoria Park Road (Plate 1.2). DIALOG undertook a load rating and condition assessment of the Victoria Bridge in 2013 (DIALOG 2016a) and the City would like to proceed with rehabilitation of this bridge. The proposed repairs are expected to extend the service life of the bridge by 50 years, with a deck overlay and regular maintenance performed over that time period (City of Edmonton 2015). This bridge is not located on a designated truck route.

Plate 1.2. Victoria Bridge – view to northeast (20 June 2016)

1.1.3 Emily Murphy Park Road Bridge (B099)

Emily Murphy Park Road Bridge (Emily Murphy Bridge) was constructed in 1963 and is a 59.13 m, 3-span post-tensioned concrete, haunched lab-type bridge (City of Edmonton 2015). The bridge carries up to seven lanes of traffic at the west end merging to four lanes at the east end (two westbound and two eastbound) over Groat Road (Plate 1.3). DIALOG undertook a load rating and condition assessment of the Emily Murphy Bridge in 2013 (DIALOG 2016b) and the City proposes to proceed with rehabilitation of this bridge. The proposed repairs should preserve the remaining service life of the bridge, assuming regular maintenance is maintained, with more extensive repairs required in the future (in approximately 10 years) (City of Edmonton 2015). This bridge is not located on a designated truck route.

Plate 1.3. Emily Murphy Bridge – view to north (20 June 2016)

The preliminary design phase for the Groat Road Bridges has been completed and those preliminary designs form the basis of this environmental assessment.

1.2 Environmental Assessment Objectives

Initial review of the proposed Groat Road Bridges project identified the City of Edmonton as the primary regulator with respect to environmental assessment. The City of Edmonton Sustainable Development Department, which administers the North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188), indicated that one report covering all three bridges was preferable and that the appropriate level of environmental review to comply with Bylaw 7188 would be an Environmental Impact Assessment (EIA). An EIA is indicated because of the proposed Groat Road Bridge (B059) superstructure replacement over the North Saskatchewan River (B059). That work is anticipated to involve instream berms to accommodate construction and, therefore, has greater potential for environmental impacts. Work at the other two bridges (at Victoria Park and Emily Murphy Park roads) will comprise rehabilitation work only, with no changes to the existing superstructure. An Environmental Impact Assessment (EIA) is required, pursuant to Bylaw 7188 and must be submitted to City Council for approval. Preparation of this EIA document covering rehabilitation activities for all three bridges was guided by the following project environmental objectives:

- Meet the requirements for an environmental review of the project pursuant to Bylaw 7188.
- Ensure that all required environmental permits are identified (and eventually secured).
- Achieve an environmentally sound design and ensure that environmental objectives are met during construction.

1.3 Study Area

This impact assessment focuses on the geographic area most likely affected by the proposed bridge rehabilitation work. One study area, encompassing all three bridges and connecting land, covered the following: all lands potentially directly (physical) or indirectly impacted by all stages of the project (construction, operation and disturbance reclamation); any adjacent lands that may be indirectly affected by construction; all park lands (excluding non-park roads) affected by project laydown and access (Figure 1.1). In certain sections of this document, discussions specific to each bridge focus only on the lands within this study area affected by work at that particular bridge. Study area boundaries were delineated through consideration of:

- the location of each of the three bridges and their proximity to each other,
- all potential construction access points and construction laydown areas situated within green space within Bylaw 7188 boundaries,
- ecologically relevant boundaries,
- potential visual impacts, and
- potential reclamation activities.

1.4 Bylaw 7188 Environmental Review Process

Environmental assessments prepared for City of Edmonton Sustainable Development pursuant to Bylaw 7188 are routinely circulated amongst identified City stakeholders for their comments and feedback. The proponent then prepares responses to feedback to the satisfaction of the reviewers and Sustainable Development. Once all outstanding concerns are addressed and reviewers are satisfied with the EIA, Sustainable Development will sign off on the EIA and recommend that it be forwarded to City Council for approval pursuant to the requirements of Bylaw 7188. Sustainable Development has indicated that a Site Location Study (SLS) is not required for this project, as the project consists of superstructure replacement and rehabilitation of *existing* transportation structures.

1.5 Report Organization

This report contains seven chapters. Chapter 1 (Introduction) provides background information related to the project and describes the report structure. Chapter 2 (Project

Description) is the detailed project description, including project justification, the scope of the work, procedures to be used and construction scheduling. Chapter 3 (Methodology) outlines the impact assessment methodology and provides a brief summary of the public consultation process. Chapter 4 (Existing Conditions) and Chapter 5 (Potential Impacts and Mitigation Measures) are organized to describe each potentially affected resource in terms of valued environmental components (VECs). Chapter 6 (Summary Assessment) summarizes findings of the EIA, identifies monitoring requirements and follow-up work. Chapter 7 provides all references and personal communications cited in the report.

Appendices to the report include[1]:

- Appendix A: Groat Road Bridge Berm Plans
- Appendix B: Groat Road Bridges Rehabilitation: Public Feedback Summary
- Appendix C: Groat Road River Bridge Rehabilitation, Edmonton, Alberta: Geotechnical Investigation (Thurber Engineering Ltd. 2016b)
- Appendix D: Phase 1 Environmental Site Assessment: Groat Road Bridges Rehabilitation Project (Thurber Engineering Ltd. 2016a)
- Appendix E: Groat Road Bridge Rehabilitation Hydrotechnical Assessment of Berms – 2D Modeling (Northwest Hydraulic Consultants Ltd. 2017)
- Appendix F. Vegetation Survey Results (20 June 2016)
- Appendix G: Groat Road Bridge Rehabilitation: Fisheries Resources Assessment for Alternative 4b Design Option (Kingfisher Aquatics Ltd. 2017)
- Appendix H: Historical Resources

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[1] In consultation with City of Edmonton Sustainable Development, the environmental impact assessments for the bridge rehabilitation and interchange roadworks were conducted separately; however, due to overlaps in study areas for select VECs, much of the supporting information included in the appendices is common between the two projects.

2.0 PROJECT DESCRIPTION

2.1 Declaration

The project proponent and project manager is the City of Edmonton Transportation Planning & Design and Transportation Infrastructure Delivery. The prime consultant for the proposed Groat Road Bridges project is DIALOG. Spencer Environmental Management Services Ltd. (Spencer Environmental) was retained by DIALOG to act as the environmental consultant responsible for preparation of this EIA.

This report represents the findings and conclusions of the environmental consultants, but it also incorporates suggestions and comments from the proponents and the design team. The specific mitigation measures outlined in this document will be followed by the proponent as part of their commitment to environmental best management practices.

2.2 Project Need/Rationale

Groat Road and three of its component bridges [Groat Road Bridge (B059), Victoria Bridge (B060) and Emily Murphy Bridge (B099)] form an important commuter and recreation route for all transportation modes, including cyclists, pedestrians and vehicles. They provide access to the downtown area via Victoria Park Road and River Valley Road and the University of Alberta via Emily Murphy Park Road and Saskatchewan Drive. In addition, they also provide access to the river valley park system, as Government House Park, Emily Murphy Park and Hawrelak Park can all be accessed by Groat Road or adjacent roadways.

The City of Edmonton and DIALOG undertook bridge condition assessments in 2013 and 2014 for each of the three aging bridges to determine repairs required to extend or maintain the service lives of each of the bridges (DIALOG 2016a, b; DIALOG 2017). Groat Road Bridge over the North Saskatchewan River (constructed in 1955) was identified as requiring the most extensive repair work while the Victoria (constructed in 1954) and Emily Murphy (constructed in 1963) bridges require relatively minor repairs.

2.3 Project Details

2.3.1 Project Setting

The three bridges are located within the North Saskatchewan River valley in central Edmonton, west of downtown (Figure 1.1). That reach of Edmonton's river valley is relatively developed and includes City parks, shared-use paths and informal trails, arterial roadways and golf courses. The area also supports several recognized natural areas (Figure 1.1). Adjacent lands on the north side of the North Saskatchewan River comprise Government House Park to the west and Victoria Golf Course and Driving Range to the east. Shared-use paths and informal trails parallel the river through the study area. The Westmount neighbourhood occupies the tablelands above the river valley terrace on the north side of the river. Adjacent lands on the south side of the North Saskatchewan River comprise Emily Murphy Park and the Royal Mayfair Golf Club. The Windsor Park neighbourhood and the University of Alberta occupy the tablelands near the project area on the south side of the river.

2.3.2 Land Use/Zoning

All project lands are owned by the City of Edmonton. The bed and shore of the North Saskatchewan River is owned by the Province of Alberta.

The North Saskatchewan River Valley in the study area is zoned as A (Metropolitan Recreation Zone (Figure 2.1). Land uses in the immediate vicinity of the proposed project include a major transportation corridor (Groat Road), Government House Park and Victoria Golf Course and Driving Range on the north side of the river, and Emily Murphy Park on the south side of the river. Shared-use paths (SUPs) in this area comprise part of the City's North Saskatchewan River Valley and ravine system trail network. On the tablelands on the north side of the river are the Westmount neighbourhood (various zonings) and the Royal Alberta Museum (now closed to the public) (zoned AJ). On the tablelands on the south side of the river is the Windsor Park neighbourhood (various zonings) and the University of Alberta (zoned AJ).

Figure 2.1. Land Use Zoning in the Groat Bridges Rehabilitation Project Area (taken from City of Edmonton Zoning Bylaw No. 12800, as amended)—red stars denote the three bridge locations

2.3.3 Scope of Proposed Work/Key Project Components

The scope of proposed work and key project components are:

- Replacement of the Groat Road Bridge (B059) superstructure.
- Rehabilitation of Victoria (B060) and Emily Murphy (B099) bridges.
- Post-construction site reclamation.

The following sections describe each of the bridges and their respective key project components in more detail.

2.3.3.1 Groat Road Bridge (B059)

Proposed rehabilitation work at Groat Road Bridge will comprise the following (Figure 2.2) (DIALOG 2017):

- Demolition of the existing deck and girders.
- Removal and replacement of abutment seat, bearings, roof slab, and beams.
- Removal, rehabilitation and reconstruction of fieldstone facing slabs.
- Realignment of roadway at abutments.
- Addition of four new abutment support piles at south abutment.
- Installation of new steel plate girders.
- Installation of new concrete deck, barriers, railings, drains and new asphalt surface and waterproofing system.
- Widening of sidewalk to provide a 3 m clear walkway.
- Installation of underground oil grit separators at each abutment.
- Installation of streetlights on bridge according to standard City requirements.
- Installation of enhanced lighting.

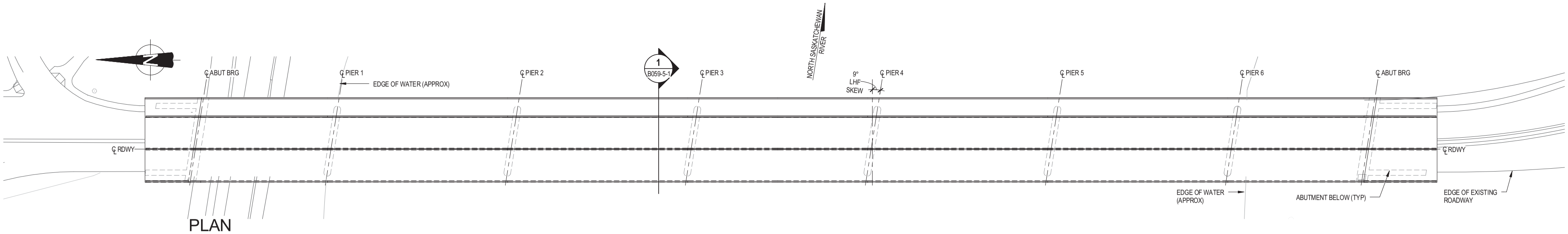
The City of Edmonton requires that the Groat Road Bridge remain available to vehicle and pedestrian traffic during rehabilitation activities. To meet that goal, to maximize construction efficiencies and to mitigate the risk of having debris from demolition falling into the open water, a complex construction methodology was developed by the project team including the installation and use of a series of instream berms in the North Saskatchewan River. The proposed construction staging sequence outlined in more detail below ensures that half of the bridge will be available to north/south vehicular and pedestrian traffic during the construction period.

Design Flood Levels

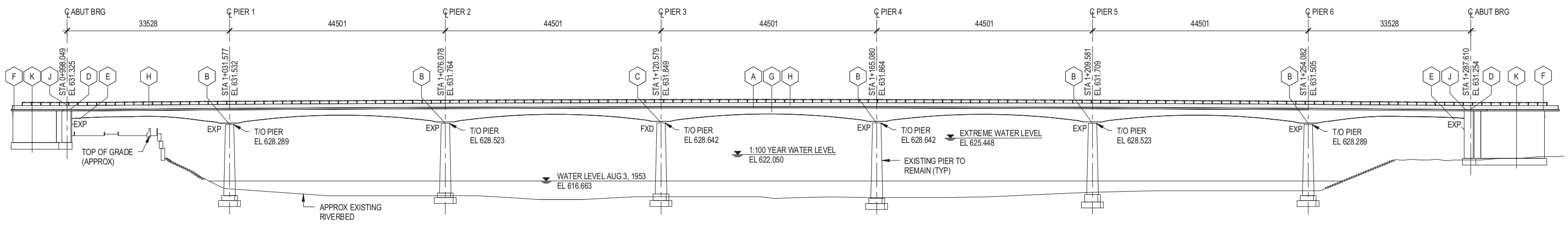
The proposed superstructure replacement will be constructed on the existing bridge piers and abutments. The new superstructure will be designed for a 1:100 flood event, which is estimated to have a discharge of 5,020 m^3 and a high water level geodetic elevation of 620.66 m (DIALOG 2017).

Freeboard/Navigation

The new Groat Road Bridge superstructure will have a longitudinal grade of 0.5%, sloping upwards from north to south and ending at 0.75% sloping downwards. The existing bridge piers will remain in place with the top of the existing bridge piers at an elevation of approximately 628 m (Figure 2.2). At normal (average) water level of 616 m, the minimum clearance will be approximately 12 m. Navigability of the North Saskatchewan River will be maintained as in the current condition.



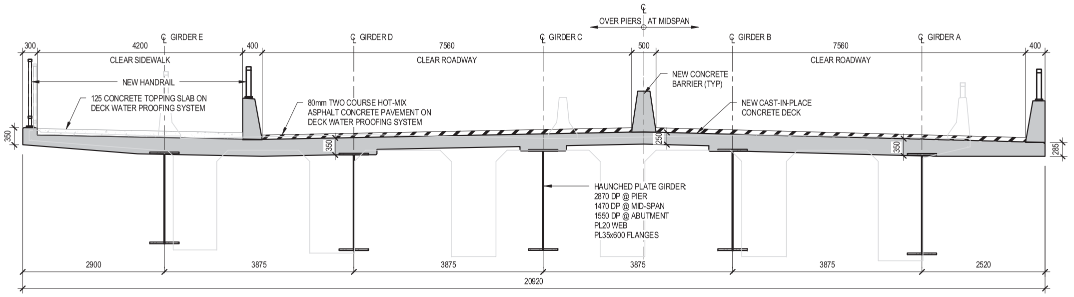
PLAN
SCALE: 1 : 500



ELEVATION
SCALE: 1 : 500 LOOKING EAST

GENERAL SCOPE OF WORK
(CONSTRUCTION SEQUENCE MAY VARY)

A	DEMOLISH EXISTING DECK AND GIRDERS.
B	INSTALL NEW EXPANSION BEARINGS.
C	INSTALL NEW FIXED BEARINGS.
D	REMOVE AND REPLACE ABUTMENT SEAT, BEARINGS, ROOF SLAB, AND BEAMS. ADD FOUR NEW ABUTMENT SUPPORT PILES AT SOUTH ABUTMENT ONLY. REFER TO SHEET B059-4-4 AND DETAIL 1/B059-4-5.
E	REMOVE, REHABILITATE, AND RECONSTRUCT FIELDSTONE FACING SLABS.
F	REALIGN ROADWAY AT ABUTMENTS.
G	INSTALL NEW STEEL PLATE GIRDERS.
H	INSTALL NEW CONCRETE DECK, BARRIERS, RAILINGS, AND DRAINS. INSTALL NEW ASPHALT SURFACE AND WATERPROOFING SYSTEM.
J	INSTALL NEW ABUTMENT DECK JOINT.
K	INSTALL UNDERGROUND OIL GRIT SEPARATORS AT EACH ABUTMENT.



1 SECTION
B059-5-1

SCALE: 1 : 50

Figure 2.2

NO.	REVISIONS	BY	DATE	APP'D

PROGRAM NO.

CONTRACT NO.

NO.	ISSUE	BY	DATE

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

DIALOG

APPROVED FOR CONSTRUCTION

DATE

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF TRANSPORTATION INFRASTRUCTURE DATE

MANAGER OF TRANSPORTATION INFRASTRUCTURE DATE

SURVEY

JOB NO.

SCALE

HOR.

VER.

DRAWN	MTC	2017-01-20
DESIGNED	SAO	2017-01-20
CHECKED	NSR	2017-01-20

THE CITY OF Edmonton

INTEGRATED INFRASTRUCTURE SERVICES

TRANSPORTATION INFRASTRUCTURE BRANCH

PROJECT

GROAT ROAD OVER N SASKATCHEWAN RIVER

REHABILITATION ALTERNATIVE 4B

GENERAL ARRANGEMENT

DRAWING

B059-5-1

Instream Demolition/Construction Staging

Instream berms are proposed to support superstructure demolition and girder erection. Expected berm construction methodology and sequencing is described below (B. Moisey, *pers.comm.*). Detailed construction methodology will be confirmed by the successful contractor.

Detailed drawings showing the proposed seven (7) berm stages and associated access points from the north and south banks of the North Saskatchewan River may be found in Appendix A of this document and a proposed construction schedule for instream works is provided in Figure 2.3. The proposed overall bridge construction period is expected to extend from June 2018 to August 2020, with the instream berm component extending from August 2018 to April 2020.

Demolition/Construction on West Half of Bridge (see Appendix A for berm plan drawings)

- **Stage 1** (No berms in water yet): the end two spans (north and south) would be demolished in this stage to permit abutment rehabilitation work to be completed before the 01 August window opens for instream work.

- **Stage 2** (Berm Stage 1): once the instream window opens, the berm is advanced from the south shore using the access from Emily Murphy Park. The following will apply to all berm work:

    - It is assumed that berms will be constructed from Class 2 riprap. This will allow water to pass through the berm and will keep siltation to a minimum. The berms can be topped with granular material to make passage over the berm smoother.
    - The top of each berm will extend up to 6.0 m outside of the plan view of the bridge segment that is being demolished.
    - It is assumed that the sideslopes of each berm will be a maximum of 2V:1H.
    - It is assumed that the height of each berm will be 600 mm above the seasonal water level.
    - Crane pads (approximately 10 m x 10 m) may need to be incorporated into the berm footprint to allow for girder erection.

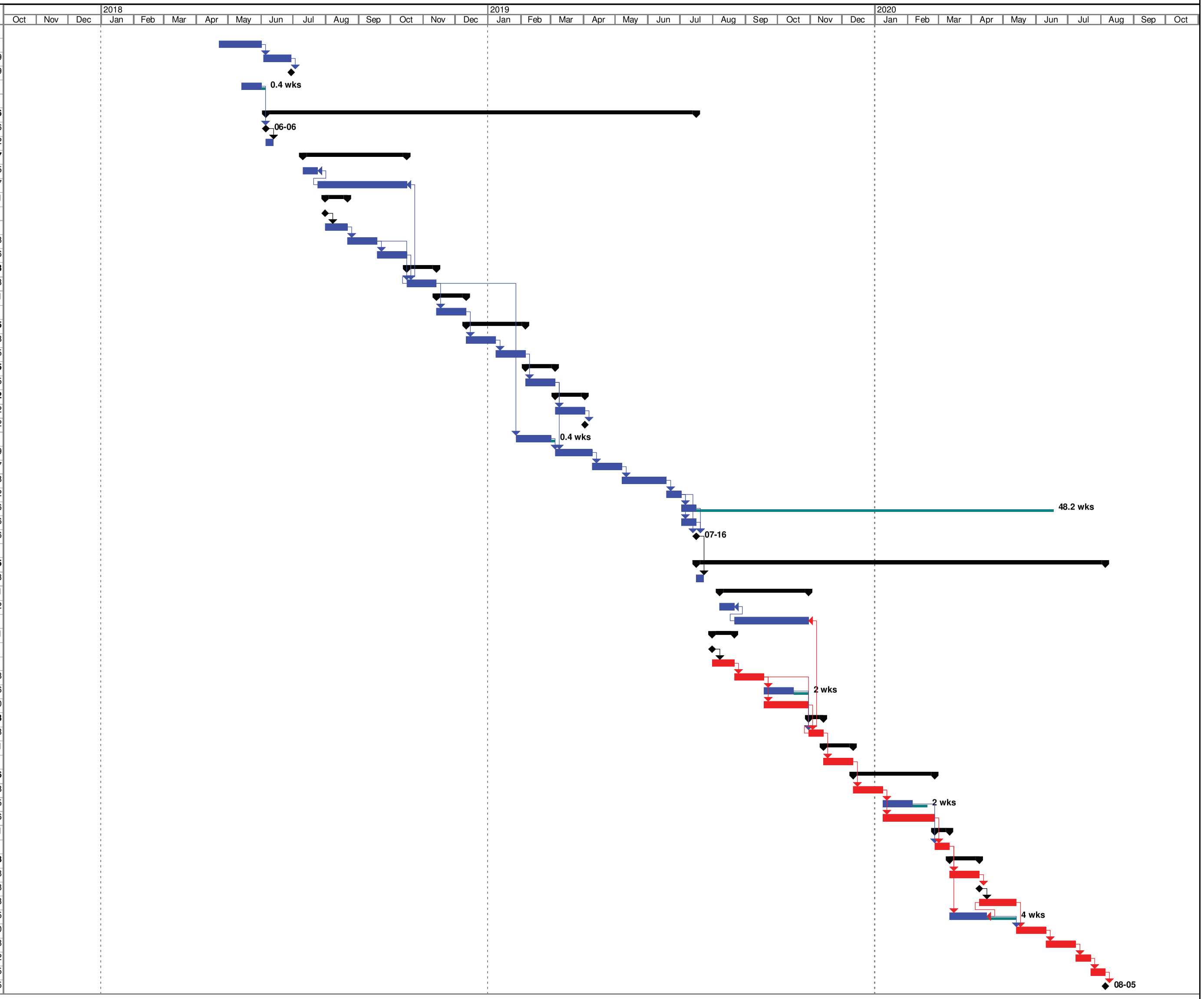
  Demolition will be completed on spans 2, 3 and 4 from the south end using a combination of hoe mounted hydraulic “crunchers” and hydraulic hammers. Demolition material would be hauled off the site to the south.

- **Stage 3** (Berm Stage 1): Cranes will be located on crane pads on the instream berm and the girders may be lifted from trucks on the berm or on the bridge. In general, girders will be erected on the three most southern spans, commencing with the abutment girder. The length of the girders (44 - 47 m) can be placed

Figure 2.3

Groat Road Bridge - Option 4 - With Pier Modifications - Upper and Lower

ID	ℹ	Task Name	Duration	Start	Finish
1					
2	▦	Tender Period	6 wks	Mon 18-04-23	Fri 18-06-01
3		Tender Evaluation	4 wks	Mon 18-06-04	Fri 18-06-29
4		Contract Award	0 days	Fri 18-06-29	Fri 18-06-29
5	▦	Move Utilities	3 wks	Mon 18-05-14	Fri 18-06-01
6					
7		**WEST Side Work - 2018 / 2019**	**290 days**	**Wed 18-06-06**	**Tue 19-07-16**
8	▦	Mobilize to site	0 days	Wed 18-06-06	Wed 18-06-06
9		Implement Traffic Control	1 wk	Wed 18-06-06	Tue 18-06-12
10		**Stage 1**	**70 days**	**Wed 18-07-11**	**Wed 18-10-17**
11		Demo End Spans	2 wks	Wed 18-07-11	Wed 18-07-25
12		Abutment Reconstruction	12 wks	Wed 18-07-25	Wed 18-10-17
13		**Stage 2**	**15 days**	**Wed 18-08-01**	**Tue 18-08-21**
14	▦	In Stream Window Open	0 days	Wed 18-08-01	Wed 18-08-01
15		Install Berm	3 wks	Wed 18-08-01	Tue 18-08-21
16		Demo spans 2, 3 and 4	4 wks	Wed 18-08-22	Tue 18-09-18
17		Pier Modifications	4 wks	Wed 18-09-19	Tue 18-10-16
18		**Stage 3**	**20 days**	**Wed 18-10-17**	**Tue 18-11-13**
19		Erect South Girders - 3 spans	4 wks	Wed 18-10-17	Tue 18-11-13
20		**Stage 4**	**20 days**	**Wed 18-11-14**	**Tue 18-12-11**
21		Move berm to north side	4 wks	Wed 18-11-14	Tue 18-12-11
22		**Stage 5**	**40 days**	**Wed 18-12-12**	**Tue 19-02-05**
23		Demo north spans	4 wks	Wed 18-12-12	Tue 19-01-08
24		Pier Modifications	4 wks	Wed 19-01-09	Tue 19-02-05
25		**Stage 6**	**20 days**	**Wed 19-02-06**	**Tue 19-03-05**
26		Erect North Girders	4 wks	Wed 19-02-06	Tue 19-03-05
27		**Stage 7**	**20 days**	**Wed 19-03-06**	**Tue 19-04-02**
28		Move / store berm materials	4 wks	Wed 19-03-06	Tue 19-04-02
29		Instream Work Complete	0 days	Tue 19-04-02	Tue 19-04-02
30	▦	Form south deck	5 wks	Mon 19-01-28	Fri 19-03-01
31		Form north deck	5 wks	Wed 19-03-06	Tue 19-04-09
32		Cast Deck	4 wks	Wed 19-04-10	Tue 19-05-07
33		Form and cast barrier	6 wks	Wed 19-05-08	Tue 19-06-18
34		Waterproof / pave	2 wks	Wed 19-06-19	Tue 19-07-02
35		Complete tie ins	2 wks	Wed 19-07-03	Tue 19-07-16
36		Move utilities	2 wks	Wed 19-07-03	Tue 19-07-16
37		Open for traffic	0 days	Tue 19-07-16	Tue 19-07-16
38					
39		**EAST Side Work - 2019 / 2020**	**276 days**	**Wed 19-07-17**	**Wed 20-08-05**
40		Switch Traffic Control	1 wk	Wed 19-07-17	Tue 19-07-23
41		**Stage 8**	**60 days**	**Thu 19-08-08**	**Thu 19-10-31**
42		Demo End Spans	2 wks	Thu 19-08-08	Thu 19-08-22
43		Abutment Reconstruction	10 wks	Thu 19-08-22	Thu 19-10-31
44		**Stage 9**	**15 days**	**Thu 19-08-01**	**Wed 19-08-21**
45	▦	In Stream Window Open	0 days	Thu 19-08-01	Thu 19-08-01
46		Install Berm	3 wks	Thu 19-08-01	Wed 19-08-21
47		Demo spans 6, 5 and 4	4 wks	Thu 19-08-22	Wed 19-09-18
48		Pier Modifications - Top	4 wks	Thu 19-09-19	Wed 19-10-16
49		Pier Modifications - Hinge (1 of)	6 wks	Thu 19-09-19	Wed 19-10-30
50		**Stage 10**	**10 days**	**Thu 19-10-31**	**Wed 19-11-13**
51		Erect North Girders - 3 spans	2 wks	Thu 19-10-31	Wed 19-11-13
52		**Stage 11**	**20 days**	**Thu 19-11-14**	**Wed 19-12-11**
53		Move berm to south side	4 wks	Thu 19-11-14	Wed 19-12-11
54		**Stage 12**	**55 days**	**Thu 19-12-12**	**Wed 20-02-26**
55		Demo south spans	4 wks	Thu 19-12-12	Wed 20-01-08
56		Pier Modifications - Top	4 wks	Thu 20-01-09	Wed 20-02-05
57		Pier Modifications - Hinge (2 of)	7 wks	Thu 20-01-09	Wed 20-02-26
58		**Stage 13**	**10 days**	**Thu 20-02-27**	**Wed 20-03-11**
59		Erect South Girders	2 wks	Thu 20-02-27	Wed 20-03-11
60		**Stage 14**	**20 days**	**Thu 20-03-12**	**Wed 20-04-08**
61		Remove berm materials	4 wks	Thu 20-03-12	Wed 20-04-08
62		Instream Work Complete	0 days	Wed 20-04-08	Wed 20-04-08
63		Form North Deck	5 wks	Thu 20-04-09	Wed 20-05-13
64		Form South Deck	5 wks	Thu 20-03-12	Wed 20-04-15
65		Cast Deck	4 wks	Thu 20-05-14	Wed 20-06-10
66		Form and cast barrier	4 wks	Thu 20-06-11	Wed 20-07-08
67		Waterproof / pave	2 wks	Thu 20-07-09	Wed 20-07-22
68		Complete tie ins	2 wks	Thu 20-07-23	Wed 20-08-05
69		Open for traffic	0 days	Wed 20-08-05	Wed 20-08-05



Proposed Groat Road Bridge Construction Schedule

Project: Groat Road Bridge - OPTION
Date: Wed 17-03-29

Critical	🟥	Task	🟦	Progress	▬	Slack	▬	Summary	▬	Rolled Up Critical	🟥	External Tasks	▬	Deadline	⇩
Critical Split	⋯	Split	⋯	Milestone	◆	Slippage	▬	Project Summary	▬	Rolled Up Critical	⋯	External Milestone	◆		

without any shoring towers. This will significantly lower the risk involved in girder erection.

- **Stage 4** (Berm Stage 2): this stage involves moving the berm from the south side of the river to the north side. Two potential methods are proposed:
    - The proposed methodology assumes that the berms will be moved instream meaning that equipment would excavate berm materials from the south end of the berm and move them to the north end of the berm with either trucks or loaders. The work would essentially be completed on an island and a plan would have to be in place for the access / egress of workers (e.g., stair tower until the berm is advanced to the north shore). Specific environmental requirements for refueling/containment during instream work are provided in *Sections 5.1.2.1* and *5.1.2.2*.
    - Alternatively, the berm could be moved in a more traditional manner such as excavating from the north end of the berm, and trucking materials over the existing bridge, and constructing the north berm from the north shore. This would create icing issues throughout the haul route that will have to be addressed. This option is currently not being assumed.

- **Stage 5** (Berm Stage 3): the remaining two spans of the bridge will be demolished. The demolition materials will be removed using the north access.
    - Access from the north river bank is challenging due to steep and high (approximately 12 m) slopes in the vicinity of pier 1. To that end, access is proposed from an area upstream adjacent to an existing outfall where there is a shallower point of entry that would require some vegetation clearing and fill. The proposed access would ramp down to the water, intersecting with the existing streambed about 190 m upstream from the bridge. An access road, likely built from class 1 riprap, would be built along the toe of the slope to the work area with a top width of approximately 5-6 m and be approximately 300 mm above the seasonal water level.

- **Stage 6** (Berm Stage 3): erection of the remaining girders starting from the north end. Girder #7 would be dropped in place to connect the south and north sides of the bridge.

- **Stage 7** (Berm Stage 4): to maximize efficiencies and reduce the footprint of the berm in the water during periods of high flow, it is proposed that the berm material (Class 2 rip rap) be stockpiled in a reduced area within the watercourse between March 2019 and August 2019. The 9,400 m^3 of rock would remain in a footprint of approximately 30m x 40m x 8m deep (plan dimensions could vary). This “platform” would be located primarily between the north bank and the first river pier.

Demolition/Construction on East Half of Bridge

- **Stage 8** (Berm Stage 4): the two end spans (north and south) are to be demolished in this stage to permit the abutment rehabilitation work to be completed before the August 1 instream works window re-opens.

- **Stages 9-14** (Berm Stages 5-7): Berm construction would begin on August 1 when the instream works window opens and the "reverse" of the works on the west side structure would be repeated on the east structure.

  Pier base strengthening work will be undertaken as part of Berm Stages 5-7 (Appendix A). During Berm Stage 5, the berm will be locally extended around the base of Pier 2 and a cofferdam will be built around Pier 2. The method of dewatering will be determined by the contractor and may comprise a non-dispersive clay berm, fine granular material, hydraulic barriers, ice berm or sheet piles. A reinforcing steel and concrete collar will be installed at the base of Pier 2. Similarly, during Berm Stage 7, the berm will be locally extended around the base of Piers 4 and 5, with the methodology consistent with Pier 2 strengthening work.

After the girders on the east side are completed, all instream berm material is expected to be removed from the river by April 2020.

Bridge Lighting

Bridge street lighting will remain consistent with the current condition where streetlights will be situated along the bridge median. Proposed enhanced lighting on the new bridge superstructure will comprise light directed upwards from the girders to the underside of the cantilevered slab on both sides of the bridge, with low-level pedestrian lighting over the sidewalk (N. Robson, *pers. comm.*). All lighting will be controlled/shielded to prevent light pollution into the river valley, consistent with Night Sky protection best practices.

Emily Murphy Park Boat Dock

City of Edmonton City Council previously approved the Bylaw 7188 EIA and Site Location Study for a new boat dock facility in Emily Murphy Park at the existing hand launch area immediately east of the Groat Road Bridge (Spencer Environmental 2016). To maximize construction efficiencies due to overlapping project areas and construction timelines between the bridge and boat dock projects, construction of the boat dock facility will be completed as part of the Groat Road Bridge rehabilitation project. Boat dock project construction is expected to occur at the end of the bridge rehabilitation project in spring/summer 2020. Environmental impacts and mitigation measures associated with proposed construction of the Emily Murphy Park boat dock are addressed under separate cover in the approved *North Saskatchewan River Boat Docks and Launches Environmental Impact Assessment – Final Report* (Spencer Environmental 2016) and will not be addressed in this EIA. The contractor will, however, be expected to implement all approved mitigation measures for boat dock and associated infrastructure construction as outlined in the Spencer Environmental (2016) EIA.

2.3.3.2 Victoria Bridge (B060)

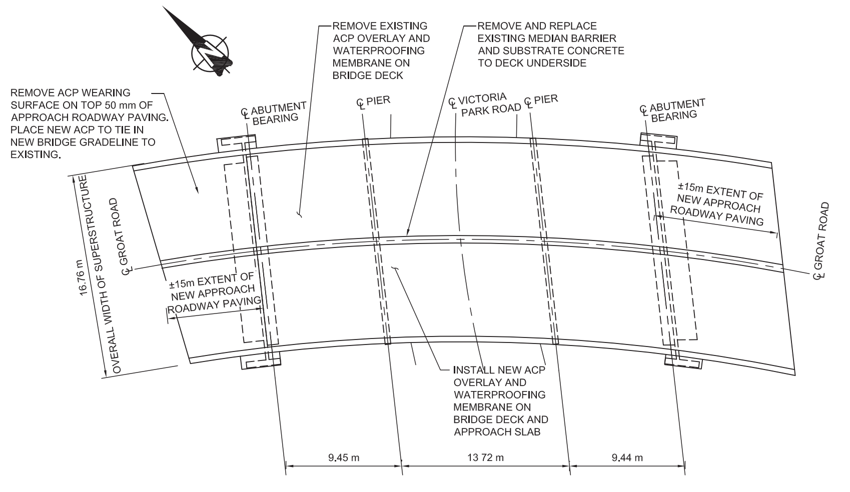
A 2014 condition assessment determined Victoria Bridge to be in generally good condition; however, repairs were recommended to extend the service life of the bridge by 50 years. Proposed rehabilitation of Victoria Bridge will comprise the following (Figure 2.4a and b) (DIALOG 2016a):

- Removal of existing wearing surface
- Partial and full depth repairs to bridge deck concrete
- Partial depth repairs to exterior fascia of superstructure, abutments, piers, and wingwalls
- Removal of backwall
- Median barrier replacement
- New waterproofing membrane and 2-course 80 mm of 10mm-HT ACP wearing surface on bridge deck and approach slabs
- Transition ACP paving
- Application of penetrating sealer inside surface of barriers
- Application of pigmented sealer on exterior fascia of bridge

2.3.3.1 Emily Murphy Bridge (B099)

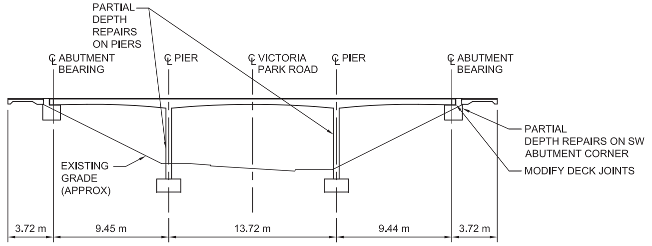
A 2014 condition assessment determined Emily Murphy Bridge to be in generally good condition, and minimal repairs were recommended to maintain the existing service life of the bridge. The recommended rehabilitation for the Emily Murphy Bridge comprises the following work (Figure 2.5) (DIALOG 2016b):

- Partial depth repairs to the substructure
- Construction of a new east deck joint
- Crack repairs to the curbs
- Construction of a new bridgerail on south curb of bridge, designed to TL-2 requirements
- Installation of new crashworthy guardrail terminals at the northeast and southwest approach guardrail turndowns
- Application of penetrating sealer to the deck and medians
- Reconstruction of north sidewalk to 4.2 m wide, with a bicycle railing and a new barrier between the sidewalk and roadway



PLAN

1:200



ELEVATION

1:200

Figure 2.4a

NO	REVISIONS	BY	DATE	APP'D
7				
6				
5				
4				
3				
2				
1	PRELIMINARY DRAWING	MET	2016-08-26	

PROGRAM NO
CONTRACT NO

NO	ISSUE	BY	DATE
3	TO G B I S		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN
CONTRACTOR
SURVEYOR
DATE
FILE NUMBER
CONSTRUCTION ENGINEER DATE
GENERAL SUPERVISOR DATE

DIALOG

PRELIMINARY
NOT FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE
TRANSPORTATION & STREETS TRAFFIC OPERATIONS		
TRANSPORTATION & STREETS ROADWAYS ENGINEERING		
TRANSPORTATION & STREETS TRANSPORTATION PLANNING		
PLANNING AND DEVELOPMENT URBAN DESIGN		
COMMUNITY SERVICES LANDSCAPING		
EPCOR STREET LIGHTING		

DIRECTOR OF ARTERIAL ROADS DESIGN AND CONSTRUCTION DATE
MANAGER OF ROADWAYS DESIGN AND CONSTRUCTION DATE

SURVEY
JOB NO
SCALE
HOR
VER

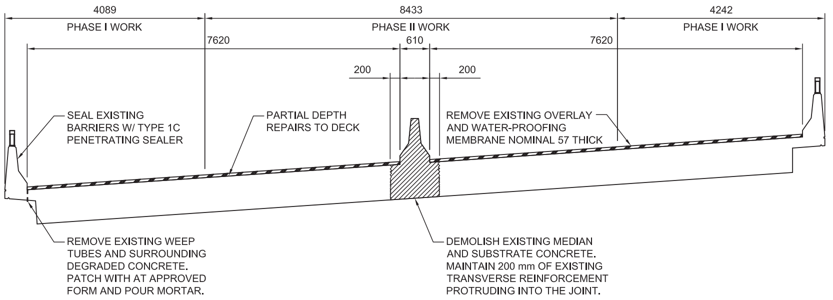
DRAWN MTC DATE AUGUST 2016
DESIGNED MET DATE AUGUST 2016
CHECKED --- DATE AUGUST 2016

THE CITY OF Edmonton

SPECIAL PROJECTS SECTION
TRANSPORTATION INFRASTRUCTURE BRANCH
INTEGRATED INFRASTRUCTURE SERVICES

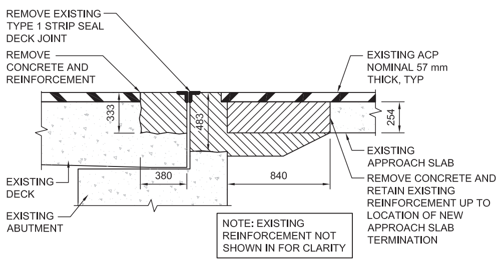
PROJECT
GROAT ROAD OVER VICTORIA PARK ROAD REHABILITATION
GENERAL ARRANGEMENT

DRAWING
B060-1



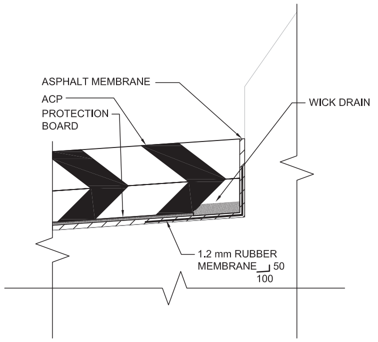
SECTION - EXISTING BRIDGE DECK

1:100



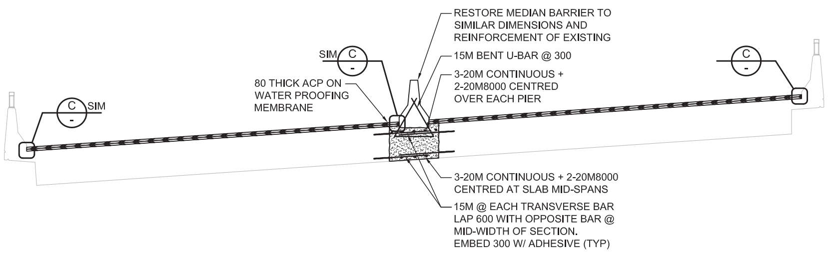
A
-
DETAIL - EXISTING DECK JOINT

(SIMILAR ON OPPOSITE END OF BRIDGE) 1:40



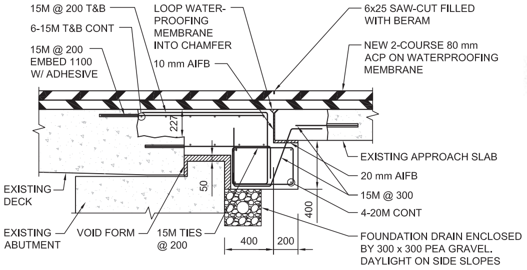
C
-
SECTION - VERTICAL EDGES OF OVERLAY

NTS



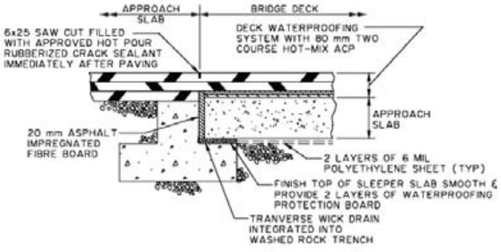
SECTION - NEW MEDIAN AND OVERLAY

1:100



B
-
DETAIL - NEW SEMI-INTEGRAL ABUTMENT JOINT

(SIMILAR ON OPPOSITE END OF BRIDGE) 1:40



CYCLE CONTROL JOINT TYPE C2

Figure 2.4b

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6				
5				
4				
3				
2				
1	PRELIMINARY DRAWING	MET	2014-05-23	

PROGRAM NO
CONTRACT NO

NO	ISSUE	BY	DATE
3	TO G B I S		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN
CONTRACTOR
SURVEYOR
DATE
FILE NUMBER
CONSTRUCTION ENGINEER DATE
GENERAL SUPERVISOR DATE

DIALOG

PRELIMINARY
NOT FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE
TRANSPORTATION & STREETS TRAFFIC OPERATIONS		
TRANSPORTATION & STREETS ROADWAYS ENGINEERING		
TRANSPORTATION & STREETS TRANSPORTATION PLANNING		
PLANNING AND DEVELOPMENT URBAN DESIGN		
COMMUNITY SERVICES LANDSCAPING		
EPCOR STREET LIGHTING		

DIRECTOR OF ARTERIAL ROADS DESIGN AND CONSTRUCTION DATE
MANAGER OF ROADWAYS DESIGN AND CONSTRUCTION DATE

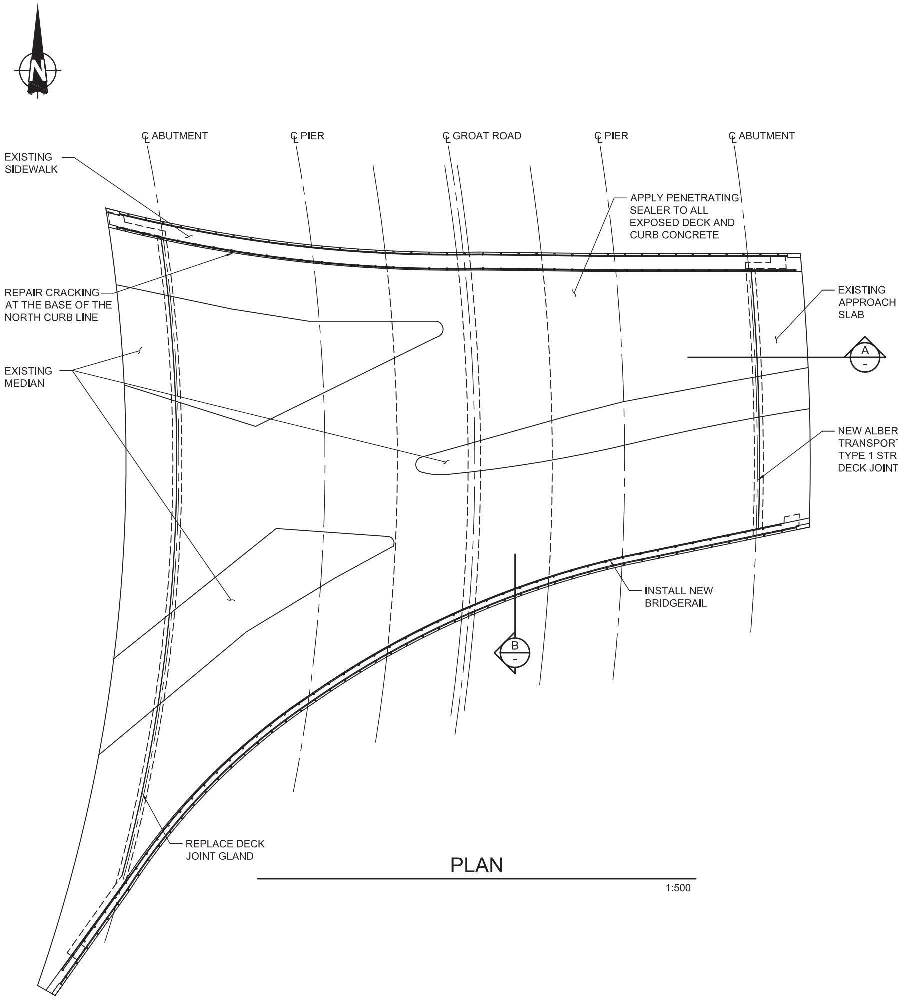
SURVEY
JOB NO
SCALE
HOR
VER

DRAWN MTC DATE AUGUST 2016
DESIGNED MET DATE AUGUST 2016
CHECKED -- DATE JULY 2014

THE CITY OF Edmonton
SPECIAL PROJECTS SECTION
TRANSPORTATION INFRASTRUCTURE BRANCH
INTEGRATED INFRASTRUCTURE SERVICES

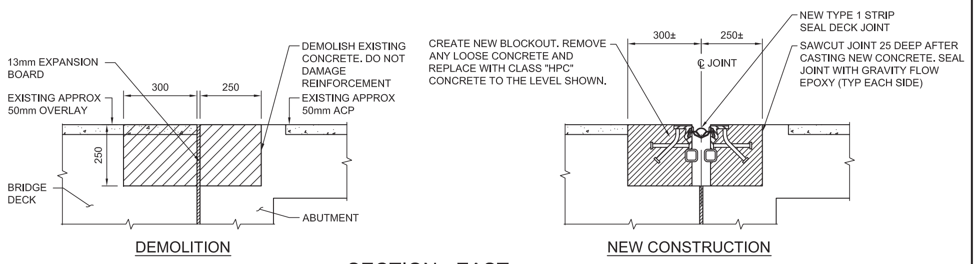
PROJECT
GROAT ROAD OVER VICTORIA PARK ROAD REHABILITATION
REHAB DETAILS - SHEET 1

DRAWING
B060-2



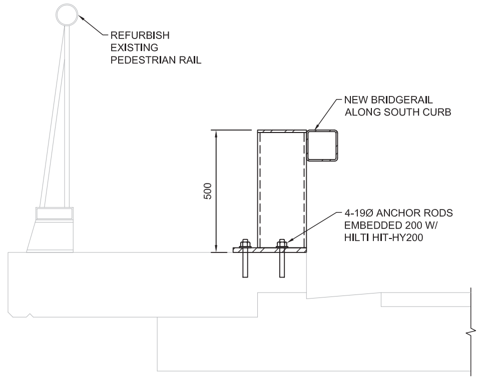
PLAN

1:500



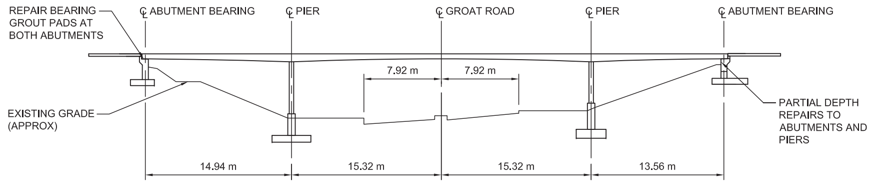
SECTION - EAST
(A/-) ABUTMENT DECK JOINT

1:20



SECTION
(B/-) NEW BRIDGERAIL

1:20



ELEVATION

1:500

Figure 2.5

NO	REVISIONS	BY	DATE	APP'D
7				
6				
5				
4				
3				
2	--	--	--	
1	PRELIMINARY DRAWING	MET	2014-05-23	

PROGRAM NO ______

CONTRACT NO ______

NO	ISSUE	BY	DATE
3	TO G B I S		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

DIALOG™

PRELIMINARY
NOT FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE
TRANSPORTATION & STREETS TRAFFIC OPERATIONS		
TRANSPORTATION & STREETS ROADWAYS ENGINEERING		
TRANSPORTATION & STREETS TRANSPORTATION PLANNING		
PLANNING AND DEVELOPMENT URBAN DESIGN		
COMMUNITY SERVICES LANDSCAPING		
EPCOR STREET LIGHTING		

DIRECTOR OF ARTERIAL ROADS DESIGN AND CONSTRUCTION DATE

MANAGER OF ROADWAYS DESIGN AND CONSTRUCTION DATE

SURVEY

JOB NO

SCALE

HOR

VER

DRAWN MTC DATE AUGUST 2016

DESIGNED MT DATE AUGUST 2016

CHECKED -- DATE AUGUST 2016

THE CITY OF Edmonton

SPECIAL PROJECTS SECTION
TRANSPORTATION INFRASTRUCTURE BRANCH
INTEGRATED INFRASTRUCTURE SERVICES

PROJECT

MAYFAIR INTERCHANGE
REHABILITATION
GENERAL ARRANGEMENT

DRAWING

B099-1

2.3.4 Surface Water Management

Groat Road Bridge (Bridge B059)

Water from the deck of the existing bridge is discharged directly into the river through drain pipes, which penetrate the deck and extend along the outside edge of the exterior girders to their soffit (DIALOG 2016a). Proposed bridge repairs will include deck replacement, and a two-stage deck drainage system. Deck drainpipe orifices will be positioned so that they are 50 mm above the road surface, allowing water to run from the crest near the middle of the bridge, past the drainpipes, toward the abutments and into underground oil grit separators situated near the abutments (DIALOG 2016a). Separators will remove pollutants and the treated runoff will then discharge into the existing stormwater management system. The proposed project area is situated approximately 3 km upstream of the Rossdale Water Treatment Plant. During extreme storms, deck water level will rise above the drain orifices, enter the drainpipes and overflow to the river (DIALOG 2016a). During these events, runoff pollutants will be diluted.

Victoria Bridge (Bridge B060)

Surface water management at Victoria Bridge will remain unchanged from the existing condition. Victoria Bridge has no deck drains; water runs off the end of the bridge and enters a catch basin.

Emily Murphy Bridge (Bridge B099)

Surface water management at Emily Murphy Bridge will remain unchanged from the existing condition. Emily Murphy Bridge has no deck drains; water runs off the end of the bridge and enters a catch basin.

2.3.5 Construction Timing

Groat Road Bridge (Bridge B059)

Pending City of Edmonton budget availability, bridge rehabilitation activities are tentatively scheduled for 2018-2020 (DIALOG 2017). It is estimated that a total of 570 site occupancy days will be required to complete the rehabilitation work on this bridge (S. Oosterhof, *pers. comm.*). A proposed construction schedule is provided in Figure 2.3.

Victoria Bridge (Bridge B060)

Based on preliminary engineering, it is estimated that a total of 60 site occupancy days will be required to complete the rehabilitation work on this bridge (DIALOG 2016a). Rehabilitation will be completed in the same timeframe as Groat Road Bridge.

Emily Murphy Bridge (Bridge B099)

Based on preliminary engineering, it is estimated that a total of 72 site occupancy days will be required to complete the rehabilitation work on this bridge (DIALOG 2016b). Rehabilitation will be completed in the same timeframe as Groat Road Bridge.

2.3.6 Construction Environmental Protection Measures

Responsibility for construction environmental protection measures will lie with the contractor pursuant to the City's Enviso program and, therefore, cannot be fully detailed until after project award. It is expected that the appropriate fuel handling procedures, erosion and sedimentation control measures and occupational health and safety requirements will be followed. Posting warning signs near all active construction traffic access points that are freely accessible to the public will alert the public to the temporary construction activities. Fencing will be erected around staging areas. In addition, the contractor will be required to implement environmental protection measures stemming from mitigation measures identified in this EIA. The City of Edmonton will be obtaining all environmental permits and approvals required for the proposed project and the contractor will be committed to all permit conditions.

The contractor will develop, to the satisfaction of the City, an Environmental Construction Operations (ECO) Plan including a site-specific Erosion and Sedimentation Control (ESC) Plan pursuant to the City's Enviso program and the Environmental Construction Operations Plan Framework 2016. The ESC Plan will include temporary and permanent erosion and sedimentation control measures, as detailed in the City of Edmonton's *Erosion and Sedimentation Control Guidelines* (2005), with particular emphasis on work areas within and adjacent to the North Saskatchewan River, and will be adhered to at all times during construction. All related monitoring will be undertaken by a Certified Professional in Erosion and Sediment Control (CPESC) or equivalent.

2.3.7 Resource and Material Requirements

Key construction materials required during bridge rehabilitation activities will include: concrete, asphalt, steel girders and railing, waterproofing membrane, granular material, geotextile, Class 2 riprap and sealer. Potential hazardous materials on-site will include fuel, lubricants, oils, etc., typically associated with construction equipment. Hazardous materials will be stored at the staging areas away from City storm drains and waterbodies.

2.3.8 Waste Disposal

All waste disposal materials will become the property of the contractor. Waste disposal methods will be at the discretion of the contractor; however, disposal must be at appropriate designated disposal sites remote from the project site and in compliance with environmental regulations. The City of Edmonton requires contractors to develop and maintain a construction material collection and recycling program throughout the duration of the project. As a minimum, 100% of the following materials must be collected and disposed of at an approved recycling facility: concrete, asphalt and asphalt millings, soil cement, granular material and surplus steel material.

2.3.9 Key Project Activities

2.3.9.1 Site Preparation Phase

Several preparatory activities will precede the proposed Groat bridges rehabilitation activities for all three bridges. Those include (not necessarily in this order):

- notification of stakeholders and the general public of the proposed construction schedule,
- relocation/protection of utilities,
- protection (hoarding) of trees selected for retention and removal of vegetation as required,
- coordination of access for project equipment, establishment of interim safety measures for recreationalists, vehicles, etc., and site security,
- establishment of construction staging areas, and
- establishment of erosion and sedimentation control measures, including areas adjacent to the North Saskatchewan River and catch basins and stormwater drains/outfalls leading to the North Saskatchewan River.

2.3.9.2 Construction Phase

The main construction activities for each of the three bridge rehabilitation projects are summarized in *Section 2.3.3*.

2.3.9.3 Reclamation Phase

All disturbed areas in the three respective bridge project areas will be recontoured, topsoiled with Class B topsoil and seeded/planted with native species. Replacement of any trees removed in support of construction will be undertaken during the reclamation phase, in accordance with the *Corporate Tree Management Policy* (C456A) and in consultation with the City of Edmonton.

Specific to the Groat Road Bridge, disturbed river bank areas will be restored to a condition similar to existing conditions without extensive armouring.

2.3.9.4 Operations and Maintenance Phase

The three bridges included in the proposed project will remain a part of the city's roadway network and will be operated by the City of Edmonton. The City of Edmonton will continue to conduct winter and summer maintenance.

2.3.10 Construction Working Hours

Construction will not extend beyond the hours permitted in Part III of the City of Edmonton's Bylaw 14600 (Community Standards Bylaw) (0700-2100 hours Monday to Saturday; 0900-1900 hours Sundays and holidays), unless special permission is granted by the City following standard protocols for exceptions to those Bylaws.

2.3.11 Construction Laydown Areas and Access

DIALOG and City of Edmonton Transportation Planning & Design and Transportation Infrastructure Delivery have developed a potential laydown and parking areas plan that would serve construction of the Groat Road Bridges rehabilitation project (i.e., three bridges) and Groat Road interchange roadworks project (EIA under separate cover), combined. Figure 2.6 illustrates potential laydown areas that are unique to the Groat Road Bridges rehabilitation project, as well as those that may be shared by the two projects. Laydown areas for Emily Murphy Bridge are not shown on Figure 2.6; the current scope of work assumes the laydown areas for that bridge will be situated on existing roadways. The proposed laydown and parking areas plan was submitted to the Facility and Landscape Infrastructure Branch (formerly Parks Department) for review and was deemed acceptable.

As noted on Figure 2.6, access to the Groat Road Bridge site will be through Government House Park on the north side of the river and from Emily Murphy Park on the south side of the river. Parking Lot 1 in Government House Park will be provided to the contractor for parking throughout the project. Access through the lot and along a section of multi-use trail will be provided during instream berm, bridge demolition and erection on the north half of the bridge. Parking Lot 2 and its associated access roadway will remain open to the public for the duration of the proposed project.

Construction access through Emily Murphy Park will be along the internal park roadway to the existing parking lot near the south end of the Groat Road Bridge. The contractor will maintain the internal park roadway throughout construction. That roadway will be reconstructed at the end of the bridge project. In addition, the contractor will be required to maintain a public trail connection through Emily Murphy Park along the river in the project area and provide an alternate access to the Royal Mayfair Golf Club when their primary access under the bridge is blocked.

Contractors will access the Victoria and Emily Murphy Bridge project areas using existing City roadways.

2.3.12 Construction Equipment

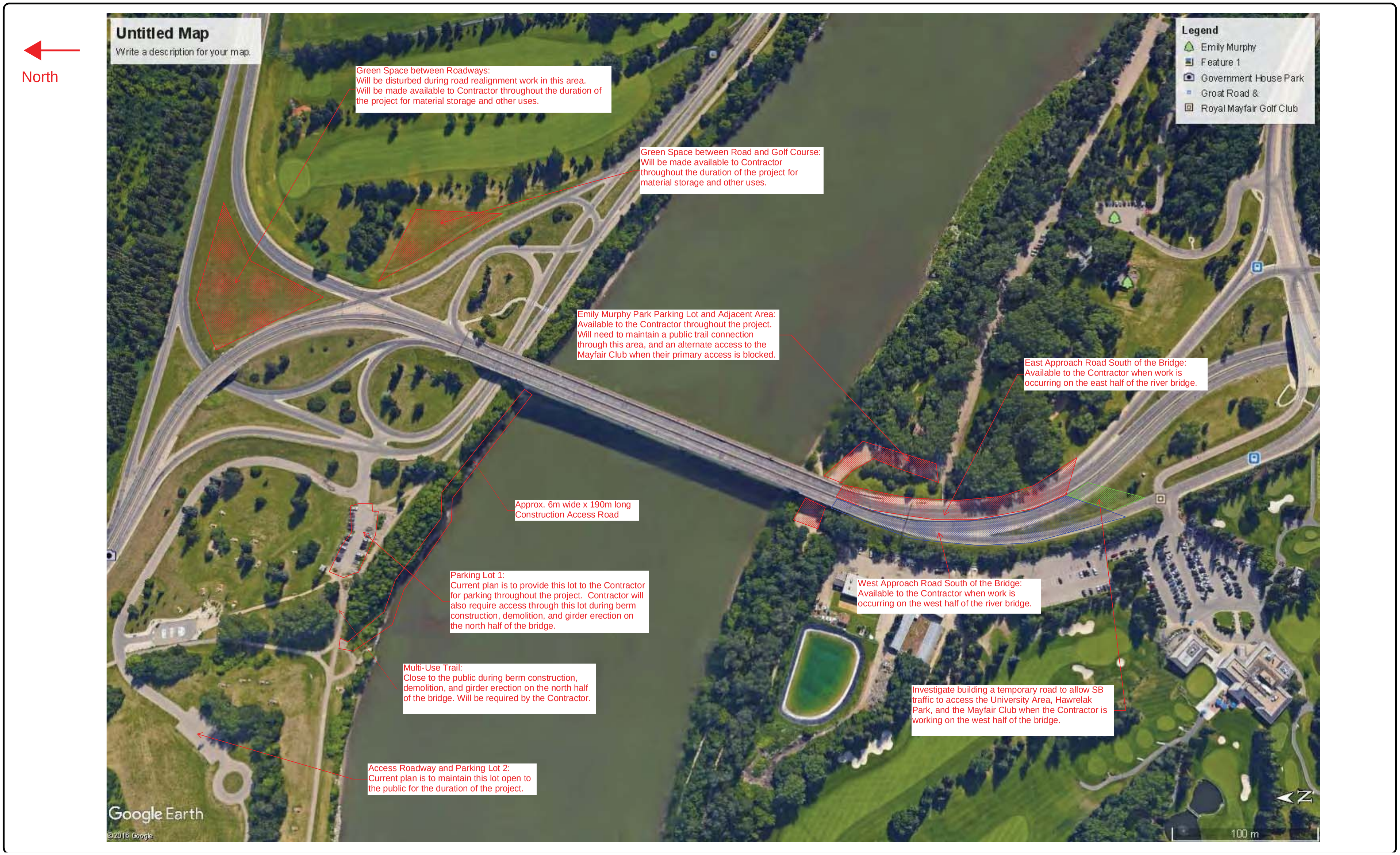
Construction equipment used for bridge rehabilitation/superstructure replacement activities will include typical bridge construction equipment such as excavators, bulldozers, rear dump trucks, mobile cranes, graders, scrapers, steel compaction rollers, front end loaders, tandem trucks, asphalt rollers and pavers.

2.3.13 Alternatives Considered

2.3.13.1 Bridge Design

Groat Road Bridge (Bridge B059)

The following rehabilitation alternatives were examined as part of the preliminary engineering design phase of the project (DIALOG 2017):



Green Space between Roadways:
Will be disturbed during road realignment work in this area.
Will be made available to Contractor throughout the duration of the project for material storage and other uses.

Green Space between Road and Golf Course:
Will be made available to Contractor throughout the duration of the project for material storage and other uses.

Emily Murphy Park Parking Lot and Adjacent Area:
Available to the Contractor throughout the project.
Will need to maintain a public trail connection through this area, and an alternate access to the Mayfair Club when their primary access is blocked.

East Approach Road South of the Bridge:
Available to the Contractor when work is occurring on the east half of the river bridge.

Approx. 6m wide x 190m long Construction Access Road

Parking Lot 1:
Current plan is to provide this lot to the Contractor for parking throughout the project. Contractor will also require access through this lot during berm construction, demolition, and girder erection on the north half of the bridge.

West Approach Road South of the Bridge:
Available to the Contractor when work is occurring on the west half of the river bridge.

Multi-Use Trail:
Close to the public during berm construction, demolition, and girder erection on the north half of the bridge. Will be required by the Contractor.

Investigate building a temporary road to allow SB traffic to access the University Area, Hawrelak Park, and the Mayfair Club when the Contractor is working on the west half of the bridge.

Access Roadway and Parking Lot 2:
Current plan is to maintain this lot open to the public for the duration of the project.

*Adapted from Dialog figure Groat Road Over N Saskatchewan River - Rehabilitation and superstructure replacement construction laydown area - B059-Laydown

Figure 2.6

Construction Laydown Areas and Access Points

- Alternative 1 – Deck Overlay and FRP Girder Strengthening
- Alternative 2 – External Post-tensioning to Strengthen Girders
- Alternative 3 – Extradosed Cables to Strengthen Girders
- Alternative 4 – Structural Steel Superstructure Replacement

Alternative 1 proposed to rehabilitate the bridge to extend its life 20 to 25 years before another major rehabilitation or superstructure replacement was required, and many of the deficiencies in the existing structure were rectified. The existing roadway and sidewalk geometry would be maintained. This alternative provided a short-term solution to the existing deficiencies, but did not address the long-term performance of the bridge or widening the sidewalk. No instream work would be required for this alternative.

Alternative 2 proposed to strengthen the girders, rebuild the abutments, and recast a new deck to widen the sidewalk from 2.4 m to 3.0 m while maintaining the existing lane widths. This alternative would make use of the existing girders, while providing the ability to replace the entire deck and increase the capacity of the girders, extending the life of the bridge by 75 years. No instream work would be required for this alternative.

Alternative 3 proposed to rehabilitate the bridge using extradosed post-tensioning. The abutments would be rebuilt, the expansion hinges would be removed, and a new deck would be cast to provide a 3.0 m wide sidewalk and accommodate the width of the new towers while maintaining the existing lane widths. The bridge life would be extended by 75 years. Alternative 3 would provide similar benefits to Alternative 2, but with a longer construction schedule and a higher estimated cost. No instream work would be required for this alternative.

Alternative 4 proposed to replace the existing superstructure with a deck slab supported on haunched structural steel plate girders that would be similar in form to the existing concrete girders. The new deck would provide a 3.0 m wide sidewalk and maintain the existing lane widths. For this alternative, the bridge would be reconstructed to last 75 years or more, however, it would require instream work to facilitate superstructure replacement while maintaining traffic availability.

The four proposed alternatives were analyzed based on initial costs and life cycle costs, maintainability, constructability, aesthetics, added functionality, schedule and environmental impact (DIALOG 2017). Based on that analysis, Alternative 4 was recommended for the rehabilitation of the Groat Road River Crossing. An all-new superstructure would extend the life of the existing bridge by 75 years or more, and would increase the functionality of the bridge by providing the opportunity to widen the existing sidewalk and traffic lanes, however, it would require instream work.

Following identification of Alternative 4 as the preferred alternative, Alternative 4b was developed. Provided that additional funding is available, Alternative 4b proposed to further widen the bridge deck. Increasing the overall bridge width by 1.2 m would allow the sidewalk width to be increased from 3.0 m to 4.2 m to conform to Transportation Association of Canada guidelines for a shared-use path, while maintaining the existing clear widths between barriers for the two northbound and southbound traffic lanes at 7.56 m. The overall scope of the bridge work, requirement for instream work to facilitate construction while maintaining traffic availability on the bridge and construction schedule would remain generally similar to Alternative 4.

The City has confirmed that Alternative 4b is the preferred option, and Alternative 4b forms the basis of this environmental assessment. Alternatives considered for the instream berm construction methodology are described below.

Instream Berm Construction Methodology Alternatives for Groat Road Bridge

Two construction staging sequences were considered for Groat Road Bridge superstructure demolition, construction and associated instream works. Alternative 1 included demolition and reconstruction of the bridge in a longitudinal direction where the full length of the west side would be completed in the first year, followed by the full length of the east side in the second year (N. Robson, *pers.comm.*). This alternative would require a sequence of instream berms that would begin in the southwest corner and be moved to the northwest corner followed by the northeast and southeast corners. This staging sequence would ensure that half of the bridge would be available to north/south vehicular and pedestrian traffic during the construction period.

Alternative 2 included demolition and reconstruction of the bridge in a transverse direction where the full width of the south half of the bridge superstructure would be completed in the first year followed by the full width of the north half in the second year (N. Robson, *pers. comm.*). This alternative would result in less instream work (one large berm on the south bank in year one and then one on the north bank in year two), however, it would require twice as much material compared to Alternative 1 and would require placement of a temporary tower on the instream berm to support the half of the bridge that is not under construction and maintain live traffic. That temporary tower on the instream berm would be vulnerable to flooding and ice flows, resulting in significant risk to the stability of the temporary tower and increase the potential for the bridge structure to fall into the river.

Analysis of the two alternatives, considering design, constructability, cost and environmental factors, resulted in rejection of Alternative 2 because it had substantial risks from a constructability perspective (i.e., supporting the bridge using a temporary tower on the instream berm while maintaining live traffic) and increased costs that significantly outweighed the potential benefits (i.e., less instream work) (N. Robson, *pers. comm.*). Alternative 1, therefore, was the preferred construction staging option and is the subject of this environmental assessment.

Victoria Bridge (Bridge B060)

Following the condition assessment in 2013 (DIALOG 2016a), several rehabilitation options were developed and compared to each other and to a complete bridge replacement option. The preferred option, based on a life-cycle cost analysis was bridge rehabilitation and wearing surface replacement with a new waterproofing membrane and

ACP overlay. As this bridge neither crosses a waterway nor incorporates any sensitive environmental features, environmental impact was not a factor in the evaluation of alternatives.

Emily Murphy Bridge (Bridge B099)

Following the condition assessment in 2013 (DIALOG 2016b), two rehabilitation options were developed; a total bridge replacement option was not considered. The preferred option based on a life-cycle cost analysis was selected bridge rehabilitation with deferral of overlay replacement. Deferral of the overlay replacement will require a maintenance program to prolong the service life of the bridge deck. As this bridge neither crosses a waterway nor incorporates any sensitive environmental features, environmental impact was not a factor in the evaluation of alternatives.

2.4 Environmental Permitting Requirements

2.4.1 Federal Regulatory and Permitting Processes

2.4.1.1 Navigation Protection Act

The *Navigation Protection Act* (*NPA*) is administered in Alberta by Transport Canada. Groat Road Bridge (B059) spans the North Saskatchewan River, which is a scheduled navigable water under the *NPA*. As such, replacement of the bridge superstructure and the associated use of instream berms during construction may pose a risk of substantial interference with navigation. Therefore, application to Transport Canada pursuant to the *NPA* is required. The bridge is currently not registered with Transport Canada and will require registration prior to application in support of the proposed rehabilitation works.

2.4.1.2 Fisheries Act

The federal *Fisheries Act* (Section 35) requires that projects avoid causing serious harm to fish that are part of or support a commercial, recreational, or Aboriginal fishery (CRA fish). The proposed project will involve placement of temporary instream berms in the North Saskatchewan River, a fish-bearing watercourse. The potential for adverse effects on CRA fish within this watercourse will trigger the need for a submission to Fisheries and Oceans Canada (DFO) for review to determine if an Authorization pursuant to the *Fisheries Act* is required.

2.4.1.3 Migratory Birds Convention Act

Environment Canada administers the *Migratory Birds Convention Act* (*MBCA*), which prohibits the disturbance of nests and individual birds of species covered by the *Act* and prohibits release of deleterious substances into waters or areas frequented by migratory birds. With respect to construction, the *Act* provides guidelines for enforcement only; it is not linked to formal approvals required for construction. Violation of the *MBCA* may, however, result in penalties. Projects that require clearing of bird habitat or working in or near waters or areas frequented by migratory birds must respect this *Act*. To avoid disturbance of bird nests and dens, vegetation clearing practices should respect breeding periods of species covered by this *Act* and ensure no harm to nesting birds or nests. If this EIA finds that the proposed project has potential to adversely affect breeding birds, mitigation measures will be developed to ensure compliance with the *Act*.

2.4.1.4 Species at Risk Act

The *Species at Risk Act* (*SARA*), administered by Environment Canada, prohibits disturbance to listed species and, in some instances, listed species' habitat. Habitat is defined not only as the area where a species naturally occurs and on which it depends to carry out its life processes, but also areas where that species formerly occurred and has the potential to be reintroduced. The *SARA* emphasizes guidelines for enforcement, and harming a Schedule 1 species is prohibited. Although no approvals or permits are required, violation of the *SARA* may result in penalties. There is some native vegetation in the local study area, which may have potential to support habitat for federally-listed wildlife species at risk. This will be examined in the wildlife section (*Section 4.1.4*).

2.4.2 Provincial Regulatory and Permitting Processes

2.4.2.1 Alberta Public Lands Act

The bed and shore of permanent and naturally-occurring bodies of water, including the North Saskatchewan River, are owned by the province pursuant to the *Public Lands Act*. The bed and shore of the NSR is Crown-owned. The City of Edmonton currently holds a DLO for the existing permanent Groat Road Bridge structure. The proposed project will require temporary works (e.g., instream berms and north access road) on the riverbed and shores. Those activities would require Temporary Field Authorizations pursuant to the *Public Lands Act*.

2.4.2.2 Alberta Water Act

Alberta *Water Act* approval may be required for placement of permanent structures on the banks of the North Saskatchewan River. Specific requirements pursuant to the *Water Act* will be confirmed once project detailed design is available. This *Act* could apply only to Groat Road Bridge (B059), which crosses the North Saskatchewan River.

2.4.2.3 Alberta Wildlife Act

The Alberta *Wildlife Act* prohibits disturbance to a nest or den of prescribed wildlife species. Although permitting is not required under that *Act*, violations may result in fines. Projects that require clearing of habitat in use by these species must respect this *Act*. To avoid disturbance of nests and dens, vegetation clearing practices should respect breeding periods of species covered by this *Act* and follow practices similar to restrictions that facilitate compliance with the *Migratory Birds Convention Act*. If this EIA finds that this project has potential to adversely affect covered wildlife species, mitigation measures will be developed to ensure compliance with this *Act*.

2.4.2.4 Historical Resources Act

Any development with potential to disturb historical resources requires clearance by Alberta Culture and Tourism (ACT), pursuant to the *Historical Resources Act*.

Therefore, the standard first step, preparation of a Historical Resources Overview Statement of Justification, was undertaken for this project, by Turtle Island Cultural Resource Management Inc. and submitted to the Province. Further details are provided in *Section 4.3.1*.

2.4.2.1 Alberta Weed Control Act

The *Weed Control Act* regulates designated weed species and weed seeds in the province through various control and enforcement measures, while creating provisions for the recovery of expenses in the case of non-compliance. Within the *Act*, there are two categories of designated weeds: noxious and prohibited noxious. Noxious weeds are required to be controlled, while prohibited noxious weeds are required to be destroyed. The responsibility for the control/destruction of designated weed species lies with the owner or occupier of the land in question. The *Act* also gives power to municipalities to designate additional weed species as noxious or prohibited noxious but does not allow for the delisting of species or reduction in status from prohibited noxious to noxious. This EIA discusses provisions to enable project compliance with the *Weed Control Act*.

2.4.3 Municipal Bylaws, Policies and Plans

2.4.3.1 North Saskatchewan River Valley Area Redevelopment Plan (City of Edmonton Bylaw 7188)

The City of Edmonton's *North Saskatchewan River Valley Area Redevelopment Plan* (Bylaw 7188) requires environmental reviews for projects undertaken in the North Saskatchewan River Valley and tributary ravines. The proposed project is situated within Bylaw 7188 boundaries; therefore, an environmental assessment is required. This report has been prepared to meet that requirement.

2.4.3.2 The Way We Grow, Municipal Development Plan (Bylaw 15100)

The Way We Grow, Municipal Development Plan (City of Edmonton 2010a) is the City of Edmonton's strategic growth and development plan for the next ten years. This plan provides guidance to for developing the City into a more compact, transit oriented and sustainable city. Key objectives that relate to the proposed project are listed below:

The City of Edmonton:

- ensures that streets, sidewalks and boulevards are designed to perform their diverse roles and to enable safe access for all users (Strategic Objective 5.7.1).
- protects, preserves and enhances a system of conserved natural areas within a functioning and interconnected ecological network (Strategic Objective 7.1.1).
- protects, preserves and enhances the North Saskatchewan River Valley and Ravine System as Edmonton's greatest natural asset (Strategic Objective 7.3.1).
- protects, preserves and improves the North Saskatchewan River Valley and Ravine System as an accessible year-round place for recreation and activity for people of all ages (Strategic Objective 7.3.2).

- mitigates the impact of development upon the natural functions and character of the North Saskatchewan River Valley and Ravine System (Strategic Objective 7.3.3).
- mitigates impacts upon water resources by ensuring that new developments in Edmonton embody an exemplary standard of ecological design (Strategic Objective 7.5.1).
- plans for growth in the Capital Region based on an integrated and effective transportation system and an integrated approach to land use planning (Strategic Objective 8.1.1).

2.4.3.3 The Way We Move, Transportation Master Plan

The Way We Move (City of Edmonton 2009) is the City of Edmonton's transportation master plan, pursuant to the City's overarching strategic plan, *The Way Ahead*. *The Way We Move* sets out goals and objectives to enable the City of Edmonton to address future transportation needs. The plan addresses public transportation as the cornerstone of the transportation master plan and states that "Access for All" is the overriding principle adopted for the development of Edmonton's public transportation network, emphasizing the need for an accessible system for those with mobility challenges, including people with physical, sensory and cognitive disabilities as well as the elderly and people with young children. The plan also incorporates strategies to encourage more active transportation throughout the City. Key objectives that relate to the proposed project are listed below.

The City will:

- integrate land use planning and transportation decisions to create an accessible, efficient and compact urban form (Strategic Objective 4.1).
- develop a comprehensive program to continually optimize the efficiency of the existing roadway system using traffic management and transportation supply measures (Strategic Objective 7.1).
- focus major roadway improvements on the efficient movement of goods, services and transit vehicles (Strategic Objective 7.3).
- promote and undertake the safe planning, design and operation of the transportation system (Strategic Objective 7.5).
- fully utilize asset management best practices to achieve a safe, enjoyable and well-maintained transportation system (Strategic Objective 10.1).

2.4.3.4 The Way We Live, Edmonton's People Plan

The Way We Live (City of Edmonton 2010b) is the City of Edmonton's people plan, pursuant to the City's overarching strategic plan, *The Way Ahead*, and intended to advance and support the 10-year goal of improving Edmonton's livability. The plan provides direction on how the municipal government can contribute to the well-being of its citizens by delivering the greatest value of services and infrastructure that are most important to Edmontonians. Key guiding values of the plan include inclusiveness, relationships with the urban Aboriginal population, accessibility, public involvement, and integration with other long-range strategic plans. Key objectives that relate to the proposed project are listed below.

The City of Edmonton:

- provides and encourages people to explore and enjoy their connection to the natural environment (Strategic Policy Direction 1.2.3).
- provides access to its parks, natural areas and green spaces for the enjoyment of Edmontonians (Strategic Policy Direction2.2.1).
- promotes, protects and maintains the North Saskatchewan River Valley as the centerpiece of an integrated regional parks system (Strategic Policy Direction 2.2.4).
- promotes the use of its parks, green spaces and natural areas (Strategic Policy Direction 2.2.6).
- designs, operates and maintains a safe transportation network (Strategic Policy Direction 4.1.3).
- designs, builds and partners to protect and maintain city boulevards and green spaces and the North Saskatchewan River Valley as an integral part of an attractive city (Strategic Policy Direction5.3.1).

2.4.3.5 The Way We Green, Environmental Strategic Plan

The Way We Green (City of Edmonton 2011) is the City of Edmonton's updated, long-term environmental strategic plan, pursuant to the City's overarching strategic plan*, The Way Ahead*. *The Way We Green* sets out principles, goals, objectives, policies and approaches for the City of Edmonton to preserve and sustain its environment. The two main focuses of the plan are sustainability and resilience, and the plan outlines 12 goals that describe what must ultimately be achieved for the City to be sustainable and resilient with respect to its environment. The goals address healthy ecosystems, emphasizing land, water and air, as well as food and waste concerns faced by the city now and in the future. *The Way We Green* includes a particular emphasis on the natural environment and sustaining healthy ecosystems but also emphasizes increased use of public transit and transit supportive planning. Many key objectives relating to the Groat Road Bridges project presented in *The Way We Green* overlap with those of *The Way We Grow* and are presented in Section 2.4.3.2 above. Additional key objectives that relate to the proposed project area listed below.

The City of Edmonton:

- ensures biodiversity corridors are appropriate for all scales of development (neighbourhood to regional) and that infrastructure developments provide appropriate wildlife passage (Strategic Action 3.3.16).
- establishes, implements and maintains procedures that make it aware of construction projects in the North Saskatchewan River Valley and its tributary ravines in order to protect and preserve ecological connections (Strategic Action 3.7.1).

- establishes, implements and maintains lighting design policies and standards based on best practices for minimizing adverse effects on wildlife (Strategic Action 3.13.1).
- establishes, implements and maintains an Outdoor Lighting Plan for Edmonton that promotes light use where needed, when needed and no more than is necessary for safety and security (Strategic Action 6.6.1).

2.4.3.6 City of Edmonton Environmental Policy C512

The purpose of this policy is to state the City of Edmonton's commitment to environmental sustainability in accordance with the following guiding principles: 1) quality of life; 2) shared responsibility; 3) decision-making model; 4) protection of the natural environment; 5) intergenerational equality; 6) public awareness and understanding; and 7) citizen consultation and participatory decision-making. Through its planning, decision-making process, and leadership, the City will promote the development of an environmentally sustainable community that functions in harmony with the natural environment. In addition, it will exercise environmental stewardship of its operations, products and services, based on its commitment to: (a) prevent pollution, (b) continually improve its environmental performance by setting and reviewing environmental objectives and targets, and (c) meet or exceed applicable environmental legal requirements and other requirements to which it subscribes. Further, the City commits to taking a leadership role in protecting natural heritage and biodiversity within the region. It is expected that construction of the proposed Groat Bridges rehabilitation project will follow the guiding principles of this policy.

2.4.3.7 City of Edmonton Community Standards Bylaw (Bylaw 14600)

Part III of the City of Edmonton's Community Standards Bylaw (Bylaw 14600) establishes construction working periods (07:00-21:00 hours Monday to Saturday; 0900-19:00 Sundays and holidays) and acceptable noise levels (not to exceed 65 dBA). Adherence to this bylaw will be required during construction.

2.4.3.8 Corporate Tree Management Policy C456A)

All ornamental trees and natural treed areas on City-owned property are the responsibility of City of Edmonton, implemented by Edmonton Facility and Landscape Infrastructure (including procurement, maintenance, protection and preservation) pursuant to the City of Edmonton's *Corporate Tree Management Policy* (C456A). That policy states that where damage to, or loss of, City trees or shrubs occurs as a result of not complying with the City Guidelines, equitable compensation for that loss will be recovered from the entity causing the damage or loss and applied to future tree (canopy) replacement. Compensation amounts are dependent on the type of plant species lost or damaged and are calculated using set formulae or, in some cases, negotiations between City departments.

2.4.3.9 Natural Area Systems Policy (C531)

In 2007, City of Edmonton adopted Policy C531 and a new approach to natural area management. The policy commits the City to conserving, protecting and restoring the natural uplands, wetlands, water bodies and riparian areas, as integrated and connected natural systems throughout the City. To that end, the Natural Areas inventory was updated (to 2010) and includes both tablelands and river valley Natural Areas. The City is committed to balancing the ecological and environmental considerations of a project with economic and social considerations in its decision-making and will demonstrate that it has done so. This goal requires the procurement of appropriately detailed ecological information about any project that has potential to affect a City Natural Area. The proposed project area comprises primarily cleared and manicured areas, with some native riparian and upland vegetation and designated natural areas adjacent to the proposed project area. Reporting requirements of Policy C531 are addressed as part of this Bylaw 7188 EIA.

2.4.3.10 City of Edmonton Wildlife Passage Guidelines

In June 2010, the City of Edmonton Transportation Department introduced its *Wildlife Passage Engineering Design Guidelines* (Stantec 2010). The purpose of those guidelines is to provide transportation designers and decision makers with recommendations that incorporate the needs of wildlife into transportation projects. That goal will be met through restoring previously removed habitat connections and ensuring that existing connections remain. The guidelines are also meant to reduce the problem of anthropogenic habitat fragmentation and human-wildlife conflict, including wildlife-vehicle collisions. Although the guidelines represent the ideal designs for wildlife passage structures, the City recognizes that not all transportation projects will be capable of meeting that standard and will consider alternative structures on a project-specific basis. The City of Edmonton Sustainable Development Department requires that these guidelines be considered during project design and construction to reduce any potential impacts to wildlife passage resulting from project activities.

2.4.3.11 Enviso Checklist

The City of Edmonton has in place an ISO 14001 registered Environmental Management System (EMS) called ENVISO that is subject to internal and external audits. All City construction projects are expected to meet the environmental performance standards of the EMS. Prior to tender, the City must ensure an Enviso permit and approvals checklist is completed to provide information on the permitting requirements for the project and the status of obtaining the permits. After project award, the successful contractor will be required to review the contractor’s environmental responsibility package and sign the acknowledgement form. An ECO Plan may be required for some projects. Engineering consultants must review ENVISO bulletins and monitoring forms to determine those applicable to the project and ensure the contractor is made aware of the requirements of ENVISO. Engineering consultants must ensure continued ENVISO compliance for the duration of the project.

2.4.3.12 City of Edmonton Sewers Use Bylaw 16200

The release of material, including contaminated runoff, into the river valley and ravine system and ultimately into the North Saskatchewan River is regulated by the *Sewers Use Bylaw*. Part III of this Bylaw prohibits the release of hazardous materials and materials that produce a colour value greater than or equal to 50 true colour units. The release of any material other than that permitted in this Bylaw may result in penalties. Compliance will be achieved through spill prevention measures, erosion and sedimentation control measures, and adherence to the City of Edmonton's "Contractor's Environmental Responsibilities Package" (City of Edmonton 2008).

3.0 METHODOLOGY

3.1 General Methods

The following are brief descriptions of the general methods employed in the preparation of this Environmental Impact Assessment (EIA):

- A scoping meeting was held on 21 March 2016 with representatives from City of Edmonton Sustainable Development to discuss the scope of proposed work, as understood to date, identify issues to be addressed in the environmental review and confirm that the appropriate level of environmental review for the three bridges, as previously anticipated was an ESR.
- An appropriate environmental review study area was delineated (see *Section 1.3*).
- A breeding bird survey was conducted on 08 June 2016.
- A plant community survey and rare plant survey (20 June 2016) were conducted.
- A second scoping meeting was held with City of Edmonton Sustainable Development on 31 October 2016. Based on advancement of preliminary design for Groat Road Bridge, proposed activities for that bridge had changed from rehabilitation of the existing superstructure to complete replacement of the superstructure. The proposed minor rehabilitation activated for the Victoria and Emily Murphy bridges remained the same. Sustainable Development determined that an EIA, rather than an ESR, is the appropriate level of environmental review for the project comprising three proposed bridges rehabilitation. No site location study (SLS) was required for this project.
- The earlier-identified study area was confirmed to still be appropriate.
- Technical information prepared in support of the proposed project, other existing technical information generated in the vicinity of the study area and existing provincial databases were reviewed.
- Potential environmental impacts associated with the proposed project were assessed and mitigation measures to minimize the severity of identified impacts were developed.

3.2 Detailed Methods

The following sections describe in greater detail the steps taken in preparing this EIA.

3.2.1 Literature Review

3.2.1.1 Technical Reports

The following technical reports prepared for the Groat Road Bridges rehabilitation project were reviewed to assist in study area characterization and impact assessment:

- *Groat Road Interchange, Victoria Park Area (North Bridge Approach): Concept Planning Report* (City of Edmonton 2015)
- *Phase 1 Environmental Site Assessment: Groat Road Bridges Rehabilitation Project, Edmonton, Alberta* (Thurber Engineering Ltd. 2016a)

- *Phase 1 Environmental Site Assessment Addendum: Groat Road River Bridge Rehabilitation, Edmonton, Alberta* (Thurber Engineering Ltd. 2016b)
- *Groat Road River Bridge Rehabilitation, Edmonton, Alberta: Geotechnical Investigation* (Thurber Engineering Ltd. 2016c)
- *Groat Road over Victoria Park Road (B060) Bridge Rehabilitation: Preliminary Engineering Report* (DIALOG 2016a)
- *Emily Murphy Park Road over Groat Road (B099) Bridge Rehabilitation: Preliminary Engineering Report* (DIALOG 2016b)
- *River Scour Survey, Assessment and Rehabilitation Strategy Project B059, Groat Bridge* (Parsons 2016)
- *Groat Road Bridge over the North Saskatchewan River (B059) Bridge Rehabilitation: Preliminary Engineering Report* (DIALOG 2017)
- *Groat Road Bridge Rehabilitation: Hydrotechnical Assessment of Berms – 2D Modeling* (Northwest Hydraulic Consultants Ltd. 2017)
- *Groat Road Bridge Rehabilitation: Fisheries Resources Assessment for Alternative 4b Design Option* (Kingfisher Aquatics Ltd. 2017)

Information from these technical reports was reviewed and incorporated into this EIA.

3.2.1.2 Databases

The following databases were queried for relevant information pertaining to vegetation, wildlife, recreational amenities and residential neighbourhoods within the study area:

- The Alberta Conservation Information Management System (ACIMS) [Alberta Environment and Parks (AEP) 2016a] for all records of special status plant species within, and immediately adjacent to, the study area, using a legal land description search. Site accessed on 22 March 2016.
- The Fisheries and Wildlife Internet Mapping Tool (FWIMT) (AEP 2016b) for all records of special status wildlife species within, and immediately adjacent to, the study area, using a 1 km radius centred on the proposed project area. Site accessed 06 June 2016.
- The City of Edmonton Open Data website (City of Edmonton 2017) was reviewed for tree inventories, recreational amenities and neighbourhood maps in the vicinity of the project area. The site was accessed on 03 January 2017.
- City of Edmonton Office of Traffic Safety for information on wildlife-vehicle collisions in the city, accessed in February 2017.

3.2.2 Description of Existing Conditions

A thorough description of each environmental component within the study area was prepared using all available new and existing sources of information. The description of existing conditions provides a current snapshot of conditions in the local study area, over which the proposed project can be overlaid to assist in identification of issues, potential interactions and potential impacts. Specific methods used to generate the descriptions vary slightly with each environmental component and are described in the respective sections of Chapter 4.

3.2.3 Potential Impact Analysis

The impact analysis process typically involves several key steps. First, environmental issues and potential environmental impacts associated with the proposed project, including all project phases (preparation, construction, operation), are identified using various means and sources. All issues and potential impacts identified as warranting further assessment are described and assessed.

3.2.3.1 Impact Identification

To identify ways that the proposed project could affect environmental components, we developed a matrix with project activities along one axis and environmental component along the other axis (Table 5.1). Potential for interaction between the elements of each axis was then identified. Each of the interactions was then analysed in detail looking for changes to environmental components that could occur as a result of the project. This process involved the following:

- Spencer Environmental's extensive experience of environmental impacts typically associated with bridge projects undertaken in the Edmonton region, a comprehensive understanding of the natural environment within the North Saskatchewan River Valley in Edmonton and an understanding of the various components of the proposed project.
- Discussions with specialist consultants and members of DIALOG's engineering team.
- Literature reviews as needed.

No additional environmental concerns or potential environmental impacts were raised by the public as part of the project's public engagement program.

3.2.3.2 Impact Characterization

The characteristics used to describe impacts were based on the requirements of Bylaw 7188. Bylaw 7188 recognizes the importance of the North Saskatchewan River Valley and Ravine System as a contiguous open space and recreation system, and establishes the Plan Area as an environmental protection area. Bylaw 7188 recognizes the Plan Area as containing natural resource areas that will be preserved and enhanced for recreation, scenic and ecological purposes. The essential question regarding the impact of development on any area of the river valley system is whether or not the impact(s) would positively or negatively affect the present quality of the valley as a highly valued recreational and natural open space. Project practices that had been identified during design and are known to be built into contracts to reduce the degree of impact, such as best management practices in erosion and sedimentation control, were reviewed at this stage and influenced impact characterization. At this point in characterizing *potential* impacts, no additional mitigation measures were applied.

Based on Bylaw 7188 as the guiding regulatory document, potential impacts were described and classified as to their direction (positive or adverse), magnitude/severity (negligible, minor or major), duration (short-term, long-term or permanent), and confidence in impact prediction (predictable effect or uncertain effect). These criteria were defined as follows:

Direction

Positive Impact: An interaction that enhances the quality or abundance of physical features, natural or historical resources, or recreational pursuits or opportunities.

Adverse Impact: An interaction that diminishes the abundance or quality of physical features, natural or historical resources, or recreational pursuits or opportunities.

Magnitude

Negligible Impact: An interaction that is determined to have essentially no effect on the resource. Such impacts are not characterized with respect to direction duration or confidence.

Minor Impact: An interaction that has a noticeable effect but does not affect local or regional populations, natural or historical resources, or physical features beyond a defined critical threshold (where that exists) or beyond normal limits of natural perturbation.

Major Impact: An interaction that affects local or regional populations, natural or historical resources, or physical features beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation.

Duration

Short-term Impact: An interaction resulting in a measureable change that does not persist for longer than one year post-construction.

Long-term Impact: An interaction resulting in a measureable change that persists longer than one year post-construction but at some point dissipates completely.

Permanent Impact: An interaction resulting in measureable change that persists indefinitely.

Confidence

Predictable Impact: Effects are well understood through application in projects of a similar nature.

Uncertain Impact: Effect on VEC is not well understood due to lack of knowledge of the VEC and its response to disturbance, or lack of previous experience with proposed mitigation measures in similar circumstances.

3.2.4 Development of Mitigation and Residual Impact Assessment

Once potential impacts had been identified and characterized, the next step of the assessment process involved developing mitigation measures to address the identified adverse impacts. In all cases, attempts were made to reduce impact severity; however, this was not always feasible or practical. Any adverse impact remaining after implementation of mitigation was termed a residual impact. Adverse residual impacts were classified according to the impact characteristics described above, with one exception – impact rating confidence used the following descriptors:

Predictable Residual Impact: Efficacy of proposed mitigation measures is well understood through application in similar projects or circumstances.

Uncertain Residual Impact: Efficacy of proposed mitigation measures is not well understood because of lack of previous experience in similar circumstances or lack of knowledge about the environmental component.

3.2.5 Public Engagement

As part of its commitment to public engagement, the City of Edmonton hired Gray Scott Consulting Group Inc. (Gray Scott) to manage all public communications and engagement for the proposed Groat Road Bridges Rehabilitation project. To that end, the City of Edmonton posted proposed project details to the City of Edmonton website in summer 2016. A public information session was held on 29 November 2016. A summary of the responses from the information session, as well as a summary of stakeholder input, is provided in the sections below. A complete copy of the public engagement program and progress report may be found in Appendix B.

3.2.5.1 Public Information Session

A public information session was held on 29 November 2016 at the Royal Mayfair Golf Club. A total of 54 members of the public signed in. Nineteen comment forms were filled out at the information session, and an additional 14 comment forms were submitted online (Gray Scott 2016; Appendix B). Responses to the project varied, with some responders supporting the project as necessary rehabilitation. Main concerns included construction duration and costs, as well as lack of improved accommodation of pedestrians and cyclists, through wider SUPs/sidewalks and improved connections throughout the area (Gray Scott 2016; Appendix B). No environmental concerns were raised.

3.2.5.2 Stakeholder Input

In addition to the public information session, the project team undertook specific consultation with the following select stakeholders:

- City of Edmonton internal stakeholders (Parks and Golf Courses, Civic Events),
- Royal Glenora Club (meeting held 8 September 2016),
- Royal Mayfair Golf Club (meeting held 24 August 2016),
- Edmonton Queen Riverboat,
- Royal Alberta Museum (location is now closed and no further contact is required),
- University of Alberta (contacted via email; University will contact project team if they require more information),
- Government House (contacted via email; no response), and
- Edmonton Canoe (private business contacted at public information session).

Stakeholder meetings provided the opportunities for stakeholders to learn more about the project and raise concerns. The Royal Glenora Club and Royal Mayfair Golf Club requested being kept up to date with road closures and detours during construction, as access to their facilities would be directly affected. The Edmonton Queen riverboat occasionally traverses the proposed project area; consequently, they raised questions with respect to clearance under the existing Groat Bridge and during construction and how flow rates will be altered when the berms are in place. Edmonton Canoe operates a business that uses the boat launch at Emily Murphy Park and raised concerns that the proposed Groat Bridge rehabilitations would affect their business for up to three summers. Discussions with internal City departments are ongoing.

3.2.6 Indigenous Consultation

City of Edmonton Integrated Infrastructure Services is undertaking ongoing discussions with the City of Edmonton's Indigenous Relations Office (IRO) about the proposed project. The IRO will provide feedback regarding additional information/communication required.

4.0 EXISTING CONDITIONS

For the following VECs, existing conditions will be considered and described at the scale of the study area to account for all areas that may be affected by bridge construction components and/or construction staging and access. When bridge-specific data was collected, it will be identified as such.

4.1.1 Geotechnical/Soils

4.1.1.1 Methods

Thurber Engineering Ltd. (Thurber) undertook a geotechnical investigation for the proposed Groat Road bridges rehabilitation project in spring 2016 (Thurber 2016c; Appendix C). The investigation included a site reconnaissance and a drilling program, accompanied by laboratory testing of soil samples. Thurber's geotechnical assessment specifically did not include Victoria Bridge or Emily Murphy Bridge because the rehabilitation program for those two bridges will not exert any additional loading on their bridge foundations (Thurber 2016c; Appendix C). Therefore, geotechnical conditions at those two bridges are not discussed further in this section.

The site reconnaissance took place on 8 April 2016. The drilling program comprised eight test holes, the majority of which were drilled on the north alley terrace in support of the associated Groat interchange roadworks; however, two test holes provided data specific to the Groat Road bridge rehabilitation project: one test hole on the north side of the river (test hole 16-2, drilled 19 April 2016) and one on the south side (test hole 16-1, drilled 18 April 2016) (Thurber 2016c; Appendix C). Test holes were drilled to depths of 25.3 m (south side) and 25.9 m (north side). Following completion of drilling, standpipe piezometers were installed in both of the test holes (Thurber 2016c; Appendix C).

Following collection of soil samples, laboratory tests included visual classification and determination of natural moisture content of all recovered soil samples. Bedrock cores were logged and the moisture content of selected bedrock samples was determined. Grain size analyses, Atterberg limits, water soluble sulfate tests and uniaxial compressive strength tests were also undertaken for selected samples (Thurber 2016c; Appendix C).

4.1.1.2 Description

Surficial Conditions

Groat Road Bridge connects alluvial terraces on the north and south sides of the North Saskatchewan River. The river terrace at the location of the north bridge abutment is approximately 13 m above the riverbed elevation, and the abutment is located approximately 25 m north of the edge of the river channel (Thurber 2016c; Appendix C). The test hole on the north side of the river showed topsoil overlaying clay and gravel (Thurber 2016c; Appendix C).

The river terrace at the location of the south bridge abutment is approximately 8 m above the riverbed elevation, and the abutment is located approximately 20 m south of the edge of the river channel (Thurber 2016c; Appendix C). The test hole on the south side of the river had no topsoil and showed gravel fill over sand and clay (Thurber 2016c; Appendix C).

Subsurface Conditions

On the north side of the river, the clay underlying topsoil was silty and firm, and the underlying layer of gravel was medium to coarse-grained and dense (Thurber 2016c; Appendix C). On the south side of the river, the underlying layers beneath gravel fill comprised sand, clay, silt, a thin layer of wood chips and rootlets, and gravel. The sand and clay were both characterized as silty, and the gravel comprised 54-55% gravel, 34-39% sand and 7-11% fines (Thurber 2016c; Appendix C). The subsoil-bedrock interface occurred at an approximate elevation of 615 m asl on the north side of the river and 614 m asl on the south side (Thurber 2016c; Appendix C).

Bedrock

Bedrock in the two test holes belonged to the Horseshoe Canyon Formation, characterized by a sequence of sandstone, siltstone and clay shale with coal and bentonite seams (Thurber 2016c; Appendix C). The Horseshoe Canyon Formation was overlaid by the Empress Formation (Saskatchewan Sands and Gravels). Thurber (2016c; Appendix C) also analyzed bedrock conditions in the context of pier footings and abutment structures. That analysis is beyond the scope of this EIA.

Slope Stability

Thurber (2016c; Appendix C) did not assess riverbank stability in the vicinity of Groat Road Bridge as part of their geotechnical investigation because that was not included in their scope of work.

Topsoils

Based on the recent borehole data from the north side of the North Saskatchewan River, topsoils in the project area were typically described as black and organic (Thurber 2016c; Appendix C). Topsoil on the north side of the bridge was present to a depth of 0.3 m and immediately overlaid clay and gravel. Topsoil was absent on the south side of the bridge; gravel fill overlaid sand and clay at that location.

Phase 1 Environmental Site Assessment

A Phase 1 ESA conducted by Thurber (2016a; Appendix D) covered lands occupied by all three subject bridges. The Phase 1 ESA did not encounter any historical evidence indicating the proposed project area had been impacted by contaminants beyond acceptable limits for sites of this nature (Thurber 2016a; Appendix D). A review of historical imagery identified potential fill on the north side of the river, which was likely used in roadway construction in the 1960s. Sampling and analysis of the fill material was outside the scope of work for the Phase 1 ESA; Thurber (2016a; Appendix D) recommended that if fill materials are identified during project excavation or regrading, they should be sampled and analyzed as part of the project.

An addendum to the Phase 1 ESA was prepared in December 2016 to account for the inclusion of a temporary access road on the north side of the Groat Road Bridge (B059) and a temporary laydown area on the south side of the Groat Road Bridge (B059) (Thurber 2016b; Appendix D). No historical evidence of contamination beyond acceptable limits for sites of this nature was detected, and, therefore, the proposed project expansion in these areas did not alter the findings of the Phase 1 ESA (Thurber 2016b; Appendix D).

4.1.2 Hydrology/Surface Water Quality/Groundwater

4.1.2.1 Methods

Surface Water

Surface water flows in the proposed Groat bridges study area were described based on examination of topographic maps and field observations. Available literature and environmental assessments and overviews prepared by Spencer Environmental and others were reviewed for additional information.

Northwest Hydraulic Consultants Ltd. (NHC) (2017) conducted a hydrotechnical assessment in support of the proposed project (Appendix E). Their open water hydraulic analysis comprised 1D and 2D models of August 1 to freeze-up flood for three scenarios: 1) base case (unobstructed and without any berms in place); 2) right berm in place (berm extending from the right when looking downstream); and 3) left berm in place (berm extending from the left when looking downstream).

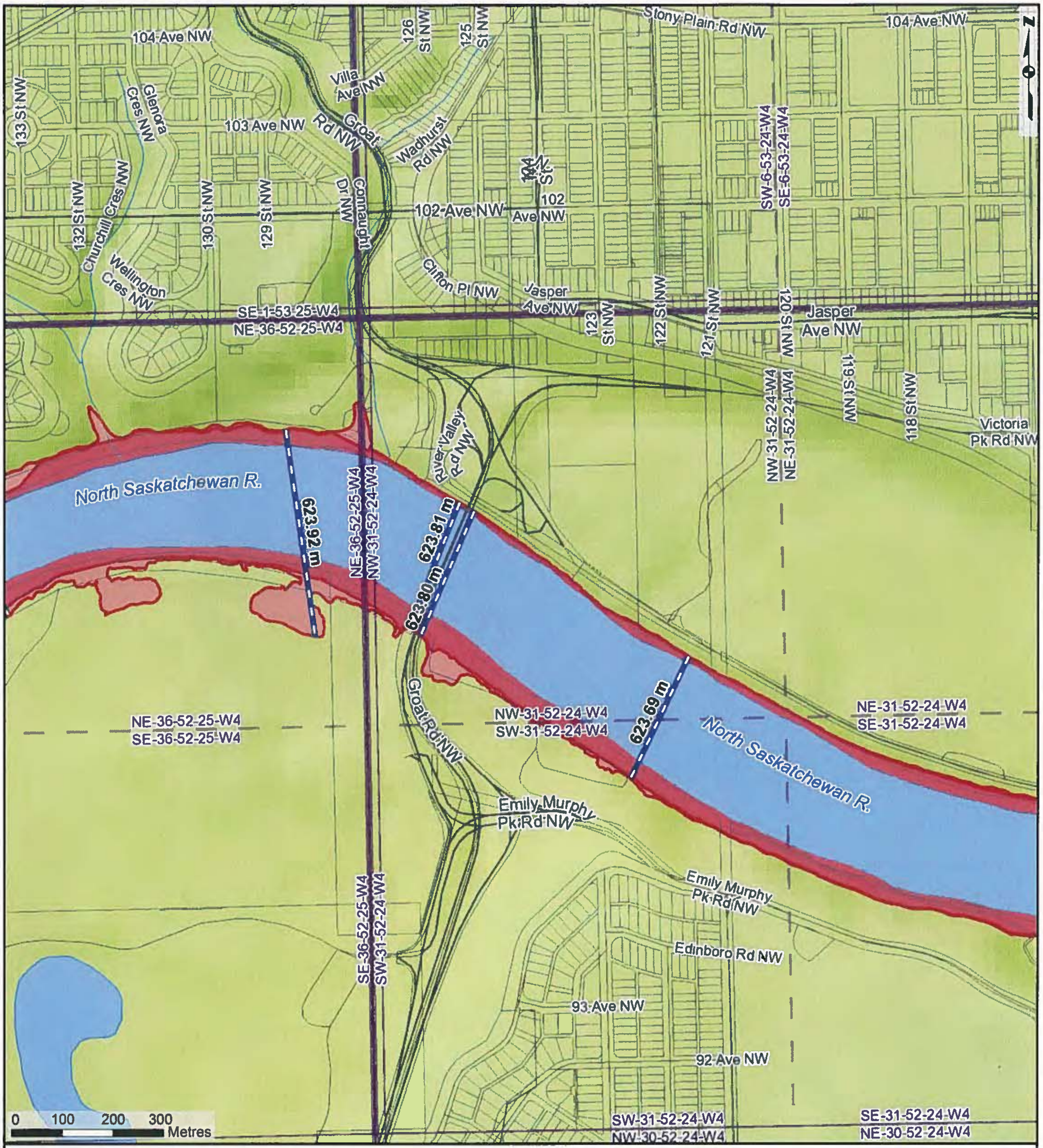
Based on Water Survey of Canada data for the period 1973-2013, the last ice cover on the NSR in the project area is typically observed in April, with ice effects persisting into May (NHC 2017; Appendix E). Ice effects can range from April 3 – May 5 in any given year, with an average date of last ice of April 16.

North Saskatchewan River Floodplain

The extent of the study area located in the North Saskatchewan River floodplain was assessed through examination of the City of Edmonton Floodplain Protection overlay (Figure 4.1; City of Edmonton 2016) and the Alberta Flood Hazard Map (AEP 2016c).

Groundwater

Thurber's geotechnical investigation (2016c; Appendix C) included installation of standpipe piezometers at two boreholes drilled near Groat Bridge to monitor groundwater levels. Groundwater levels were measured on 2 or 3 May 2016 and 18 May 2016, approximately one month after the boreholes were drilled. That groundwater level information was reviewed in support of this report.



Legend

🟥 Floodway	▨ Under Review	🟧 First Nation Boundary
🟥 Flood Fringe	855.09 m Cross Section and Design Flood Level	🟨 Municipal Boundary
🟪 Overland Flow (Flood Fringe)	🟦 Water Body	

Information as depicted is subject to change, therefore the Government of Alberta assumes no responsibility for discrepancies at time of use.
Cadastral data provided by Alberta Data Partnerships Ltd. (ADP)
Base Map Data provided by the Government of Alberta under the Alberta Open Government License, November, 2014
National Framework Data © Department of Natural Resources Canada. All rights reserved.
Alberta Road Network data provided by GeoBase ®
Alberta Environment and Parks

Figure 4.1

Groat Bridges Flood Hazard Map

Projection:	Datum:	Date:
ALBERTA 10TM	NAD 83	2016-Dec-01

maps.srd.alberta.ca/floodhazard/

4.1.2.2 Description

Surface Water

The only surface water body located in the regional study area is the North Saskatchewan River, which is the drinking water source for the City of Edmonton. Groat Road Bridge spans the North Saskatchewan River in the project area; Victoria Bridge (B060) and Emily Murphy Bridge (B099) span roadways situated away from and on the north and south sides of the river, respectively. The North Saskatchewan River originates at the Saskatchewan Glacier 500 km upstream of Edmonton and flows through the City for 48 km, from southwest to northeast (AEP 2016d; River Valley Alliance 2016). River flow is regulated by two hydroelectric dams, the Brazeau dam and the Bighorn dam. Several tributary streams release into the North Saskatchewan River within city limits; however, none are located within the local study area.

Groat Road Bridge is located in a relatively straight reach of the river, several hundred meters downstream of a large meander bend (NHC 2017; Appendix E). The channel width through the bridge crossing reach was approximately 250 m with a channel bed comprised of gravel overlying shale and/or sandstone bedrock at shallow depth. Channel banks are typically comprised of sand/gravels that are experiencing only minor erosion (NHC 2017; Appendix E).

NHC (2017; Appendix E) used the North Saskatchewan River two-year flood as a base case for the hydraulic modeling analysis. Based on a flood frequency analysis of peak flows from the beginning of August to freeze-up from 1972 to present, the two-year event has a maximum discharge of 343 m^3/s (NHC 2017). Based on that discharge, the depth-averaged velocity in the majority of the main channel in the vicinity of Groat Road Bridge was 0.8-1.0 m/s, with slower velocities (0.2-0.6 m/s) near the banks (NHC 2017; Appendix E).

Bathymetric studies were undertaken by Parsons Inc. (2016), covering a segment of the North Saskatchewan River extending approximately 80 m upstream and 160 m downstream of the existing Groat Road Bridge. The deepest part of the channel was located in the vicinity of Groat Road Bridge between Piers 2 and 3, on the north side of the channel (Parsons Inc. 2016). A large scour area was noted approximately 60 m downstream of the bridge and extended approximately 110 m (Parsons Inc. 2016). Cross-sectional transect data collected by Kingfisher Aquatics (2017; Appendix G in this report) and base case hydraulic conditions modelled by Northwest Hydraulic Consultants (2017; Appendix E in this report) supported that finding.

North Saskatchewan River Floodplain

Most of the proposed Groat bridges study area is located outside the City of Edmonton's 1:100 year floodplain, as well as the provincial flood hazard area. Victoria Bridge and Emily Murphy Bridge are situated on lower river valley terraces, outside the floodplain (City of Edmonton 2016). The Groat Road Bridge abutments, however, are situated within the floodplain area and within the Province's floodway area, as shown in the Province of Alberta's flood hazard map (Figure 4.1; AEP 2016c). The floodway is defined as the portion of the flood hazard area where flows are deepest, fastest and most destructive (AEP 2016c).

Groundwater

Groat Road Bridge (B059)

Groundwater levels measured at two standpipe piezometers showed groundwater on the north side of the river was 8.4 m below the surface of the ground and 5.9 m below the surface of the ground on the south side of the river. Groundwater depths are known to fluctuate in relation to climate, precipitation and water levels in the river; therefore, groundwater levels on the alluvial terraces on north and south sides of Groat Road Bridge were expected to closely mirror river levels (Thurber 2016c; Appendix C).

4.1.3 Vegetation

4.1.3.1 Methods

Literature Review

A search of the Alberta Conservation Information Management System (ACIMS) was conducted on 22 March 2016 to determine if any rare plant species had been reported from the study area (AEP 2016a). Aerial photographs of the study area were examined and preliminary plant communities delineated based on professional knowledge, for use in field investigations.

Field Investigation

Rare Plant and Plant Community Surveys

A rare plant and plant community survey was undertaken by a professional plant ecologist on 20 June 2016. All plant communities in the project area were surveyed to fully describe the communities and to document rare plant occurrences. Preliminary community delineations were ground-truthed and boundaries adjusted as necessary.

The survey area encompassed all proposed project components, access routes and staging areas, as well as lands immediately adjacent to these proposed areas. Each community was surveyed via meandering transects. Representative sites were photographed. All species were documented and their relative abundances were ranked as dominant, abundant, frequent, occasional or rare (locally uncommon). That species information was used to classify communities, according to the system developed by Westworth & Associates (1980, *in* EPEC Consulting Western Ltd. 1981) for plant communities in the North Saskatchewan River Valley in Edmonton. In addition to communities identified in this system, occasionally other communities were observed that were characterized by non-native vegetation and, thus, are not covered by the Westworth & Associates system but are defined and described below.

All communities were surveyed at an intensity that was deemed sufficient to capture the diversity of habitats within each community and to encounter any rare species present. Species ranked as S1 and S2 are considered rare provincially; the City of Edmonton Urban Analysis Section also considers S3 species as rare within the City of Edmonton.

When S1, S2 or S3 species were observed, their occurrence was noted and their location was marked with a GPS.

Species that could not be identified in the field were collected and identified with the aid of a dissecting microscope and various botanical manuals. Species scientific and common names follow the most recent data from ACIMS (AEP 2016a). Common names are used throughout the text; however, complete plan community data, including species scientific names, are provided in Appendix F.

Weed Survey

A noxious weed survey was conducted concurrently with the rare plant and plant community surveys on 20 June 2016. The weed survey covered all plant communities within the project area. In each community, any noxious or prohibited noxious species observed were recorded and their relative abundance ranked as dominant, abundant, frequent, occasional or rare (locally uncommon).

4.1.3.2 Description

Regional Vegetation

The project study area lies within the Central Parkland Subregion of the Parkland Natural Region, characterized by a mosaic of aspen groves and prairie vegetation (Natural Regions Committee 2006). The mixed landscape is the product of till plains and hummocky uplands, with moisture availability determining the proportion of grass and aspen. Aspen forests dominate the area with balsam poplar stands occurring on poorly drained sites. Both forest types generally have a well-developed and diverse shrub layer, dominated by species such as snowberry, prickly rose, red-osier dogwood and willow (Natural Regions Committee 2006). Much of the native vegetation within this subregion has been cleared for urban and agricultural development, with remnant communities found in ravines or valleys, such as in the local study area.

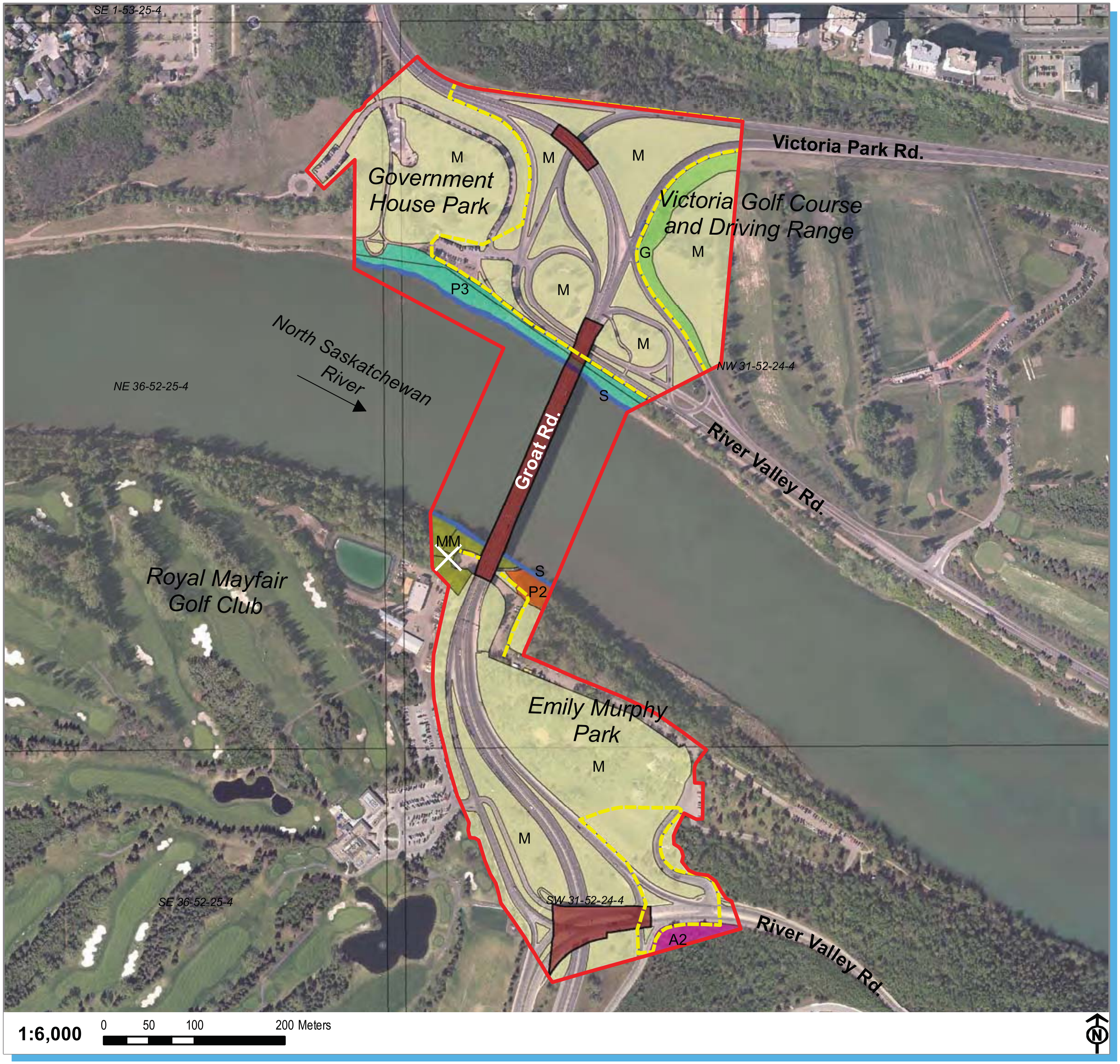
Local Vegetation

Altogether, six different plant communities were present within the Groat Road Bridges local study area, with differences evident at each bridge site. (Figure 4.2):

- Balsam Poplar-White Spruce (P2)
- Balsam Poplar-Aspen (P3)
- Aspen-Balsam Poplar (A2)
- Manitoba Maple (MM)
- Shoreline (SL)
- Manicured (M)

A summary description of the communities observed at each bridge site and in the larger surrounding study area is provided below.

Figure 4.2
Plant Communities and Breeding Bird Survey Transects
Groat Road Bridges Rehabilitation



Date Map Created: 28 March 2017
Aerial Photograph Date: May 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Balsam Poplar-White Spruce (P2)

Balsam poplar-white spruce communities are typically found in cool, moist sites on north-facing slopes in the river valley and are characterized as having a canopy of balsam poplar with white spruce (Westworth & Associates 1980, *in* EPEC Consulting Western Ltd. 1981). This community type has a well-developed tall shrub layer dominated by red-osier dogwood and relatively species-poor low shrub and herb layers. A balsam poplar-white spruce community was observed in Emily Murphy Park, immediately east of Groat Road Bridge (Figure 4.2).

The balsam poplar-white spruce community was characterized by a canopy dominated by balsam poplar, with frequent occurrences of white spruce and Manitoba maple (Plate 4.1). The shrub layer was characterized by abundant occurrences of prickly rose, red-osier dogwood and buckbrush. The understorey was characterized by abundant wild sarsaparilla and frequent occurrences of woodland horsetail, Lindley's aster, star-flowered Solomon's seal and wild lily-of-the-valley.

Plate 4.1. A P2 community dominated by balsam poplar and white spruce in Emily Murphy Park, near Groat Road Bridge (20 June 2016)

Overall, 21 vascular plant species were observed in the P2 community (Appendix F). Of these, 17 (81%) were native, while the remaining four species (19%) were exotic. No special status species were observed in the P2 community. One noxious weed species, creeping thistle, was observed in this community. No prohibited noxious species were observed.

Balsam Poplar-Aspen-Birch (P3)

Balsam poplar-aspen-birch communities are widespread in moist areas in the river valley and are characterized as having a canopy of codominant balsam poplar and aspen, with occasional birch (Westworth & Associates 1980, *in* EPEC Consulting Western Ltd. 1981). The understorey is typically variable, with a mixture of tall and short shrubs, forbs and grasses. A balsam poplar-aspen community was documented along the north bank of the North Saskatchewan River in the vicinity of Groat Road Bridge (Figure 4.2). At that site, balsam poplar and Manitoba maple were dominant, with abundant occurrences of aspen (Plate 4.2). Prickly rose and buckbrush were widespread in the shrub layer. The understorey was characterized by abundant smooth brome and quack grass, with occasional common goat's-beard and alsike clover.

Plate 4.2. A P3 community dominated by balsam poplar and Manitoba maple on the north bank of the North Saskatchewan River upstream of Groat Road Bridge (20 June 2016)

Overall, 40 vascular plant species were observed in the P3 community (Appendix F). Of these, 25 (63%) were native, while the remaining 15 (38%) were exotic. No special status species were observed in the P3 community. Two noxious weed species, creeping thistle and common tansy, were observed in this community. No prohibited noxious species were observed.

Aspen-Balsam Poplar (A2)

Aspen-balsam poplar communities are widespread in the river valley, occurring on a variety of aspects (Westworth & Associates 1980, *in* EPEC Consulting Western Ltd. 1981). These communities are characterized by a canopy dominated by aspen, with balsam poplar as a codominant. The understorey consists of a mixture of tall and short shrubs, forbs and grasses. An aspen-balsam poplar community was observed on the slope above Emily Murphy Park Road at Emily Murphy Bridge (Figure 4.2). Aspen was the dominant tree species, with abundant balsam poplar and frequent occurrences of Manitoba maple. The shrub layer was dominated by prickly rose with abundant red-osier dogwood and buckbrush (Plate 4.3). The understorey was characterized by abundant wild sarsaparilla, spreading dogbane, northern bedstraw and tall lungwort.

Plate 4.3. An A2 community dominated by aspen and prickly rose near Emily Murphy Bridge (20 June 2016)

Overall, 36 species were observed in the A2 community (Appendix F). Of these, 26 (72%) were native, while the remaining 10 (28%) were exotic. No special status plant species were observed in this community. Three noxious weed species were detected in the A2 community: creeping thistle, common toadflax and common tansy. No prohibited noxious weed species were observed in this community.

Manitoba Maple (MM)

Manitoba maple communities are not described as part of the Westworth & Associates classification system, which focuses on native plant communities throughout the river valley. Manitoba maple communities, however, are widespread throughout the river valley in Edmonton. They are characterized by a canopy and understorey dominated by Manitoba maple, with a particularly poorly developed understorey comprising few species (Plate 4.4). A Manitoba maple community was documented on the south side of Groat Road Bridge (B059) (Figure 4.2).

Plate 4.4. A typical Manitoba maple community on the south side of Groat Road Bridge (B059) (20 June 2016)

Overall, 32 species were observed in the MM community (Appendix F). Of these, 20 (63%) were native, while the remaining 12 (38%) were exotic. One special status species, high-bush cranberry (S3S4) was observed within the MM community, near the south end of Groat Road Bridge. Two noxious weed species were observed in this community: common burdock and creeping thistle. No prohibited noxious weed species were observed.

Grassland

Grassland communities are dominated by herbaceous material, especially grasses and species of legume that are often used in land reclamation (Westworth & Associates 1980, *in* EPEC Consulting Western Ltd. 1981). Within the proposed project area, a grassland community was located on the steep slope adjacent to Victoria Park Road, upslope of the Victoria Golf Course and Driving Range (Figure 4.2). This community is not located in close proximity to any of the three bridge sites; however, it may be affected by associated laydown and staging areas and/or traffic detours.

The grassland community was dominated by unmown smooth brome, quack grass and Kentucky bluegrass, with frequent crested wheatgrass and common dandelion. A small patch of low shrubs included prickly rose, buckbrush and snowberry (Plate 4.5).

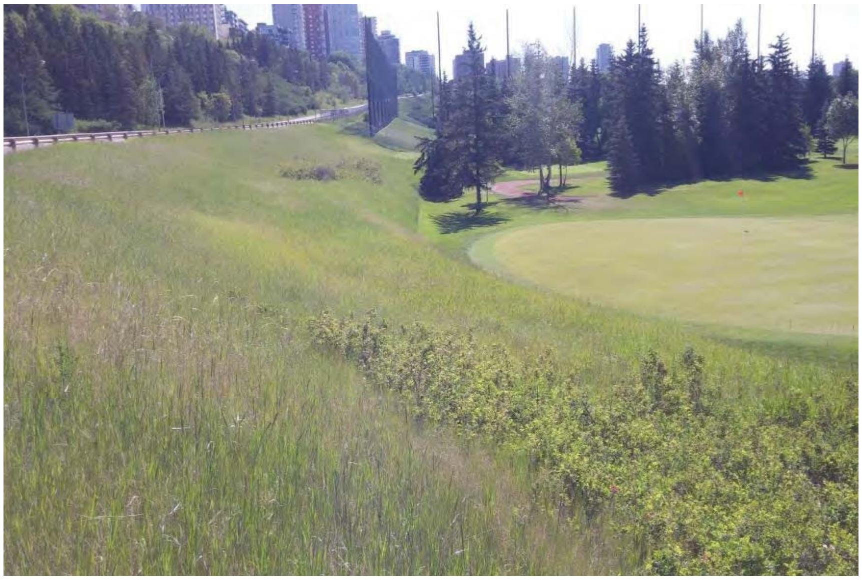


Plate 4.5. A grassland community characterized by smooth brome and scattered prickly rose, on the slope above the Victoria Park Golf Course, adjacent to Victoria Park Road (20 June 2016)

Overall, 16 species were observed in the grassland community (Appendix F). Of these, four (25%) were native, while the remaining 12 (75%) were exotic. No special status species were observed in this community. Two noxious weed species were observed: creeping thistle and scentless chamomile. No prohibited noxious weeds were observed.

Shoreline

Shoreline communities are not described as part of the Westworth & Associates classification system, which focuses on riparian vegetation throughout the river valley area and does not isolate the narrow band of vegetation at the river's edge as a distinct community. Shoreline areas are situated immediately adjacent to the North Saskatchewan River and are subject to occasional flooding during periods of high water levels. They were characterized by exposed muddy soils and sparse, moisture-loving vegetation (Plate 4.6). Due to steep river bank topography on the north side of the North Saskatchewan River, only the shoreline community on the south side of the river was formally surveyed. The shoreline in that area was characterized by abundant sandbar willow and shining willow, with frequent shrubby willow, Manitoba maple, field wood-rush, smooth brome and yellow and white sweet-clover.

Plate 4.6. Sparsely-vegetated shoreline community on the south side of the river at Groat Road Bridge (20 June 2016)

Overall, 20 species were observed in the shoreline community at Emily Murphy Park on the south side of the river. Of these, nine species were native and 11 species were exotic (Appendix F). No special status species were observed, and one noxious weed species, common tansy, was occasionally observed.

Manicured Areas

Manicured areas are subject to regular mowing or maintenance; they are characterized by grassy areas and planted beds, as well as areas where the original cover has been maintained but severely thinned. Manicured areas in the proposed project area consisted mainly of mown grass and planted trees and shrubs that included both native species and ornamental cultivars (Plate 4.7). Manicured picnic areas were located in Emily Murphy Park and Government House Park. Other manicured areas included lands adjacent to roadways (e.g., Groat Road, River Valley Road, and Emily Murphy Park Road). Manicured areas were documented within the local study area at all three bridge sites (Groat Road Bridge, Victoria Bridge and Emily Murphy Bridge) (Figure 4.2). Due to the frequent maintenance of these communities and prevalence of exotic species, comprehensive inventories were not taken, but general descriptions follow.

Plate 4.7. A manicured area with mown grass, planted trees and picnic tables at Government House Park (20 June 2016)

Groat Road Bridge (B059)

Much of the local study area on the north side of the North Saskatchewan River at Groat Road Bridge is characterized as manicured grass adjacent to roadways and shared-use paths. River Valley Road and Groat Road, and their associated entrance and exit lanes are situated within the local study area. The majority of this manicured area was mown grass, mainly smooth brome, Kentucky bluegrass and quack grass. Scattered trees include planted mugo pine, Norway spruce and Amur maple. Mulched planted beds contained species such as mockorange and prickly rose.

Victoria Bridge (B060)

Much of the local study area around Victoria Bridge is characterized as manicured grass adjacent to roadways. Groat Road, Victoria Park Road and River Valley Road, as well as their associated entrance and exit lanes are all situated within the local study area. The majority of this manicured community was mown grass, mainly smooth brome, Kentucky bluegrass and quack grass. Scattered trees include planted mugo and Ponderosa pines and weeping birch.

Emily Murphy Bridge (B099)

Much of the local study area around Emily Murphy Bridge is characterized as manicured grass adjacent to roadways. Groat Road and Emily Murphy Park Road, as well as their associated entrance and exit lanes are situated within the local study area. The majority of this manicured community was mown grass, mainly smooth brome Kentucky bluegrass and quack grass. Scattered trees include planted balsam poplar, lodgepole pine, jack pine and green ash.

Special Status Species

In Alberta, rare plant species are typically considered to be those that are found in fewer than 20 locations in the province (AEP 2016e). These plants are given provincial conservation rankings of S1 or S2. S1 species are known from five or fewer locations in the province, while S2 species are known to occur in 6-20 locations. The Province typically considers species ranked S3 (21-100 known occurrences) as uncommon, rather than rare, and thus, S3 species are not tracked and mitigation measures for their disturbance are not required. However the City of Edmonton Urban Analysis Section considers species ranked as S1, S2 and S3 to be rare.

A comprehensive rare plant survey was conducted on 20 June 2016 and covered the entire study area, including the three bridge sites and adjacent lands. As much of the proposed project area comprises manicured lands, with minimal anticipated impacts to native plant communities, a second rare plant survey specific to the bridges study area was not undertaken.

A search of ACIMS records for the proposed project area conducted on 22 March 2016 returned records of two special status vascular plant species in the immediate project area: flat-topped white aster and smooth sweet cicely. Neither of these species was detected during the vegetation surveys conducted in June and August 2016. Flat-topped white aster was last reported in the vicinity of the proposed project area in 1952. As this species has not been reported since, its occurrence in the project area is unlikely. Smooth sweet cicely has been documented in the vicinity of the proposed project area several times in the last 10 years, most recently in 2013. This species is typically observed in moist wooded areas, such as the moist forests along the North Saskatchewan River. Consequently, this species could potentially occur in the moist forests in the vicinity of the proposed project area, although they were not observed in 2016.

One potential special status species was observed during the rare plant surveys: high-bush cranberry, which is currently ranked as S3S4. High-bush cranberry was downgraded from S3 to S3S4 in October 2015, as part of a comprehensive review which AEP undertook for all vascular plant species in 2015 (AEP 2016a). While S3 species are considered uncommon and are known from 21-100 occurrences, S4 species are considered uncommon but apparently secure and are known from >100 occurrences (AEP 2016e). A blended rank of S3S4 suggests there is some uncertainty about this species' abundance in Alberta, and/or this species is vulnerable to extirpation due to various internal or external factors (AEP 2016e).

High-bush cranberry is a tall shrub from the honeysuckle family (Caprifoliaceae). This species is found in moist woods and river valleys and has a wide range in Alberta, from the southern limit of the Central Parkland in the south to the lower Peace and Athabasca valleys in the north (Moss 1983). It occurs in low abundances over much of its range but is locally abundant in the North Saskatchewan River valley in Edmonton. Within the proposed project area, high-bush cranberry was detected in the Manitoba maple community on the south side of Groat Road Bridge (coordinates: 12U 331658E, 5934884N).

Weeds

The Alberta *Weed Control Act* defines two categories of weeds: prohibited noxious and noxious. Prohibited noxious weeds are those that are currently uncommon or absent in the province but have been identified as noxious due to their potential to invade and damage natural and cultivated systems. Provincial legislation requires that prohibited noxious weeds be destroyed where they are found. Noxious weeds are generally those that are currently widespread in the province and are considered difficult to eradicate. Provincial legislation, however, requires that noxious weed species be controlled.

Noxious Species

Noxious weeds found in the proposed project area include creeping thistle, common toadflax, common tansy and scentless chamomile (Table 4.1). All these species are relatively common on disturbed lands in the Edmonton area. Noxious weeds were widespread throughout the proposed project area, as all plant communities supported at least one noxious weed species. Creeping thistle was the most widespread noxious weed, as it was present in all communities surveyed in support of the roadworks project. Surface disturbance associated with construction could create ideal conditions for the spread of these and other noxious weed species; Provincial legislation does, however, require control of these species.

Table 4.1. Observed Noxious Weeds within the Bridges Study Area in Summer 2016

Status	Common Name	Scientific Name	Plant Community
Noxious	Common burdock	*Arctium minus*	MM
	Creeping thistle	*Cirsium arvense*	P2, P3, A2, MM, G
	Common toadflax	*Linaria vulgaris*	A2
	Common tansy	*Tanacetum vulgare*	P3, A2
	Scentless chamomile	*Tripleurospermum inodorum*	G

4.1.4 Wildlife and Wildlife Habitat

4.1.4.1 Methods

Wildlife and wildlife habitat within the project area were characterized through a combination of field surveys and desktop analysis.

Field Surveys

On 08 June 2016, a breeding bird survey was conducted in the study area to characterize the breeding bird community and assess species richness and abundance. The survey was conducted along three fixed-width transects, 40m wide and measuring 1882m, 700m and 136m in length (Figure 4.2; Table 4.2). These transects encompassed all representative habitat types present within the study area. The transects were walked slowly at a rate of approximately 15m to 20m per minute and all birds detected within a distance of 20 m on either side of the transect were recorded. All additional wildlife observations or sign were documented. No formal field surveys for other wildlife taxa were undertaken specifically for this project.

Table 4.2. Summary of Breeding Bird Survey Fixed-Width Transects Surveyed on 8 June 2016

Site	Transect Length (m)	Transect Area (ha)
Transect 1	1882	7.5
Transect 2	700	2.8
Transect 3	136	0.54
Total	**2718**	**10.84**

Desktop Analysis

Information regarding wildlife habitat and other potentially-occurring wildlife species in the study area was developed from the following: review of the vegetation mapping completed for this assessment; review of available habitat documented during the breeding bird survey; review of wildlife species known to occur in the region and wildlife species records from other studies completed in the vicinity of the project area, including the recently completed *North Saskatchewan River Boat Docks and Launches Environmental Impact Assessment* (Spencer Environmental 2016).

The likelihood of species occurring in the local study area was determined based on our professional opinion arrived at by considering habitat availability within the study area and potential habitat use by each species (e.g., potentially breeding at the site or passing through the area on migration and stopping to forage). The potential for species listed in current provincial and federal conservation legislation (i.e., Alberta's *Wildlife Act*, federal *Species At Risk Act*, *Migratory Birds Convention Act*) to occur in the study area is a critical consideration for assessments related to development, as the potential for a project to affect these species must be assessed and mitigation provided to demonstrate due diligence in complying with the legislation.

4.1.4.2 Description

Wildlife Habitat

The vast majority of the terrestrial habitat in the study area comprises manicured turf with scattered planted trees. Areas of natural terrestrial habitat within the study area are restricted to the following areas: the coniferous-dominated woodland along the valley slope at the north edge of the study area, a narrow strip of grassland and low shrub habitat along Victoria Park Road, deciduous woodland habitat along the north and south edges of the NSR, and a small area of deciduous woodland at the very southern edge of the study area along Emily Murphy Park Road. An extensive network of arterial roadways is also present within the study area.

The study area also includes the NSR itself. From a wildlife perspective, the NSR is known to support fish. The river's function as fish habitat is discussed separately in *Section 4.1.6*. In addition to fish, the NSR supports various aquatic invertebrates and some use by waterbirds. Invertebrates are excluded from the scope of this ESR, however, the potential presence of waterbird species is discussed in following sections.

In general, the study area consists of low quality habitat that is expected to be suitable for only a relatively small suite of urban-adapted wildlife species. The areas of naturally vegetated habitat along the valley slope and the north and south river banks represent the best available wildlife habitat in the project area. However, even for those areas, because of their proximity to arterial roadways and their relatively small areas, the habitat is expected to support primarily generalist and urban-tolerant species.

Wildlife

Avifauna

In total, 31 individual birds of 10 different species were observed within the study area during the breeding bird survey in June 2016 (Table 4.3). The observed species comprise common and generalist species that are adapted to urban environments and edge habitat. More typical woodland species, such as the red-eyed vireo and white-throated sparrow, were observed only in the woodland southeast of the Emily Murphy Bridge. Despite the relatively disturbed nature of the available habitat throughout much of the study area, all species observed in June 2016 could potentially nest within the project area.

Table 4.3. Summary of Bird Species Observed in the Project Area during the Breeding Bird Survey (June 2016)

Species	Manicured	NSR North Bank	NSR South Bank	Emily Murphy Road	Total
American crow	1			1	**1**
American robin	1				**1**
Black-billed magpie			1		**1**
Black-capped chickadee	2			1	**1**
Cedar waxwing	12				**12**
Chipping sparrow	2	1			**3**
House finch	2				**2**
Red-eyed vireo				1	**1**
White-throated sparrow				1	**1**
Yellow warbler		2	1	2	**5**
Totals (species richness)	**6**	**2**	**2**	**5**	**10**
Totals (abundance)	**20**	**3**	**2**	**6**	**31**

Mammals

Several mammal species have the potential to occur within the project area; however, as a result of the nature of the available habitat, mammals are expected to consistently inhabit only areas of naturally vegetated habitat, while the open, manicured areas would typically support occasional movement and foraging of various species.

The species most likely to occur in the study area are small and medium-sized mammals. Species such as deer mouse, red-backed vole and red squirrel, are expected to commonly occur within the deciduous woodland habitat along the north and south banks of the NSR, and, for the mouse and vole, along the strip of grassland adjacent Victoria Park Road. White-tailed jackrabbits are well-adapted to open, urban environments and are also expected to frequently occur in the study area, particularly the manicured areas. The woodland area along the south bank of the NSR, although relatively little of this community is located within the study area, may also support additional species such as least chipmunks, snowshoe hares and porcupines as these are all common species within the North Saskatchewan River valley.

Among larger, wider-ranging species, both deer (mule and white-tailed) and coyote are expected to be occasionally present within the project area. Considering the general lack of natural vegetative cover, the presence of many roads in the study area, and the wide-ranging habits of these species, deer and coyote are most likely to use the project area as part of a larger travel corridor, although they may occasionally forage (or hunt) in the study area. The treed cover along the south bank of the river may provide both deer and coyote with sufficient protective cover to accommodate more extended use of that habitat.

Other large mammals, such as moose and some carnivores, are occasionally observed in Edmonton's river valley and, therefore, have some potential to be fleetingly present in the study area. Moose would not likely linger owing to a lack of suitable habitat. Observations of other large mammals (e.g., lynx, cougar) in Edmonton river valley parks are rare and likely the result of dispersing individuals moving through the region in search of new territory; the possibility of such occurrences does not warrant further consideration in this EIA.

Amphibians and Reptiles

Amphibians generally require ponded aquatic habitat for breeding and overwinter in adjacent areas of terrestrial habitat. None of the lands within or immediately adjacent to the study area provide suitable amphibian breeding habitat; the NSR is too fast flowing for potentially occurring amphibian species. Accordingly, amphibians are not expected to occur within the project area.

Red-sided garter snakes are the most commonly-occurring reptile species in the City of Edmonton. There are no known hibernacula (i.e., communal over-wintering sites) near to the study area (AEP 2016b), however, the banks of the NSR may provide suitable overwintering sites and, as a result, it is possible that garter snakes move into the study area from the riverbank or more distant hibernacula locations during their active season. Although the potential exists, the likelihood of frequent occurrence of garter snakes in the project area is considered to be low. Management and disturbance sensitivities are typically associated with hibernacula rather than habitat use during the growing season.

Special Status Wildlife Species

Based on species habitat requirements, an understanding of the available habitat and provincial species distributions, and species records in the FWIMT database, a number of special status species have been identified as having at least some potential to occur in the project area. The following section discusses the potential occurrence of species that are ranked by the Province as *At Risk* or *May Be At Risk*, or have been federally assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as either *Endangered*, *Threatened*, or *Special Concern* (Table 4.4), *and* have at least a moderate likelihood of occurrence within the local study area. Species having a provincial status of *Sensitive*, but no federal status, hold no potential to trigger project considerations beyond those applicable to wildlife in general, and, thus, are not discussed, even if their potential for occurrence was considered moderate or high.

Three species, the northern bat, little brown bat and barn swallow, met the above criteria and are discussed further below. The search of the FWIMT database returned records of four special status species observed within 1km of the project area. Two of those species are listed as *Sensitive* by the Province, but have no federal status (i.e., Cape May warbler and bay-breasted warbler), and one was determined to have a low likelihood of occurrence (i.e., short-eared owl) because of unsuitable habitat within the project area. The fourth, northern bat, met the above criteria and is discussed below.

Table 4.4. Special Status Wildlife Species with Potential to Occur in the Project Area

Common Name	**Scientific Name**	**Provincial Status (General Status of AB Wild Species)** [a]	**Wildlife Act Designation and New Species Assessed by ESCC** [b]	**COSEWIC Designation** [c]	**SARA Designation**[d]	**Potential Habitat Use**	**Likelihood of Occurrence**
Northern Bat	*Myotis septentrionalis*	May be At Risk	Data Deficient	Endangered	Endangered	Breeding/ Foraging	Moderate
Little Brown Bat	*Myotis lucifugus*	Secure		Endangered	Endangered	Resident	Moderate
Barn Swallow	*Hirundo rustica*	Sensitive		Threatened		Breeding	Moderate

[a] According to General Status of AB Wild Species (2010)
[b] Alberta Endangered Species Conservation Committee
[c] Federal ranking by Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
[d] Federal *Species at Risk Act* designation

Two mammals that have been recently assessed by COSEWIC as Endangered have a moderate likelihood of occurrence within the local study area. Both of these species are bats in the *Myotis* genus (northern bat and little brown bat) that have experienced extreme rates of mortality in the eastern United States due to white-nose syndrome (WNS; Forbes 2012a, 2012b). WNS is also present in eastern Canada and the spread of WNS westward, throughout the rest of their range, could put these two species at risk of extinction. This has directly contributed to their federal status as *Endangered*. In Alberta, the northern bat is ranked as *May Be At Risk*, while the little brown bat is currently ranked as *Secure*. During the breeding season, both species of *Myotis* occupy mid- to late- successional forests, often near water, and roost under the bark of trees or in old nest cavities (Pattie and Fisher 1999). Within the study area, the riparian balsam poplar-aspen forest combined with the presence of the adjacent NSR, provide potentially good foraging and roosting habitat. On that basis, the likelihood of either *Myotis* species occurring in the local study area is rated as moderate.

Barn swallows have been recently assessed as *Threatened* by COSEWIC due to sharp population declines, although the species is still ranked as *Sensitive* in Alberta and relatively common in the Edmonton area. Barn swallows use anthropogenic structures (e.g., barns, buildings, bridges) for supporting their nests, and require open spaces, such as above water bodies, for foraging because they catch insects in mid-air while flying (Brown and Brown 1999). While no barn swallows were observed during field investigations in 2016, the wooden toilet shelter in Government House Park and the bridge structures within the study area could function as suitable locations for nest building. The likelihood of barn swallows occurring in the local study area is rated as moderate.

4.1.5 Habitat Connectivity and Wildlife Passage

4.1.5.1 Methods

Habitat connectivity and wildlife passage were assessed based on an understanding of the available habitat within the project area, analysis of aerial photographs of the study area and surrounding vicinity, observations made during site visits and professional knowledge. Datasets from the City's Animal Care & Control and Office of Traffic Safety that contain information on wildlife-vehicle collisions in the City of Edmonton, as well as relevant literature, were also reviewed to inform our assessment of wildlife movement in the vicinity of the study area.

4.1.5.2 Description

The North Saskatchewan River Valley (NSRV) is identified as a regional biological corridor in Edmonton's Ecological Network (City of Edmonton 2007a) and facilitates regional and local wildlife movement. Effectiveness of Edmonton's river valley as a fully functioning movement corridor varies with localities influenced by a combination of topography, habitat fragmentation and urban development (Spencer Environmental 2006). In addition, for many species, particularly small and medium-sized terrestrial mammals and forest songbirds (Tremblay and St. Clair 2009), the NSR itself represents a barrier to movement at certain times of the year. As such, the study area encompasses a large portion of the valley's wildlife movement corridor, but viable movement corridors remain along valley slopes north and south of the study area.

Within the study area, habitat is fragmented and the quality and continuity of wildlife movement corridor is variable. The open manicured areas and the naturally vegetated areas are expected to function differently with respect to wildlife movement. The naturally vegetated areas provide more protective cover and natural ground cover and are crossed by fewer roads. The increased cover would facilitate movement of deer, small and medium-sized terrestrial mammals and woodland songbirds. The south side of the river, in particular, has good potential as a functional movement corridor. The woodland habitat on either side of the Groat Bridge connects to larger, more contiguous habitat patches, and the clearance under the bridge is suitable to accommodate passage of all potentially-occurring wildlife species.

In contrast, Victoria Bridge and Emily Murphy Bridge are components of arterial roadway interchanges surrounded by manicured areas. Wildlife likely do not use the roadway under those two bridges, specifically, for passage because of the roadway infrastructure, level of traffic and lack of natural habitat under the bridges and adjacent to the bridges. It is more likely wildlife would move around those bridges utilizing the adjacent manicured areas.

The manicured areas are expected to support the movement of a much-reduced subset of wildlife species. Regular movement through these areas is likely restricted to species adapted to open, fragmented urban habitat. Among mammals, coyote and white-tailed jackrabbit would willingly use these areas, while bird species such as black-billed magpie and American crow are most well-suited for movement through the manicured areas.

Roads, particularly those conveying high traffic volumes, deter wildlife movement and typically function as semi-permeable or impermeable barriers (van der Ree et al. 2015). The complicated roadway network within the study area undoubtedly impacts wildlife movement. Groat Road, in particular, is expected to impede terrestrial wildlife movement because of its high traffic volume, 4-lane width and the presence of jersey barriers separating the north and south-bound lanes. The impact is expected to be greatest for small terrestrial mammals that require the protection of natural ground cover to facilitate movement (e.g., mice and voles). Because of traffic volumes and road density, even quick-moving, urban-adapted individuals of larger species such as deer and coyote, are expected to generally avoid the center of the study area, to varying degrees. The presence of multiple roadways also presents the potential for wildlife-vehicle collisions, however, available data on wildlife-vehicle collisions in the city (city records and Found and Boyce 2011) suggest that occurrence rates are relatively low.

4.1.6 Fish and Aquatic Resources

The fish and aquatic resources environmental component only applies to the Groat Road Bridge that crosses the North Saskatchewan River. A summary of the fisheries information collected for that bridge site is provided below. The complete fish and fish habitat assessment report is provided in Appendix G.

4.1.6.1 Bridge B059 over the North Saskatchewan River Only

Kingfisher Aquatics Ltd. (Kingfisher Aquatics 2017) undertook a fish and fish habitat assessment of the North Saskatchewan River in October 2016 (Appendix G). The fisheries study area encompassed approximately 2.5 km of the North Saskatchewan River, extending 0.5 km upstream and 2.0 km downstream of the existing Groat Road Bridge (Kingfisher Aquatics 2017; Figure 4.3). The objectives of the fish and fish habitat assessment, as outlined in Kingfisher Aquatics (2017; Appendix G) were to:

- describe the existing fish and fish habitat of the North Saskatchewan River in the vicinity of the Groat Road Bridge,
- assess the potential impacts to fisheries resources that may occur as a result of the proposed Alternative 4B bridge rehabilitation option,
- identify strategies that will be employed to mitigate impacts to fisheries resources, and
- if necessary, identify the need for habitat offsetting to avoid serious harm to fish.

Kingfisher Aquatics inventoried the fish habitat in the project area along 12 transects using the Large River Classification System. Twelve transects, oriented perpendicular to flow and spanning the entire channel, were established in the vicinity of Groat Road Bridge, five situated upstream and five downstream, with two transects situated at the bridge location (Figure 4.3). A depth sounder was used to determine water depth and characterize the river profile within the study section. Select water quality variables were measured at a single location near Groat Road Bridge.

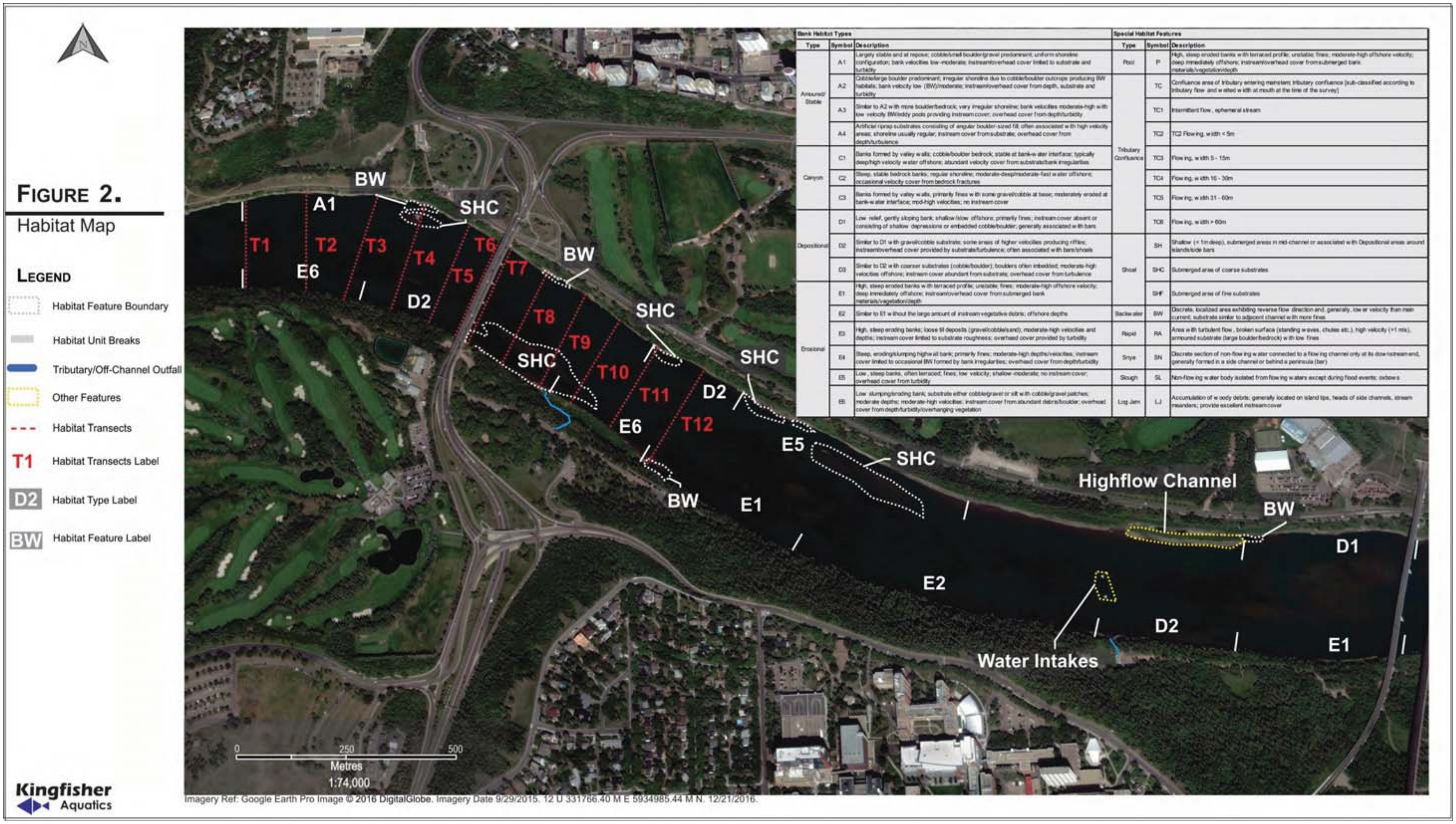
Kingfisher Aquatics also reviewed existing information regarding the fish community of the North Saskatchewan River in the vicinity of the bridge. Historical records, including the FWMIS database, were reviewed for record of fish species previously recorded in the study area.

4.1.6.1 Description

Fish Habitat

The North Saskatchewan River in the Edmonton region flows through a broad, unobstructed single channel. The upstream limit of the study area was located at the tail of a large bend in the river; within the study section, the channel broadened and was relatively straight (Kingfisher Aquatics 2017; Appendix G). Downstream of the study area, the river maintained a relatively straight path for approximately 1.2 km, beyond which a meandering flow pattern became apparent (Kingfisher Aquatics 2017; Appendix G). A summary of streambank and channel characteristics is provided in Table 4.5.

The average width of the river across the whole study area was 209 m based on measurements taken at 12 transects (Kingfisher Aquatics 2017; Appendix G). Water depths ranged from 0.5 m to 1.5 m. Streambanks were generally steep and exhibited some instability; in general, the left-upstream-bank (LUB) was higher and well-vegetated, while the right-upstream-bank (RUB) was lower and more exposed. Kingfisher Aquatics (2017) inventoried and mapped approximately 2580 m of the North Saskatchewan River in the vicinity of Groat Road Bridge and determined that the majority of the area (45.5%) was erosional habitat, while the remainder comprised depositional habitat (35.5%) and armoured habitat (19.0%) (Appendix G). Erosional habitat was more common on the LUB, while depositional habitat was more common on the RUB (Kingfisher Aquatics 2017; Appendix G).



Imagery Ref: Google Earth Pro Image © 2016 DigitalGlobe. Imagery Date 9/29/2015. 12 U 331766.40 M E 5934985.44 M N. 12/21/2016.

Bank Habitat Types

Type	Symbol	Description
Amoured/ Stable	A1	Largely stable and at repose; cobble/small boulder/gravel predominant; uniform shoreline configuration; bank velocities low-moderate; instream/overhead cover limited to substrate and turbidity
	A2	Cobble/large boulder predominant; irregular shoreline due to cobble/boulder outcrops producing BW habitats; bank velocity low (BW)/moderate; instream/overhead cover from depth, substrate and turbidity
	A3	Similar to A2 with more boulder/bedrock; very irregular shoreline; bank velocities moderate-high with low velocity BW/eddy pools providing instream cover; overhead cover from depth/turbidity
	A4	Artificial riprap substrates consisting of angular boulder-sized fill; often associated with high velocity areas; shoreline usually regular; instream cover from substrate; overhead cover from depth/turbulence
Canyon	C1	Banks formed by valley walls; cobble/boulder bedrock; stable at bank-water interface; typically deep/high velocity water offshore; abundant velocity cover from substrate/bank irregularities
	C2	Steep, stable bedrock banks; regular shoreline; moderate-deep/moderate-fast water offshore; occasional velocity cover from bedrock fractures
	C3	Banks formed by valley walls, primarily fines with some gravel/cobble at base; moderately eroded at bank-water interface; mod-high velocities; no instream cover
Depositional	D1	Low relief, gently sloping bank; shallow/slow offshore; primarily fines; instream cover absent or consisting of shallow depressions or embedded cobble/boulder; generally associated with bars
	D2	Similar to D1 with gravel/cobble substrate; some areas of higher velocities producing riffles; instream/overhead cover provided by substrate/turbulence; often associated with bars/shoals
	D3	Similar to D2 with coarser substrates (cobble/boulder); boulders often imbedded; moderate-high velocities offshore; instream cover abundant from substrate; overhead cover from turbulence
Erosional	E1	High, steep eroded banks with terraced profile; unstable; fines; moderate-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
	E2	Similar to E1 without the large amount of instream vegetative debris; offshore depths
	E3	High, steep eroding banks; loose till deposits (gravel/cobble/sand); moderate-high velocities and depths; instream cover limited to substrate roughness; overhead cover provided by turbidity
	E4	Steep, eroding/slumping highwall bank; primarily fines; moderate-high depths/velocities; instream cover limited to occasional BW formed by bank irregularities; overhead cover from depth/turbidity
	E5	Low, steep banks, often terraced; fines; low velocity; shallow-moderate; no instream cover; overhead cover from turbidity
	E6	Low slumping/eroding bank; substrate either cobble/gravel or silt with cobble/gravel patches; moderate depths; moderate-high velocities; instream cover from abundant debris/boulder; overhead cover from depth/turbidity/overhanging vegetation

Special Habitat Features

Type	Symbol	Description
Pool	P	High, steep eroded banks with terraced profile; unstable; fines; moderate-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
Tributary Confluence	TC	Confluence area of tributary entering mainstem; tributary confluence [sub-classified according to tributary flow and wetted width at mouth at the time of the survey]
	TC1	Intermittent flow, ephemeral stream
	TC2	TC2 Flowing, width < 5m
	TC3	Flowing, width 5 - 15m
	TC4	Flowing, width 16 - 30m
	TC5	Flowing, width 31 - 60m
	TC6	Flowing, width > 60m
Shoal	SH	Shallow (< 1m deep), submerged areas in mid-channel or associated with Depositional areas around islands/side bars
	SHC	Submerged area of coarse substrates
	SHF	Submerged area of fine substrates
Backwater	BW	Discrete, localized area exhibiting reverse flow direction and, generally, lower velocity than main current; substrate similar to adjacent channel with more fines
Rapid	RA	Area with turbulent flow, broken surface (standing waves, chutes etc.), high velocity (>1 m/s), armoured substrate (large boulder/bedrock) with low fines
Snye	SN	Discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar)
Slough	SL	Non-flowing water body isolated from flowing waters except during flood events; oxbows
Log Jam	LJ	Accumulation of woody debris; generally located on island tips, heads of side channels, stream meanders; provide excellent instream cover

The majority of the study area was classified as Class C habitat (moderate sensitivity), defined as habitat that is broadly distributed and sensitive enough to be potentially damaged by unconfined or unrestricted activities within a water body; however, there are several small segments of the North Saskatchewan River within Edmonton that are considered to have a greater sensitivity and are designated as Class A habitat (Kingfisher Aquatics 2017; Appendix G). Those areas protect localized deep water habitat (>4 m depth) that have been identified as preferential habitat for lake sturgeon; the nearest Class A habitat is located 7.5 km downstream of Groat Road Bridge (Kingfisher Aquatics 2017; Appendix G).

Table 4.5. Summary of Streambank and Channel Characteristics (Kingfisher Aquatics 2017; Appendix G)

	Upstream of Crossing		**Downstream of Crossing**	
Channel Properties				
Wetted Width (m)	214		204	
Depths (m)*	Habitat along transects mostly 0.5 – 1.5 m deep			
Streambed Substrate	Fines on LUB**; gravels and cobbles mid-channel and on RUB**		Gravels on LUB*, coarse substrates mid-channel, cobbles and fines on RUB**	
Instream Cover	Limited, primarily depth cover with some boulders			
Bank Properties				
	LUB	RUB	LUB	RUB
Bank Height (m)	4.1	3.2	2.3	2.2
Bank Angle (°)	78	77	73	58
Bank Cover	Generally absent		Minimal boulders present	
Bank Substrate	Fines	Armoured and fines	Fines	Mostly fines
Riparian Vegetation	Generally exposed, some shrubs and trees higher on slope	Generally exposed, some armoured and grass areas	Some exposed areas; grasses and shrubs also present	Some armoured areas, grass predominant further downstream

* Refer to Appendix D of Kingfisher Aquatics (2017; provided in Appendix G of this report) for depth profiles at each transect

** LUB: left upstream bank; RUB: right upstream bank

Water Quality

Water quality parameters were measured at a single location within the study area near Groat Road Bridge (Table 4.6).

Table 4.6. Select Water Quality Parameters in the North Saskatchewan River near Groat Road Bridge (Kingfisher Aquatics 2017; Appendix G)

Parameter	Measurement
Dissolved Oxygen (mg/L)	11.87
pH	8.6
Turbidity (NTU)	4.11
Temperature (°C)	5.0
Specific Conductivity (µS/cm)	308.7

Fish Populations

The NSR in the Edmonton area is considered a cool-water fishery and supports a wide variety of sport, non-sport and forage fish species. A search of the FWMIS database found record of 24 fish species; sport fish included burbot, goldeye, lake sturgeon, mountain whitefish, mooneye, northern pike, sauger and walleye (Kingfisher Aquatics 2017; Appendix G). While lake sturgeon likely move through the area periodically, the habitat assessment did not identify critical habitat for lake sturgeon within the study area.

At present, most of the fish species typically encountered in this section of the North Saskatchewan River are not listed by COSEWIC, the *Species at Risk Act*, or the W*ildlife Act*; however, North Saskatchewan River populations of lake sturgeon are considered Endangered by COSEWIC and are ranked as Threatened under the *Wildlife Act* (Kingfisher Aquatics 2017; Appendix G). The status of lake sturgeon under the *SARA* is currently under consideration.

4.2 Valued Socio-Economic Components

4.2.1 Recreational Land Use

4.2.1.1 Methods

Recreational land use within the local study area was determined by reviewing the City of Edmonton River Valley and Recreation website and by observation during site visits.

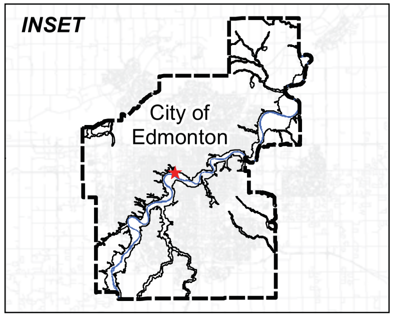
4.2.1.2 Description

The proposed Groat Road Bridges rehabilitation study area is connected to a variety of existing recreational areas in the North Saskatchewan River Valley that support numerous recreational amenities (Figure 4.4). On the north side of the river, adjacent to the north end of Groat Road Bridge, a 3.0 m wide shared-use path (SUP) extends in an east-west direction parallel to River Valley Road. From Government House Park, the SUP extends through the study area, following the lower river valley terrace through park areas towards the Rossdale neighbourhood. The SUP also connects to the sidewalk on Victoria Park Road, connecting the neighbourhoods of Westmount, Oliver and Downtown at the top-of-bank to the recreational amenities on the lower river valley terrace. The Victoria Golf Course, Victoria Skating Oval and Royal Glenora Club, located east of the proposed project area, attract additional recreationalists to the area year-round.

Figure 4.4
Existing
Recreational Uses
Groat Road Bridges
Rehabilitation

Legend

- ▭ Study Area
- Paved Trail
- Non-Paved Trail
- Trails Cleared In Winter
- Arterial Roadway
- Roadway
- LRT Track
- ☎ Emergency Blue Phone
- Drinking Fountain
- P Parking Lot
- LRT Station
- Transit Centre
- Playground
- Difficult Slope (10% and Greater)
- Moderate Slope (5% to 9%)
- Distance Markers
- 1.2 Trail Distance in Kilometres
- Golf Course
- Scenic Viewpoint
- Stairway
- Summer Washroom
- Year Round Washroom
- 🟩 Park
- Bridge



Date Map Created: 28 March 2017
Aerial Photograph Date: May 2015

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MANAGEMENT SERVICES LTD.

The River Valley Road SUP also connects to the sidewalk on the east side of Groat Road Bridge, joining an extensive trail network in the river valley parks on the south side of the river. Emily Murphy Park is located at the south end of Groat Road Bridge; SUPs connect Emily Murphy Park to Hawrelak Park upstream and Kinsmen Park downstream. Recreationalists can access Emily Murphy Park from the sidewalks along Emily Murphy Park Road and Emily Murphy Bridge. These sidewalks are well-used by recreationalists, such as joggers and dog-walkers, accessing the trail system.

4.2.2 Traffic/Parking

4.2.2.1 Methods

Existing traffic, parking and access information were assessed by review of aerial photos and the City of Edmonton Transportation website, as well as by observations made during project field surveys.

4.2.2.2 Description

Several major arterial roadways, including Groat Road, Victoria Park Road, River Valley Road and Emily Murphy Park Road, pass through the proposed project area, connecting Edmonton's downtown to neighbourhoods on the north and south sides of the North Saskatchewan River. Those roads, all of which are busy commuter arterial roadways, provide access to downtown Edmonton to the east, the University of Alberta to the south and the North Saskatchewan River Valley and ravine system in all directions (City of Edmonton 2015).

Public parking is available in several locations within and in close proximity to the study area. Free parking for recreationalists is available in Government House Park, immediately west of the north end of Groat Road Bridge on the north side of the river, and in Emily Murphy Park, east of the south end of Groat Road Bridge. Street parking, with or without parking meters is available throughout the downtown area and the Oliver, Glenora and Windsor Park neighbourhoods at the top-of-bank, upslope of the proposed project area.

4.2.3 Utilities

4.2.3.1 Methods

Existing utilities in the project area were assessed from information provided by the preliminary design team, aerial photos, the City of Edmonton Zoning Bylaw maps (Bylaw 12800) and observations made during project field surveys.

4.2.3.2 Description

Groat Road Bridge (B059)

A utility tray below the bridge deck on Groat Road Bridge supports a TELUS fibre optic cable and an EPCOR power line (DIALOG 2017). A 500 mcm (paper insulated, lead) cable and a copper cable, are also carried in the utility tray on Groat Road Bridge and are accessed through manhole portals at each end of the bridge. The manholes are either paved over or under barricades because they have not been field-located by EPCOR (Al-Terra 2016).

Victoria Bridge (B060)

EPCOR Power has a 72kV transmission power line that crosses under the southbound lanes of Victoria Park Road, immediately north of Victoria Bridge. Based on a hydrovac exposure in July 2016, the depth of the power line immediately east of Victoria Bridge site was 3.55 m below grade; further east, the depth of the power line is 5.23 m below grade (Al-Terra 2016).

Emily Murphy Bridge (B099)

Streetlights on the south side and median of the bridge are the only utilities located in the Emily Murphy Bridge project area.

4.2.4 Worker and Public Safety

4.2.4.1 Identification of Concerns Specific to the Project

This section does not constitute a detailed prescription of the safety measures that should be employed during project construction activities. That was considered beyond the scope of this EIA. The assumption is that the proposed Groat Road Bridges rehabilitation project will conform to all applicable municipal, provincial and federal worker and public safety regulations and protocols. This analysis of worker and public safety considered environmental elements that might pose risks to worker and public safety, particularly those linked to identified environmental impacts or local resources. This was done by considering all of the information presented in the preceding chapters of this document to identify physical locations or activities unique to this proposed project that might result in concerns.

4.2.4.2 Description

For the proposed project, worker and public safety concerns are most likely to arise in areas where construction activities would be located near existing public use or infrastructure, or where known safety risks had been identified by the public or regulators. The following elements were identified as warranting assessment of their potential to result in worker or public safety concerns:

- Potential for hazards during proposed bridge construction in areas adjacent to existing recreational use in the river valley
- Potential for wildfires during construction activities during dry periods in proximity to natural fuel loads.
- Potential for hazards during construction in the vicinity of existing utilities.

4.2.5 Visual Resources

4.2.5.1 Methods

Visual resources issues that were identified during this EIA concerned the temporary visual impact of construction within the North Saskatchewan River Valley and adjacent lands and in close proximity to residential and recreational areas, as well as the permanent visual impact of the completed bridge rehabilitation works. Of these, the permanent features are considered to be of greatest importance. A study area was developed for the assessment of visual resources, which comprised a variety of locations that offered nearby and distant view of the proposed Groat bridges rehabilitation project area. Visual resources were determined through a review of design plans for the bridge rehabilitation works and observations made during field surveys.

4.2.5.2 Description

North River Valley Slope

Drivers, passengers and recreationalists using many of the roadways and SUPs in the area have partial views of the river valley. In particular, Victoria Park Road offers unscreened views of the river valley, especially from vantage points further uphill (to the east), and encompasses Groat Road Bridge and Victoria Bridge. Vantage points on River Valley Road offer close, screened views of the river valley, including partially screened views of Groat Road Bridge and Victoria Bridge. Publicly accessible grounds near Government House and the former Royal Alberta Museum site, west of the project area, also provide a vantage point overlooking the river valley, with unscreened views of Groat Road Bridge and Victoria Bridge. Private vantage points from apartment and condo buildings along Jasper Avenue and 100 Avenue, particularly those from upper storeys, offer screened and unscreened views year-round of the river valley upstream and downstream of the proposed project area, encompassing Groat Road Bridge and Victoria Bridge.

North Saskatchewan River

Recreationalists on the North Saskatchewan River have uninterrupted 360° views of the river valley. Views include the river, adjacent park sites, forested areas and the downtown skyline. Recreational boaters pass under Groat Road Bridge, offering close-up views of that bridge, its piers and adjacent lands.

South River Valley Slope

Drivers and passengers traveling on Groat Road and Emily Murphy Park Road in the area have partial views of the river valley, especially from vantage points further uphill. Those views encompass Groat Road Bridge and Emily Murphy Bridge. Recreationalists using the SUPs in Emily Murphy Park have screened views of the river valley, including Groat Road Bridge; however, the south river bank tends to be densely vegetated, screening views from the SUPs. Recreationalists accessing the river valley from sidewalks along Emily Murphy Park Road or Groat Road also have screened views of the river valley, including Groat Road Bridge and Emily Murphy Bridge.

4.3 Valued Historic Components

4.3.1 Historical Resources

4.3.1.1 Methods

Historical Resources

Turtle Island Cultural Resource Management Inc. (Turtle Island) completed a Historical Resources Statement of Justification (SoJ) in April 2016 in support of the proposed Groat Road Bridges project (Turtle Island 2016). The SoJ was submitted to Alberta Culture and Tourism (ACT) for the department's review and comment regarding possible requirements pursuant to the *Historical Resources Act*.

Paleontological Resources

Steppe Consulting Inc. (Steppe) undertook a paleontological Historical Resources Statement of Justification (SoJ) in April 2016 in support of the proposed bridges rehabilitation project (Steppe 2016). The SoJ was submitted to ACT for the department's review and comment regarding possible requirements pursuant to the *Historical Resources Act*.

4.3.1.2 Description

Historical Resources

The bridges rehabilitation study area encompasses the north and south sides of the North Saskatchewan River in the vicinity of Groat Road Bridge, including alluvial terraces and the banks of the river. Two known archaeological sites are located outside the proposed project area, one located approximately 225 m northwest of the Groat Road Bridges rehabilitation project location at the valley edge adjacent to Government House, and the other approximately 1200 m south at Hawrelak Park. Neither of those known sites will be impacted by the proposed bridge rehabilitation works.

Upon review of the SoJ, ACT determined in June 2016 that a Historical Resources Impact Assessment (HRIA) was required and issued Schedule A, identifying specific requirements for the HRIA (Appendix H). Specific requirements included reviewing the results of the geotechnical work for this project to determine the extent of disturbance, the depth of intact sediments and, thus, the potential for intact archaeological deposits. In addition, ACT required a deep testing program in areas of significant sedimentation (Appendix H).

To meet ACT's requirements, Turtle Island inspected sediments collected from boreholes drilled during the geotechnical investigation and supplemented this inspection with a site visit (Turtle Island 2016). Three of the eight boreholes contained intact North Saskatchewan River flood plain deposits, and during a field inspection of the area around those borehole sites, Turtle Island confirmed the presence of flood plain deposits and observed Prehistoric Period cultural material (Turtle Island 2016). In consultation with ACT, Turtle Island also undertook deep testing via a backhoe near two of those test holes approximately 100-125 m east of the north abutment of Groat Road Bridge and detected Prehistoric Period cultural material, including animal bone and lithic artifacts (Turtle

Island 2016).Turtle Island (2016) prepared an HRIA that recommended additional deep testing in the interchange roadworks project area, but no additional work in the vicinity of the bridge rehabilitation project areas. ACT reviewed the HRIA and upon separation of the applications for the interchange roadworks and bridge rehabilitation projects, issued a *Historical Resources Act* Approval on 16 February 2017 for the bridge rehabilitation portion, with no specific conditions (Appendix H).

Paleontological Resources

The bridges rehabilitation study area encompasses the north and south sides of the North Saskatchewan River in the vicinity of Groat Road Bridge, including the banks of the river and alluvial terraces comprising sand, gravel and silt that are Holocene in age (Steppe 2016). Bedrock in the study area is part of the Horseshoe Canyon Formation, with sandstone interbedded with siltstone and mudstone (Steppe 2016). Lands in the vicinity of the Groat Road Bridges rehabilitation project study area have paleontological HRVs of 4 and 5, indicating potential for fossil remains in the area. The Horseshoe Canyon Formation has produced several important vertebrate and invertebrate paleontological localities in proximity to the project (Steppe 2016).

Due to potential impacts to Quaternary and Cretaceous paleontological resources, especially during deep excavations, and the existing disturbed nature of the study area, Steppe (2016) recommended that a paleontological evaluation take place in conjunction with construction. ACT determined that a Paleontological Historical Resources Impact Assessment (pHRIA) in the form of a monitoring program was required; Schedule A stated that the pHRIA was to comprise a monitoring program during deep excavation (>2 m) within the project area (Appendix H). No deep excavations were to take place until a professional paleontological consultant was on-site to monitor the excavation work.

5.0 POTENTIAL IMPACTS AND MITIGATION MEASURES

The proposed Groat Road Bridges rehabilitation project includes the following key project components as outlined in detail in Chapter 2:

- Replacement of the Groat Road Bridge (B059) superstructure.
- Rehabilitation of Victoria (B060) and Emily Murphy Bridges (B099).
- Post-construction site reclamation.

Potential interactions between the key project components (and related activities), with environmental components are summarized in Table 5.1. The following sections describe those interactions that have been identified as having the potential to result in an impact, adverse or positive, to any environmental component. Where relevant, potential impacts associated with construction and operation are discussed separately.

For the following VECs, impacts and mitigation measures will be described at the scale of the whole project, where they are applicable to all three bridges. In cases where impacts and mitigation measures differ among the three bridge sites, impacts and mitigation measures for each bridge will be discussed separately.

Table 5.1. Environmental Components and Project Activity Interaction Matrix

			Preparation				Construction			Reclamation	Operation	
			Establish staging area(s)	Coordinate access and public safety	Vegetation clearing	Install temporary erosion and sediment controls	Bridge Rehabilitation: Groat Road Bridge	Bridge Rehabilitation: Victoria Bridge	Bridge Rehabilitation: Emily Murphy Bridge	Site regrading, revegetation, landscaping	Operation	Maintenance
Valued Ecosystem Components	Valued Environmental Components	Geotechnical/Soils	✓		✓	✓	✓	✓	✓	✓	✓	✓
		Hydrology/Surface Water	✓		✓	✓	✓	✓	✓	✓		✓
		Vegetation	✓		✓		✓	✓	✓	✓		✓
		Wildlife	✓		✓		✓	✓	✓	✓	✓	
		Habitat Connectivity/Wildlife Passage	✓		✓		✓			✓	✓	
		Fish and Aquatic Resources			✓	✓	✓			✓	✓	
	Valued Social Components	Recreational Land Use	✓	✓	✓		✓	✓	✓	✓	✓	✓
		Traffic and Parking	✓	✓			✓	✓	✓		✓	✓
		Utilities	✓		✓		✓	✓	✓			
		Worker and Public Safety	✓				✓	✓	✓	✓		
		Visual Resources	✓		✓		✓	✓	✓	✓		
	Valued Historic Components	Historical Resources					✓					

5.1 Valued Ecosystem Components

5.1.1 Geotechnical/Soils

Potential impacts related to geotechnical/soils resources include the following:

- soil erosion,
- loss and mixing of topsoil,
- compaction of soils by heavy equipment, and
- soil contamination due to hazardous material spills.

A detailed analysis of each potential impact follows below.

5.1.1.1 Soil Erosion

Impact

In areas where existing vegetation cover is cleared, exposed soils can become susceptible to water and wind erosion. Fine-textured soil types are more sensitive to wind and water erosion than coarse-textured soil types, particularly if they are located on steep slopes. Soils on topographic slopes and temporary, stockpile slopes are particularly susceptible to erosion as a result of surface runoff.

The North Saskatchewan River banks in the vicinity of Groat Road Bridge are steep, especially on the north side of the river, and construction activities will take place in the vicinity of those steep slopes. Thus, there is potential for soil erosion during construction and until site revegetation and reclamation is complete. If eroded materials are transported as sediment into the North Saskatchewan River, soil erosion could have adverse secondary impacts on water quality and aquatic habitat.

Victoria Bridge and Emily Murphy Bridge are situated on level or gently sloping lands on river valley terraces on the north and south sides of the North Saskatchewan River, respectively. Bridge rehabilitation work will be confined to relatively level areas.

Responding to the identified potential for soil erosion, a site-specific temporary and permanent Erosion and Sedimentation Control (ESC) Plan (pursuant to the City’s Enviso program and the *Environmental Construction Operations Plan Framework 2016*) will be developed to the satisfaction of the City and implemented, with all related monitoring to be undertaken by a Certified Professional in Erosion and Sediment Control (CPESC) or equivalent. Erosion control measures compliant with the City’s *Erosion and Sedimentation Control Guidelines* (2005) will be employed during the project. Following construction, disturbed areas will be topsoiled and reseeded with a seed mix approved by City of Edmonton Facility and Landscape Infrastructure. With the proposed erosion control measures in place, the potential for wind and water erosion to result in soil loss is rated as adverse, minor, short-term and predictable at Groat Road Bridge and negligible at Victoria Bridge and Emily Murphy Bridge.

Mitigation Measures and Residual Effects

Regular inspections by a CPESC, or equivalent, during, and in the short-term following construction, will be required to ensure that all temporary erosion control measures are in place and function as intended. Longer-term ESC measures will also be monitored. It is expected that much of the key construction materials (roadway fill, gravel, concrete, asphalt and topsoil) will be brought to site on an "as-needed" basis and not stored or stockpiled on site. With these measures in place, soil losses due to wind and water erosion are anticipated to be reduced to negligible.

5.1.1.2 Compaction of Topsoil and Subsoil by Heavy Equipment

Impact

Compaction of fine topsoils and subsoils could occur where heavy equipment will be operating during construction and after grading and placement of soils during reclamation. The potential impact will be a slower rate of plant regeneration, or, more generally, a reduced capability for effective reclamation. Local drainage patterns may also be modified if compaction occurs, leading to potential erosion issues. The impact of soil compaction is rated as adverse, minor, long-term and predictable.

Mitigation Measures and Residual Impact

Disturbed ground will be graded so that pre-existing contours are restored in the reclaimed site to effectively maintain existing drainage. Subsoils will be ripped and fine topsoils will be disked after they are replaced in reclaimed areas to reduce compaction effects. This will also ensure that drainage is maintained. With these measures, the residual impact will be negligible.

5.1.1.3 Soil Contamination due to Hazardous Material Spills

Impact

Fuels or lubricants are the primary anticipated on-site hazardous materials. Spills onto soils during equipment maintenance or refueling, when stored on-site, or in the event of a malfunction on-site (e.g., leaking hydraulic hose), can cause localized soil contamination. If spill volumes are large, there is potential for the material to spread over a larger area, potentially placing downslope soils and the North Saskatchewan River at risk of contamination. As a best management practice, fuels and other hazardous materials will be stored on level ground in designated construction staging areas a minimum of 100 m from the North Saskatchewan River, with secondary containment to reduce spill potential. Refueling will also take place in the designated staging areas. If refueling within 100 m of the North Saskatchewan River is required (e.g., equipment operating on berms in the river), a protocol will be prepared and submitted to the City of Edmonton for approval before being incorporated into the project's ECO Plan. Only minor equipment repairs will be completed in the field; major repairs will take place at a central location such as a staging area, or off-site. Curbside catch basins will be hoarded appropriately to avoid hazardous material entering the stormwater system and ultimately into the North Saskatchewan River. Excess concrete materials will be handled and disposed of appropriately; concrete vehicles will not be washed on-site. All of these measures will reduce the potential for spills to occur, especially large spills. Potential for hazardous materials spills will, therefore, be low.

Accidental spills from equipment will be contained, cleaned up and disposed of following provincial best management practices, guidelines and codes of practice. A small spill, contained within the construction footprint is expected to have an adverse, minor, permanent and predictable impact to soils.

Mitigation Measures and Residual Impact

Spill kits will be carried on equipment or stored at nearby work locations and all personnel will be trained to respond appropriately to a spill. The contractor will develop and implement an Environmental Construction Operations (ECO) Plan, including a spill protection plan, to ensure any spills are quickly and effectively cleaned up, and spills beyond the AEP threshold will be reported as required by the Alberta *Environmental Protection and Enhancement Act* (*EPEA*). Such measures will reduce the ability for a spill to spread and increase the efficiency of a clean-up. All contaminated soils will be disposed of offsite and clean replacement soil imported. Properly contained and cleaned up, the residual impact to soils of a small spill within the construction footprint is rated as negligible.

5.1.1.1 Loss of Topsoil or Subsoil Mixing

Impact

Topsoil conservation is an important aspect of any work requiring clearing or earthworks. Loss or degradation of topsoil through mixing with subsoils can result in reduced soil fertility and subsequently reclamation capability. The objective of soils management for this project will be to maintain the current capability of soils in the project area, primarily by minimizing disturbance and reclaiming disturbed areas. This will involve minimizing the land area that will be affected by construction, or used for equipment storage and maintenance.

For many soil units in the project area, the transition from topsoil to subsoil layers is evident from colour or textural change; thus, salvage depth can be easily determined in the field. In other soil units, the transition is less distinct and there is potential for the topsoil and subsoils to become mixed, thereby affecting the original soil characteristics and soil fertility. In addition, if there are differences in textures between topsoils and subsoils, mixing can cause adverse effects on soil drainage and compactability.

Topsoil and subsoil will be stripped and stockpiled separately for later use in site reclamation. A soil scientist or contractor experienced/trained in identifying soil horizons will be present on site when stripping topsoil to ensure appropriate salvage depths are determined in areas where the transition to subsoil is unclear and the area involved is large. Such precautions will help reduce the potential for mixing of topsoil and subsoil layers and the attendant impacts on topsoil quantities and quality are expected to be negligible.

Mitigation Measures and Residual Impact

Stripping and stockpiling mineral soils as indicated above will take place under the guidance of a qualified soil scientist or experienced contractor. Using the soils for reclamation efforts within the area after construction completion will ensure the impact remains negligible.

5.1.2 Hydrology/Surface Water Drainage/Groundwater

Potential impacts to hydrology/surface water quality/groundwater include the following:

- release of sediments into the North Saskatchewan River from construction activities,
- accidental release of hazardous materials (e.g. fuel, oil or lubricants) used during construction into the North Saskatchewan River,
- changes to surface drainage patterns,
- altered or disrupted groundwater flow,
- temporary alteration of river hydraulics resulting from instream work, and
- potential for flooding during construction.

A detailed analysis of each potential impact follows below.

5.1.2.1 Sediment Release

Impact

The only surface water body located in the project area is the North Saskatchewan River, which is the drinking water source for the City of Edmonton. Bridge construction for Groat Road Bridge will take place immediately adjacent to the North Saskatchewan River, with bridge rehabilitation work comprising construction activities on the river banks and the establishment of instream berms. Thus, there is a possibility of sediment generated from construction activities entering the North Saskatchewan River and affecting water quality in the short term.

Bridge rehabilitation activities for Victoria and Emily Murphy Bridges will take place on the lower river valley terraces on the north and south sides of the North Saskatchewan River, respectively, where the land is relatively level but slopes gently toward the North Saskatchewan River. Both bridges are entirely outside the City of Edmonton's 1:100 year floodplain (City of Edmonton 2016; AEP 2016c). Thus, there is a slight possibility of some sediment generated from construction activities moving downslope and entering the North Saskatchewan River via overland movements and affecting water quality in the short term. Catch basins in the vicinity of the project will be hoarded appropriately to avoid sediment entering the stormwater system and discharging to the North Saskatchewan River.

As required by the City of Edmonton, the contractor will develop and implement a site-specific Erosion and Sediment Control (ESC) Plan (pursuant to the City's Enviso program) to the satisfaction of the City. Temporary erosion and sedimentation control measures will be in place during construction, and all related monitoring will be undertaken by a Certified Professional in Erosion and Sediment Control (CPESC) or equivalent. Erosion and sedimentation control measures compliant with the City's *Erosion and Sedimentation Control Guidelines* (2005) will be employed during the project. Following construction, temporarily disturbed areas will be topsoiled and reseeded with an appropriate seed mix, approved by City of Edmonton Facility and Landscape Infrastructure.

Based on the proximity of Groat Road Bridge rehabilitation works to the North Saskatchewan River, construction activities would result in an adverse, major, short-term and predictable impact. Because of the location of Victoria Bridge and Emily Murphy Bridge on relatively level terraces outside the 1:100 year floodplain, rehabilitation of those bridges would result in negligible impacts.

Mitigation Measures and Residual Impact

With the implementation of the project's future ESC Plan, the impacts of eroded sediments on the North Saskatchewan River are expected to be reduced. Regular inspections by a CPESC, or equivalent, will be required to ensure that all sediment control measures are in place and function as intended throughout the duration of construction and until such a time that vegetation is well established in areas that could pose a threat of erosion and sedimentation to the North Saskatchewan River. It is anticipated that little fill, gravel and topsoil material will be needed for construction (N. Robson, *pers. comm.*), and it is expected that much of the key construction materials will be brought to site on an "as-needed" basis and not stored or stockpiled on site. With these measures in place, residual impacts from sediment release are anticipated to remain adverse, major, short-term and predictable for work at Groat Road Bridge and negligible at the remaining two bridges.

5.1.2.2 Release of Deleterious Substances during Construction

Impact

Fuels, oils and lubricants used in construction equipment can degrade aquatic habitat or harm aquatic species if they reach the North Saskatchewan River. Bridge construction for Groat Road Bridge will take place immediately adjacent to the North Saskatchewan River, with bridge rehabilitation work comprising construction activities on the river banks and the establishment of instream berms. Construction work for that bridge will take place within the City of Edmonton's 1:100 year floodplain (City of Edmonton 2016; AEP 2016c).

Bridge rehabilitation activities for Victoria and Emily Murphy Bridges will take place on the lower river valley terraces on the north and south sides of the North Saskatchewan River, respectively, where the land is relatively level but slopes gently toward the North Saskatchewan River. Both of those bridges are entirely outside the City of Edmonton's 1:100 year floodplain (City of Edmonton 2016; AEP 2016c). Thus, in the event of a spill, there is potential for hazardous materials to move downslope and enter North Saskatchewan River via overland movements, affecting water quality in the short term.

Catch basins in the vicinity of the project will be hoarded appropriately to avoid sediment entering the stormwater system and discharging to the North Saskatchewan River.

As a best management practice, fuels and other hazardous materials will be stored on level ground in designated construction staging areas a minimum of 100 m from the North Saskatchewan River, with secondary containment to reduce spill potential. Refueling will also take place in the designated staging areas. If refueling within 100 m of the North Saskatchewan River is required (e.g., equipment operating on berms in the river), a protocol will be prepared and submitted to the City of Edmonton for approval before being incorporated into the project's ECO Plan. All equipment involved in construction of, or working on, the river berms and north riverbank access road, will use biodegradable hydraulic fluid that is vegetable based. The contractor will demonstrate compliance with hydraulic fluid requirements by submitting the service/maintenance records for each piece of equipment to the City.

Equipment operating near the river will have spill kits on hand or nearby in the work area and will employ drip pans to the extent possible, so that accidental release of such material can be quickly and effectively controlled. All personnel will be trained to respond to a spill quickly and effectively. As a result, the potential for large spills should be eliminated and the potential for small spills minimized. However, should a spill occur, it will be contained and disposed of following provincial guidelines. With best management practices followed, and any spills cleaned up following provincial guidelines, the potential impact of a hazardous material spill on the North Saskatchewan River will be minimized; however, such a spill would result in an adverse, minor, short-term and predictable impact at Groat Road Bridge and a negligible impact at Victoria Bridge and Emily Murphy Bridge.

Mitigation Measures and Residual Impact

The contractor will develop and implement an Environmental Construction Operations (ECO) Plan, including a spill protection plan with specifics relevant to working near water, to ensure any spills are quickly and effectively cleaned up. Any spills beyond the AEP threshold will be reported as required by the Alberta *Environmental Protection and Enhancement Act* (*EPEA*). Best management practices and mitigation measures will reduce the ability for a spill to spread or cause harm and increase the efficiency of a clean-up. Due to the proposed instream work for Groat Road Bridge, the residual impact of a spill at that location remains adverse, minor, short-term and predictable. The residual impacts at Victoria Bridge and Emily Murphy Bridge remain negligible.

5.1.2.3 Changes to Surface Drainage Patterns

Impact

The existing drainage network in the project area comprises catch basins, manholes, storm sewers and outfalls (Al-Terra 2016). Drainage is collected in a storm sewer system that discharges to the North Saskatchewan River through outfalls, two situated on the north bank in the vicinity of the project area and one on the south bank. Surface water management at the three bridges is expected to remain unchanged from the existing conditions. No new outfalls to the river are proposed. Based on this, impacts to surface drainage patterns are expected to be negligible.

Mitigation Measures and Residual Impact

No mitigation measures are required; residual impacts will remain negligible.

5.1.2.4 Altered or Disrupted Groundwater Flow

Impact

Groundwater in the Groat Road Bridge project area is relatively deep, occurring at depths greater than 8 m (Thurber 2016c; Appendix C). Most proposed project activities are not expected to exceed 2 m in depth. The exception is the addition of four new abutment support piles at the existing south Groat Bridge abutment. Construction of those support piles may intersect groundwater depending on groundwater levels at the time of construction. This may not be a significant concern because the new support piles would be replacing existing subsurface stabilization structures in the abutment. Any disruptions to groundwater flow would be expected to be limited to a small area. Potential impacts to groundwater at Groat Road Bridge are thus rated as negligible.

No deep (>2 m) excavations or piling are expected at Victoria Bridge or Emily Murphy Bridge, therefore, groundwater is not expected to be intersected by project activities at those locations. Impacts to groundwater at those two bridges are rated as negligible.

Mitigation Measures and Residual Impact

No mitigation measures are required; residual impacts will remain negligible.

5.1.2.5 Temporary Alteration of River Hydraulics Resulting from Instream Work

Impact

Groat Road Bridge rehabilitation will require the installation and use of a series of instream berms to accommodate construction. 1D and 2D hydraulic modeling determined that the presence of berms will constrict river flow to approximately 40% of the average channel width, increasing mean velocity, maximum flow depth and water levels during instream work, with the greatest increases occurring when the berm extends from the north bank of the river (NHC 2017; Appendix E). The north half of the channel has lower bed elevations than the south half (i.e., the thalweg), and as a result, when the north half of the river is obstructed, the south half has a further reduced capacity to carry flow (NHC 2017; Appendix E). Modeling indicated maximum depth-averaged velocities of 2.3m/s and 2.5 m/s near the noses of the south and north berms, respectively (NHC 2017; Appendix E). Lower depth-averaged velocities of 1.0 m/s were anticipated near the banks, similar to base conditions (NHC 2017; Appendix E). Modeling of ice-covered conditions demonstrated a similar trend, with increased mean velocity, maximum flow depth and water levels during instream work, with the greatest impacts experienced when the proposed berm is situated on the north side of the river (NHC 2017; Appendix E).

Berms are expected to be in place from August 2018 to April 2020. Although the berms will be in the river during that entire period, berm material will be stockpiled in a reduced area within the watercourse between the north bank and the first river pier from March 2019 to July 2019; the berms will be present at their full extent from August 2018 to April 2019 and from August 2019 to April 2020. The NSR is Crown-owned and under federal and provincial jurisdiction, therefore, the proposed project will be reviewed by those respective regulators to comment on the proposed instream berm construction methodology.

5.1.2.6 Potential for Flooding during Construction

Impact

The majority of flood events in the North Saskatchewan River occur in June and July, arising from a combination of snowmelt and precipitation in the mountains and foothills upstream (NHC 2017; Appendix E). Flow is regulated by the upstream Brazeau and Bighorn dams but those dams tend to reduce the magnitude of the median-sized flood event rather than have a significant impact on the highest open water flood events (NHC 2017; Appendix E). With temporary berms and north access road in place, however, the risk of flooding increases. The proposed berms and north access road will be designed for a 1:2 year flood event. If a larger flood event occurs while the berms and access road are in the river the impacts of flood events overtopping the berms and access road during construction are considered adverse, minor to major, short-term and predictable.

Mitigation Measures and Residual Impact

The temporary berms and access road will be constructed using clean riprap only; clay will not be used for construction of the berms and access road. Three cofferdams associated with pier base strengthening work at Piers 2, 4 and 5 will be local extensions of the instream berm. The method of dewatering will be determined by the successful contractor and may comprise a non-dispersive clay berm, fine granular material, hydraulic barriers, ice berm or sheet piles. In the event that the berm and access road experiences overflow, the riprap is expected to be able to handle the flow velocity and associated debris (or ice scour, depending on the season) (NHC 2017; Appendix E). The contractor will monitor river flows during instream construction to provide sufficient warning time to enable equipment to be moved to a higher location away from the river before flooding occurs. Moving the berm from the south to the north and vice versa will result in an approximate one week period in November/December 2018 and 2019, respectively, where the berm will effectively be an island in the middle of the river. Flooding at that time of year is unlikely. With these measures in place, residual impacts will be reduced to negligible.

5.1.3 Vegetation

Potential impacts to vegetation include the following:

- loss or alteration of native plant communities,
- loss or alteration of manicured areas and ornamental trees,

- loss of special status plant species,
- invasion of weedy species in disturbed areas, and
- contamination due to accidental spills.

A detailed analysis of each potential impact follows below.

5.1.3.1 Loss or Alteration of Native Plant Communities

Impact

Proposed staging areas will be located in manicured areas or areas of previous disturbance to avoid clearing of native vegetation. Overall, a total of 0.17 ha of native and semi-natural plant communities will be directly impacted by bridge rehabilitation works, primarily in association with Groat Road Bridge (Table 5.1). Native plant communities were described as communities comprising mainly native species. Semi-natural communities were described as communities dominated by exotic species that formed dense and relatively undisturbed communities that were unmaintained and supported some native species.

The calculated vegetation impact areas include both temporary and permanent disturbances within the study area, with temporary disturbances associated with areas cleared for construction and staging areas only and permanent disturbances associated with areas to be occupied by permanent infrastructure. Effects on native plant communities are rated as adverse, minor, short-term to permanent and predictable.

Table 5.1. Impact Areas of Native and Semi-Natural Vegetation for the Proposed Groat Bridges Project

Plant Community	Bridge Site	Description	Impact Area (ha)
Balsam Poplar-Aspen (P3)	Groat Road Bridge	Native	0.07
Balsam Poplar-White Spruce (P2)	Groat Road Bridge, Emily Murphy Bridge	Native	0.008
Aspen-Balsam Poplar (A2)	Emily Murphy Bridge	Native	0
Shoreline (S)	Groat Road Bridge	Native	0.06
Manitoba Maple (MM)	Groat Road Bridge	Semi-Natural	0.03
Manicured (M)	Groat Road Bridge, Victoria Bridge, Emily Murphy Bridge	Managed	1.11

Mitigation Measures and Residual Impact

To further lessen the potential impact on native plant communities during proposed construction, equipment storage, maintenance and refueling in areas that support native plant communities will be prohibited. Prior to construction, marking the clearing limits with highly visible flagging will help minimize the extent of vegetation loss.

Temporarily disturbed areas will be reclaimed using a native seed mix and/or plantings as soon as possible after construction. In accordance with the City of Edmonton *Corporate Tree Management Policy* (C456A), all treed areas on city-owned lands in the proposed project area will be assessed for value by the City of Edmonton Forestry department prior to removal, with required compensation undertaken. With these mitigation measures in place, an impact to mature, native vegetation will remain. Impacts to native plant communities are expected to remain adverse, minor, short-term to permanent and predictable.

5.1.3.1 Loss or Alteration of Manicured Areas and Ornamental Trees

Impact

Much of the study area comprised manicured areas (Figure 5.1). These areas support mown grass, mulched beds and scattered trees and are located along Groat Road, River Valley Road, Victoria Park Road and Emily Murphy Park Road. Overall, a total of 1.11 ha of manicured areas will be directly impacted by construction (Table 5.1). Manicured areas are valued as parkland green space, and all planted trees and shrubs are valued as part of Edmonton's canopy inventory. Temporary disturbance/removal and the potential loss of some manicured area are ranked as adverse, minor, short-term to permanent and predictable.

Mitigation Measures and Residual Impact

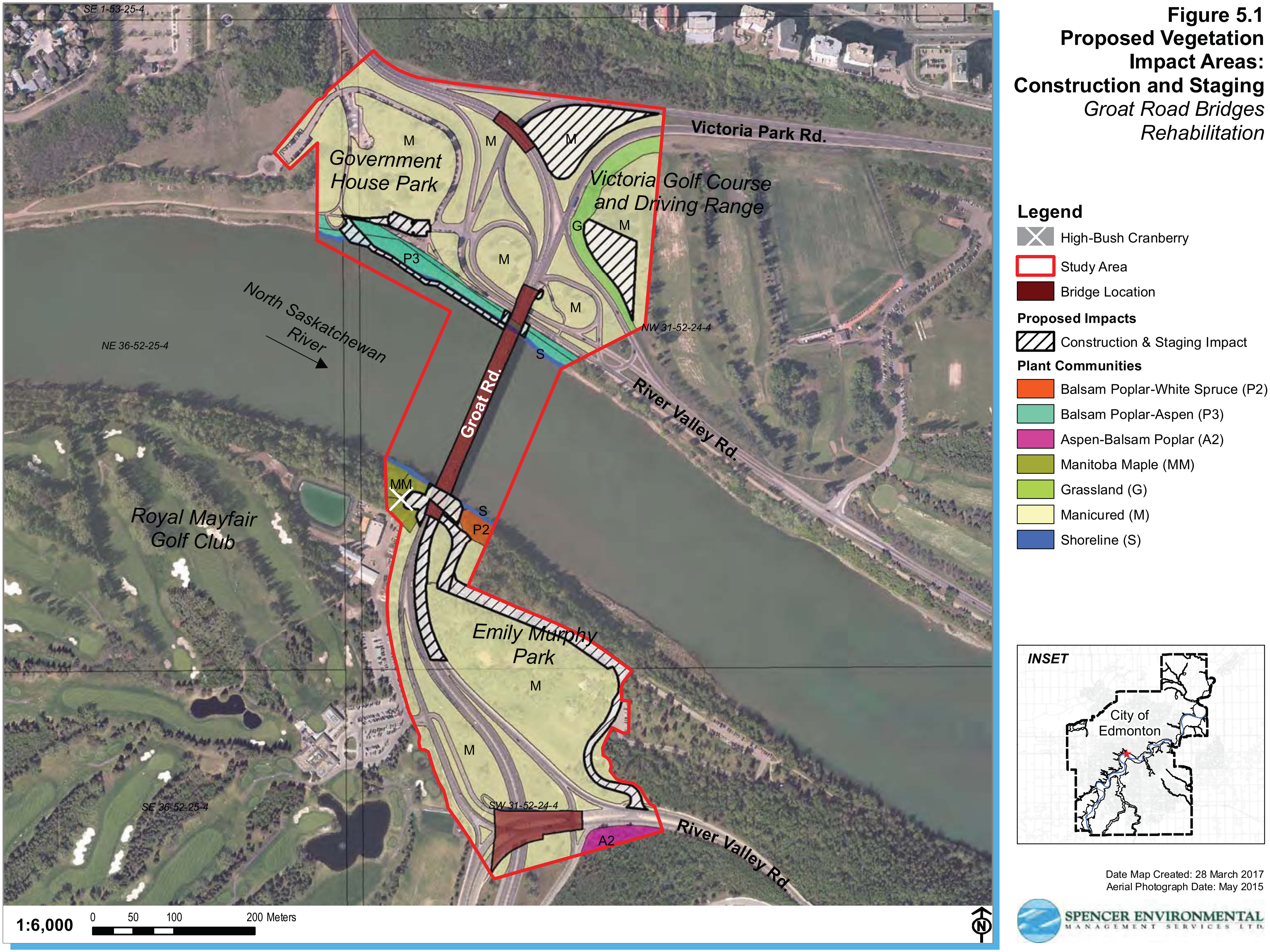
Any disturbance to manicured areas will be reclaimed by revegetating the areas with an appropriate Class B topsoil and seed mix approved by the City of Edmonton Facility and Landscape Infrastructure Branch. All damaged and removed trees will be replaced pursuant to the City's *Corporate Tree Management Policy* (C456A). Replacement plantings may occur on-site or elsewhere. Also pursuant to this policy, retained trees in close proximity to construction activities will be avoided or hoarded to protect them from damage (e.g., root damage). If, for some reason, plans change and additional trees need to be removed, they will be replaced according to the *Corporate Tree Management Policy*. With these mitigative measures implemented, the residual impacts will be reduced to negligible over the long term.

5.1.3.1 Loss of Special Status Plant Species

Impact

One S3S4 plant species, high-bush cranberry, was detected in the proposed project area during field surveys in June 2016. One individual was detected at 12U 331568E, 5934884N, in the Manitoba maple (MM) community on the south side of Groat Road Bridge in Emily Murphy Park (Table 5.2; Figure 5.1), immediately adjacent to a proposed project staging/access area. Because of the proximity of the high-bush cranberry individual to an existing road/vehicle turnaround location that will be used during construction, the plant may be inadvertently impacted by passing equipment. Unmitigated, an impact to this plant would be adverse, minor, short-term to permanent and predictable at Groat Road Bridge. It is considered minor because there is a single

Figure 5.1
Proposed Vegetation Impact Areas: Construction and Staging
Groat Road Bridges Rehabilitation



Date Map Created: 28 March 2017
Aerial Photograph Date: May 2015

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plant and high-bush cranberry is abundant in other areas within Edmonton's North Saskatchewan River Valley and ravine system. No special status species were detected in the vicinity of Victoria Bridge or Emily Murphy Bridge; thus, impacts at those sites will be negligible.

Table 5.2. Rare Plant Occurrences and Proposed Impact

Common Name	Scientific Name	Bridge Site	Plant Community	Coordinates	Occurs in Proposed Impact Area (yes/no)
High-bush cranberry	*Viburnum opulus*	Groat Road Bridge	MM	12 U 331658E, 5934884N	No

Mitigation Measures and Residual Impact

In advance of construction initiation, clearing boundaries will be marked with highly visible flagging to contain clearing damage in native plant communities. This will reduce the chance that this species, located near a staging/access area will be affected. Flagging the high-bush cranberry individual will also reduce the chance of a direct impact to the plant. With this simple mitigation measure implemented, the potential residual impact to special status plant species at Groat Road Bridge will be reduced to negligible. Residual impacts at Victoria Bridge and Emily Murphy Bridge remain negligible.

5.1.3.2 Establishment of Invasive and Weedy Species

Impact

Noxious weed species were documented throughout the project area during field investigations in June and August 2016. Noxious weeds were relatively widespread, with creeping thistle the most frequently encountered, occurring in all surveyed plant communities at all three bridge sites. Although mature weeds will be removed during grubbing, their seeds will remain in stockpiled topsoils, which may be used in reclamation. Surface disturbance from construction could create ideal conditions for the spread of these and other noxious weed species. Weeds could become established following construction through the movement of seeds and rhizomes deposited on equipment while working in different areas, as well as by colonization by seeds transported naturally from adjacent weed populations elsewhere in the area. Weed establishment in the immediate project area is undesirable, as weeds may spread to surrounding native plant communities within the North Saskatchewan River valley. Preventing weed establishment in the first place may be the best and most economical opportunity for weed management. In the absence of mitigation, the spread of weedy species within reclaimed areas will likely occur and will have an adverse, minor (local impact), permanent and predictable impact on habitat values and maintenance costs.

Mitigation Measures and Residual Impact

Precautions such as cleaning equipment used in weedy areas before moving into new construction areas will help reduce the potential transfer and spread of weedy species. Cleared areas will be revegetated with weed-free topsoil and an appropriate seed mix approved by the City of Edmonton Facility and Landscape Infrastructure Branch as soon as possible following construction. Some level of weed control will likely be required until desired vegetation becomes established, but the need for such measures can be assessed through monitoring. All weed control measures will be outlined in the contractor's Environmental Construction Operations (ECO) Plan. With proper implementation of these measures, the residual impact will be reduced to negligible.

5.1.3.3 Contamination due to Accidental Spills

Impact

Fuel or lubricant spills can occur during refueling or as a result of equipment failure or accidents (e.g., broken hydraulic hose). Should spills occur in areas with natural vegetation, these features could be contaminated with hydrocarbons and heavy metals, which, in turn, could result in plant mortality. Most spills would likely be small in nature, but if uncontrolled, could spread over large areas. That issue is particularly pertinent in working areas adjacent to the North Saskatchewan River (Groat Road Bridge) and in areas of steep slopes. Equipment will be refueled and maintained in a central location at least 100 m away from any water body and preferably on a paved or graveled area. If refueling within 100 m of the North Saskatchewan River is required (e.g., equipment operating on berms in the river), a protocol will be prepared and submitted to the City of Edmonton for approval before being incorporated into the project's ECO Plan. All equipment involved in construction of, or working on, the river berms and north riverbank access road, will use biodegradable hydraulic fluid that is vegetable based. The contractor will demonstrate compliance with hydraulic fluid requirements by submitting the service/maintenance records for each piece of equipment to the City.

Spill kits will be carried or readily accessible to equipment working on-site and at the refueling/maintenance areas. Construction personnel will be trained in the use of spill kits. As a result, the potential for large spills should be eliminated and the potential for small spills minimized. These actions will also reduce the potential for a spill to spread off the construction site and into undisturbed areas. With these practices implemented, the impact of a contaminant spill on vegetation will be negligible.

Mitigation Measures and Residual Impact

Should a spill occur, it will be contained and cleaned up following provincial guidelines and best practices. No further mitigation is required, and the residual impact is expected to remain negligible.

5.1.4 Wildlife

Potential impacts related to wildlife include the following:

- loss of terrestrial wildlife habitat from clearing activities,
- habitat alienation during construction activities,
- breeding bird mortality due to construction activity during breeding season,

- mortality or disturbance to special status wildlife species.

These impacts and recommended mitigation measures to minimize potential impacts are described in the sections below.

5.1.4.1 Loss of Terrestrial Habitat

Impact

There will be no disturbance or permanent loss of naturally vegetated habitat as a result of the proposed Groat Road Bridges Rehabilitation Project. Habitat disturbance and loss will be restricted to manicured areas and for the most part will be temporary, with reclamation occurring following construction. The anticipated impacts will have a negligible impact on the capacity of the study area to support wildlife.

Mitigation Measures and Residual Impact

As vegetation/habitat loss is restricted to manicured areas and only a relatively small area will be permanently lost (0.17 ha of native/semi natural vegetation), habitat mitigation measures are not required. Residual impacts on wildlife habitat will remain negligible.

5.1.4.2 Habitat Alienation

Impact

Construction

Activities and noise associated with construction are known to deter some wildlife species from using immediately adjacent areas of habitat. Most individuals (and at a higher level, species) using habitat in the study area must already be adapted to disturbance in the form of noise and the presence of people recreating. Any additional disturbance/stimulus caused by temporary construction activities is expected to have little to no cumulative effect and to be very limited in geographic extent. Further, construction activities will generally occur only during daylight hours, allowing animals active at night to move around the construction areas, and use the remainder of the study area. The impact to wildlife from habitat alienation during construction is rated as negligible.

Operation

Available habitat, traffic volumes and the level of recreational use within the project area are not expected to change substantially after completion of this project. Streetlights at all three bridges will remain unchanged compared to the current condition (e.g., Groat Road Bridge street lights will be located in the bridge median). There will, however, be proposed new enhanced lighting added to the new Groat Road Bridge superstructure. That will comprise lights directed upwards from the girders to the underside of the cantilevered slab on both sides of the bridge, with low-level pedestrian lighting over the sidewalk on the east side (N. Robson, *pers. comm.*). All lighting will be controlled/shielded lighting to specifically prevent light pollution into the river valley, consistent with Dark Sky best practices. Considering that most wildlife expected in the project area are urban-adapted and the project site is located adjacent to areas with existing street lights, any additional disturbance caused by the proposed controlled lighting is expected to be minimal. The impact to wildlife from habitat alienation during bridge operation is rated as negligible at all three bridges.

Mitigation Measures and Residual Impact

Construction

As with most projects in Edmonton's river valley, as best practice, all personnel onsite will be instructed not to harass wildlife and to report wildlife conflicts to the site supervisor; residual impacts will remain negligible.

Operation

No mitigation is required; residual impacts are expected to be negligible.

5.1.4.3 Breeding Bird Mortality due to Clearing

Impact

Clearing of natural vegetation can cause wildlife mortality, particularly during the spring and summer breeding season when the mobility of many species is restricted. During those times, adults remain close to dens and nest sites, and young are restricted to nests or not yet able to move long distances. To protect wildlife, and particularly nesting birds protected by the *Migratory Birds Convention Act* and *Wildlife Act*, current best management practice guidance provided by Environment Canada recommends avoiding vegetation clearing during the period when there is a high probability of nesting activity (i.e., high risk period). This extends to removal of individual ornamental trees because commonly-occurring, urban-adapted species such as the American robin are covered by the legislation. When this practice is not adopted, and, in the absence of other mitigation measures, there can be a high potential for nest disturbance. Further, owls that occur in Edmonton are protected by the *Wildlife Act*, and are early nesters. Clearing during the period 15 February and 20 April without regard for nesting owls can result in owl nest disturbance and nestling mortality. Should clearing due diligence not be employed, wildlife mortality resulting from clearing could occur. This would be an adverse, major, permanent and predictable impact. It is rated as major because it represents contravention of the law.

Mitigation Measures and Residual Impact

For most projects, avoidance of vegetation clearing during the period 20 April to 20 August is recommended as a means of achieving reasonable due diligence for the protection of nesting migratory birds and avoiding project delays. In addition, to respect the possibility of nesting owls being present, it is typically recommended that no mature trees be cleared during the period 15 February and 20 April. If possible, this project will avoid tree and shrub clearing/removal during the period 15 February and 20 August. However, should this not prove feasible, the vegetation to be affected is suited to effective nest searches. If clearing/tree/shrub removal must occur between 20 April and 20 August, the vegetation should be subjected to a nest sweep by a qualified Professional Biologist in advance of clearing. All observed nests of species protected by legislation must then be avoided and buffered appropriately until the nest is no longer active. If clearing of <u>mature trees</u> must occur between 15 February and 20 April, the trees should first be inspected for owl use by a qualified biologist and similar protective measures applied to all observed nests. Prior to construction, marking the clearing limits with snow-fence or highly-visible flagging will help minimize the extent of incidental vegetation damage and harm to nesting wildlife. With these measures in place, wildlife mortality should be avoided and the residual impact is expected to be negligible.

5.1.4.4 Disturbance or Mortality of Special Status Species

Impact

The proposed vegetation clearing associated with the proposed Groat Road Bridges Rehabilitation Project is not expected to result in the clearing of any naturally vegetated areas, thus, the key habitat features of the two potentially-occurring special status *Myotis* bat species will not be directly impacted as a result of this project. Construction activities are, however, planned to directly impact potential barn swallow nesting sites at all three bridge structures. A schedule is not yet available for the rehabilitation work at each of the bridges. Because each structure could potentially provide a suitable nest building site for barn swallows, and because work on the bridges may occur during the nesting season (i.e., 20 April - 20 August), there is the potential that bridge work could negatively impact nesting barn swallows if not mitigated appropriately. Should impacts to nesting barn swallows occur, it would be an adverse, major, permanent and predictable impact.

Mitigation Measures and Residual Impacts

To mitigate the potential impacts identified for barn swallows, each bridge structure should be inspected by a qualified Professional Biologist for nesting swallows in advance of the initiation of construction activity at the bridges if scheduled to take place during the breeding bird season of 20 April to 20 August. Any recommendations provided by that biologist would then constitute additional mitigation measures that would require completion in advance of construction. With implementation of this mitigation measure, the potential impact to barn swallows can be effectively controlled, reducing the residual impact to negligible.

5.1.5 Habitat Connectivity and Wildlife Passage

5.1.5.1 Disruption of Wildlife Movement/ Habitat Connectivity

Impact

<u>Construction</u>

Despite the wide-spread multiple construction locales in the study area (Figure 2.6), the areas of naturally vegetated habitat situated at both the north and south edges of the study area will remain physically undisturbed and available as wildlife movement routes during construction. Further, on the south side of the river, under Groat Bridge, where staging is proposed for the road surface in Emily Murphy Park, an area approximately 15 m wide will remain between the staging area and the river's edge. Most wildlife expected to be moving within and through the study area will already be habituated to certain levels of disturbance associated with the current high levels of traffic and recreational use, and thus their ability to move through the area is unlikely to be affected by construction, although any habitual routes may have to be modified in response to temporary construction fencing.

All laydown areas will be fenced for approximately one construction season. Accordingly, movement of terrestrial wildlife through the manicured areas north of the river, as is suspected to happen occasionally at present, will be made more difficult during construction and those individuals would have to look for alternative routes. In some circumstances this could modify the potential for wildlife-vehicle collisions. As the manicured area north of the river is not believed to be a high-movement route and the existing animal-vehicle collision records for this area show a low collision rate, the temporary change presented by fencing and construction activity is expected to have only low potential to increase collisions. Since construction does have some potential to adversely wildlife movement, the impact is rated as negligible to minor, short-term and predictable.

Operation

The proposed modifications to the three bridge structures that will be realized as a result of the proposed rehabilitation project will not modify any of the subject bridges in a manner that could influence wildlife movement. The aperture (height and width of the opening under the bridge) of all bridges will remain relatively unchanged. Accordingly, the impact to wildlife movement as a result of the operation of the proposed Groat Road Bridges Rehabilitation Project is rated as negligible.

Mitigation Measures and Residual Impact

Construction

All personnel will be instructed not to harass wildlife that may attempt to cross through the project area and to report any conflicts to the site supervisor. If a chronic issue arises, fencing options to address the issue will be explored. The residual impact remains rated as negligible to minor, short-term and predictable.

Operation

No mitigation is required; residual impacts will remain negligible.

5.1.6 Fish and Aquatic Resources

Impacts

Kingfisher Aquatics (2017; Appendix G) identified the following potential impacts related to fish and aquatic resources:

- release of sediment,
- release of deleterious substances,
- fish entrapment,
- channel constriction,
- alteration of streambank, and

- temporary and permanent alteration of habitat and reduction in fish habitat availability.

Those impacts and their respective mitigation measures are summarized in Table 5.3 below. Please see Kingfisher's full report and analysis in Appendix G of this report.

Table 5.3. Summary of Potential Impacts and Mitigation

Impact Pathway		**Potential Impact**
Category	**Potential Source**	**Description**
Release of sediment	• clearing of riparian area(s) • upslope and downslope earthworks • instream construction	If sediment is not controlled: • alteration of fish habitat due to fine deposition of sediment • reduction in food production due to fine deposition • reduced fish health and/or mortality due to increase in suspended sediments
Release of deleterious substances	• operation of equipment near water • demolition of existing superstructure • construction processes (i.e., pouring concrete)	If deleterious substances not contained: • reduced fish health and/or mortality
Fish entrapment	• creation of isolated pockets of water when installing rock berms • impingement of fish in pump intakes	• fish mortality if fish become permanently stranded • fish mortality if fish are impinged in pumps during dewatering process
Channel constriction	• increased water velocities in river	• impediment to fish movements if water velocities in channel are too swift • alteration of fish habitat due to scouring
Temporary alteration of habitat	• installation of rock berms and access routes	• temporary alteration of habitat • temporary reduction in habitat availability
Permanent alteration of habitat	• installation of rock berms and access routes	• habitat will be altered if berm material is not completely removed from the channel
Alteration of streambank(s)	• installation of access routes	• temporary alteration of fish habitat

In general, potential impacts arising from the proposed Groat Bridge rehabilitation can be mitigated through implementation of established BMPs. Based on Kingfisher Aquatics' (2017; Appendix G) analysis, and assuming that all mitigation is implemented as described, there is potential for the temporary instream footprint associated with the access berms and access roadway to result in serious harm to fish. Following additional analysis, Kingfisher Aquatics (2017; Appendix G) determined the proposed rehabilitation work is considered to have a low probability of resulting in serious harm to fish for the following reasons:

- the project footprint is small,
- in the short-term, the habitat is not usable; however, the impacted habitat is not unique or in short supply in the North Saskatchewan River and not considered critical habitat for fish known to occupy the area, and
- post-project, the habitat utility is expected to quickly return to pre-disturbance conditions.

Fish and fish habitat in the North Saskatchewan River are ultimately under federal and provincial jurisdiction; therefore, a Request for Review will be submitted to DFO before proceeding with the project. The provincial fisheries department will review the proposed project as part of the provincial permitting referral process.

5.2 Valued Socio-Economic Components

5.2.1 Recreational Land Use

Potential impacts to recreational land use include the following:

- Disturbance to existing recreational use from construction activities, and
- improved pedestrian safety.

5.2.1.1 Disturbance to Existing Recreational Use from Construction Activities

Impact

The proposed project area is connected to a variety of existing recreational amenities in the North Saskatchewan River Valley that currently experience a high level of recreational use. No trails or other amenities will be completely closed or rendered unavailable for the duration of construction. Recreationalists using the river valley amenities in and nearby the study area, as well as those people accessing recreational amenities by vehicle from River Valley Road or Emily Murphy Park Road may be temporarily inconvenienced by vehicle and pedestrian detours during construction. Delivers of materials and equipment as well as construction activities may cause temporary SUP closures and noise disturbances. The recreational experience in Government House Park and Emily Murphy Park (e.g., picnic areas) may be temporarily diminished, due to the proximity to construction. Vehicle access to Government House Park and Emily Murphy Park may experience short-term disruptions, as access roads will be shared between recreationalists and construction vehicles, but access will be maintained throughout construction.

Edmonton Canoe, a private business, provides canoe rentals and supports canoe and kayak tours of the North Saskatchewan River. Trips operate from mid-May to the end of the summer, primarily on weekends and weekday evenings. The informal boat launch at Emily Murphy Park, immediately downstream of Groat Road Bridge, is used as the primary launch point for the business. That launch point is expected to be inaccessible to the public for the duration of construction, which will be approximately 27 months, or three operating seasons for Edmonton Canoe.

Signage throughout the area will provide recreationalists in the area with adequate notification of the timing and duration of construction activities. Communication will be maintained with nearby residents and/or user groups who are expected to frequently use the nearby recreational amenities. Temporary fencing will be installed to prevent public access into active construction areas. The potential impacts to recreational use from construction activities are rated as adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

Construction noise will be limited to the hours permitted by the City of Edmonton's Bylaw 14600 (*Community Standards Bylaw*) (07:00-21:00 hours Monday to Saturday; 09:00-19:00 hours Sundays and holidays). The construction contractor may apply for exemptions to the hours of work if required.

Temporary fencing will be installed around active construction areas when they occur close to existing recreational areas. Detour routes will be clearly identified. Alternate boat launch locations will be communicated to users. Signage must be clearly posted indicating a project contact person and prime contractor and shall include project information, duration of construction and a phone number for inquiries. Use of corporate logos should be carefully managed in accordance with Edmonton's *Zoning Bylaw* (Bylaw 12800). Signage shall be removed within two weeks of construction completion. With these measures in place, and because no amenities will be completely unavailable for the duration of construction, residual impacts will be reduced to negligible.

5.2.1.2 Improved Pedestrian Safety

Impact

As part of proposed bridge rehabilitation activities, sidewalks at Groat Road Bridge and Emily Murphy Bridge will be widened to improve pedestrian safety. At Groat Road Bridge, the new east sidewalk will be widened to a 3.0 m clear walkway. At Emily Murphy Bridge, the north sidewalk will be widened to 4.2 m, with the addition of a bicycle railing and roadway barrier. Widening the sidewalks at those two locations will reduce conflicts between pedestrians and cyclists utilizing those busy commuter and recreational routes. The impacts to pedestrian safety are expected to be positive, major (because of the significant improvement to these well-used sidewalks), permanent and predictable.

Mitigation Measures and Residual Impact

No mitigation measures are required.

5.2.2 Traffic/Parking

5.2.2.1 Accommodation of Traffic and Parking during Construction

Impact

Project construction is expected to take 27 months and will temporarily affect traffic flow through the project area. Groat Road Bridge currently carries two lanes of traffic in each direction, and a sidewalk is located on the east side of the bridge. Victoria Bridge currently carries three lanes of traffic, two northbound and one southbound. Emily Murphy Bridge currently carries up to seven lanes at its west end, merging to four (two westbound and two eastbound) at its east end. Construction activities will be staged to reduce the impact to the travelling public. In particular, for Groat Road Bridge, one lane in each direction and a sidewalk will be maintained, and no detours will be required. During construction on all three bridges, traffic will be reduced to single lanes in each direction during certain stages, and periodic temporary or off-peak closures may be required.

Parking for recreationalists in Government House Park and Emily Murphy Park will be temporarily affected by construction. In Government House Park, the north and west parking areas and park access roads will remain designated for public parking and are expected to remain open for the majority of the construction period. The south parking area nearest the SUP and Groat Road Bridge will be closed to recreationalists and will be used for construction parking and access to the north berm during construction. In Emily Murphy Park, the park access road from Emily Murphy Park Road will be shared by construction vehicles and recreationalists, and the parking area furthest west will be utilized by project construction. The main parking area will remain open to the public. Occasional temporary closures to the park access and parking areas may be required to accommodate construction traffic. The potential impacts to traffic and parking are rated as adverse, minor, short-term and predictable.

Mitigation Measures and Residual Impact

Rehabilitation work for the three bridges will be staged to take place concurrently, as that presents the most efficient construction timeline. Construction of the Groat Road Bridge will proceed in two stages to most effectively accommodate pedestrians and traffic. In the first stage the sidewalk will remain open and single northbound and southbound lanes of traffic will be accommodated on the east side of the bridge, while the contractor demolishes and replaces the superstructure and rehabilitates the substructure on the west side of the bridge. In the second stage, single northbound and southbound lanes of traffic will be relocated to the reconstructed and rehabilitated west side, with temporary pedestrian access provided east of the traffic lanes. At that time, the contractor will complete reconstruction of the superstructure and rehabilitation of the substructure on the east side of the bridge.

The contractor will ensure access is maintained to nearby amenities (Government House Park, Emily Murphy Park, river valley SUP, Royal Mayfair Golf Club, Victoria Golf Course and Driving Range) and that lane closures during peak travel times will be minimized throughout the construction period. Areas designated for public parking will remain open during construction, with only periodic temporary closures anticipated. With these mitigation measures in place, impacts from construction will remain adverse, minor, short-term and predictable, as there will still be a reduction in public parking areas for recreationalists and available lanes on busy arterial roadways.

5.2.3 Utilities

5.2.3.1 Damage to Utilities

Impact

Earthworks in the vicinity of buried utilities always create some potential for accidental damage, potentially resulting in the interruption of services or material spills. Over much of the project area, excavations will be shallow; however, localized areas of deeper excavations will also be required.

Caution and due diligence will be required during construction in the vicinity of buried utilities. All buried utility lines will be located and marked prior to initiation of construction activities, and workers will practice diligence regarding standard safety procedures. In the event that accidental damage occurs, the City will be notified immediately, and actions will be taken to implement the City's response plan. Based on these measures, the impacts on utilities are expected to be negligible.

Mitigation Measures and Residual Impact

No mitigation measures are proposed in addition to those described above, and the residual impacts will remain negligible.

5.2.4 Worker and Public Safety

Potential impacts to worker and public safety include the following:

- construction activities posing a hazard to public safety,
- wildfires caused by construction activities, and
- public hazards caused by damaged utilities

A detailed analysis of each impact follows below.

5.2.4.1 Construction Hazards to Public Safety

Impact

The proximity of the proposed construction area to existing public and recreational infrastructure poses a potential public safety risk and has been carefully considered during project design. Without proper delineation of work areas during construction, members of the public could access construction zones and experience injury. Therefore, as part of site preparation, fencing will be erected around the staging areas, and warning signs will be posted near all staging areas, all active construction sites and all construction traffic access points that are freely accessible to the public. Traffic sight lines will be maintained on existing roadways in the project area. Should construction activity necessitate, shared-use and informal trail detours will be implemented, clearly marked and communicated with user groups following City protocols. Considering these measures, the impact of project construction on public safety is rated as negligible.

Mitigation Measures and Residual Impact

No additional mitigation measures are required, other than the application of standard operating procedures to ensure public safety. Impacts are expected to remain negligible.

5.2.4.2 Wildfires Caused by Construction Activities

Impact

In dry conditions, grasses and woody vegetation may present a fuel load for wildfires, and construction activity creates potential to ignite a fire. Construction activities will be confined to a relatively small footprint comprising mainly manicured grass, with some planted trees and shrubs; however, native plant communities are located adjacent to proposed construction activities in some areas. During dry conditions, particularly in the fall when vegetation is dormant and dry, an accidental fire ignited by sparks from machinery, construction materials or cigarettes could spread quickly. Nearby downtown businesses, residents, commuters and recreationalists would be at risk in the event of a large, fast-spreading fire. City fire crews are nearby and could respond quickly if a fire did begin. In the worst-case scenario, the impact would be adverse, minor to major, short-term and uncertain.

Mitigation Measures and Residual Impact

The following measures will help reduce the potential for construction activities, vehicles or personnel to initiate a wildfire:

- Firefighting equipment will be available near any flammable storage sites, including fuels, lubricants and other petroleum products.
- Smoking throughout the construction site will be prohibited, particularly near fuel storage areas or naturally vegetated areas. A designated smoking area will be established.
- A procedure for on-site fire response will be developed and communicated to all site personnel. That plan will include contact information for local fire and emergency departments.

With these measures in place, the residual impact will be reduced to negligible.

5.2.4.3 Public Hazards from Damaged Utilities

Impact

Accidental damage to a utility could create a risk to worker and public safety. Standard protocols for this type of work and application of due diligence will minimize the probability of accidental damage to utilities. All buried utility lines will be located and marked prior to the initiation of construction activities. When working in the vicinity of utility lines, all workers will be briefed on the nature of the utility and protocol in the event of damage, and all worker safety protocols will be followed. Based on this, the impacts will be considered negligible.

Mitigation Measures and Residual Impact

No additional mitigation measures are proposed, and the residual impact will remain negligible.

5.2.5 Visual Resources

Potential impacts to visual resources include the following:

- Construction activities affecting existing views, and
- Bridge operation affecting existing views.

These potential impacts are discussed more fully in the following sections.

5.2.5.1 Construction Activities Affecting Existing Views

Impact

As with all construction projects, the aesthetics of the project area will be adversely affected during construction. Construction work will include establishing staging areas, using construction equipment, constructing in-stream berms for Groat Road Bridge rehabilitation and some vegetation clearing. Construction is expected to take approximately 27 months, and these disturbances are expected to be present throughout the construction period.

Victoria Bridge and Emily Murphy Bridge are somewhat screened by vegetation and topography; therefore, construction is expected to affect primarily short-distance views from nearby roads and sidewalks. Groat Road Bridge, however, is a prominent feature in the river valley and is visible from nearby vantage points as well as distant vantage points, such as sidewalks, roads and SUPs at the top of bank on both sides of the North Saskatchewan River, as well as condos and apartment buildings near the top-of-bank.

Vegetation clearing and selective trimming will be kept to a minimum around Groat Road Bridge, which will maintain some screening around the work area during construction. Following construction, portions of the project area that were temporarily cleared to accommodate construction will be revegetated. Construction phase impacts on visual resources are rated as adverse, major, short-term and predictable for Groat Road Bridge and adverse, minor, short-term and predictable for Victoria Bridge and Emily Murphy Bridge.

Mitigation Measures and Residual Impact

During construction, efforts will be made to minimize vegetation clearing and trimming. In addition, clearing will be delayed until just prior to the onset of construction to minimize the duration of the disturbance. Once construction is complete, visual impacts of construction could be eliminated, over time, through careful reclamation and landscaping efforts that integrate with existing aesthetics of the river valley. With these measures in place, the impacts during construction will be somewhat reduced but will remain adverse, major, short-term and predictable.

5.2.5.2 Bridge Operation Affecting Existing Views

Impact

The proposed project will rehabilitate three bridges to extend or maintain their service lives. There are no plans to build new, permanent structures that will affect long-and short-distance views. The aesthetics of Victoria Bridge and Emily Murphy Bridge are not expected to be altered by the proposed project and will look the same as they do currently.

The new Groat Road Bridge superstructure will be similar to the existing condition (i.e., similar bridge style), but will include enhanced lighting. That enhanced lighting will comprise light directed upwards from the girders to the underside of the cantilevered slab on both sides of the bridge, with low-level pedestrian lighting over the sidewalk on the east side of the bridge (N. Robson, *pers. comm.*). All lighting will be controlled/shielded lighting to specifically prevent light pollution into the river valley, consistent with Dark Sky best practices; however, the lighting will enhance the bridge structure from both near and distant vantage points, consistent with other bridges in the river valley in Edmonton (e.g., High Level Bridge, new Walterdale Bridge).

The impacts of bridge operation on existing views are expected to be negligible at Victoria Bridge and Emily Murphy Bridge and positive, minor, permanent and predictable at Groat Road Bridge.

Mitigation Measures and Residual Impact

No mitigation measures are required; residual impacts will remain negligible.

5.3 Valued Historic Components

5.3.1 Historical Resources

Potential impacts to historical resources include the following:

- disturbance to historical resources, and
- disturbance to paleontological resources.

The potential impact and mitigation measures are described below.

5.3.1.1 Disturbance to Historical Resources

Impact

Some localized excavations and pilings will be required for the proposed Groat Bridges rehabilitation project, which could potentially disturb existing historical sites; however, no known archaeological resources were detected within the project area. Alberta Culture and Tourism granted clearance on 16 February 2016 (Appendix H). Impacts to historical resources are expected to be negligible.

Mitigation Measures and Residual Impact

If potential historical or cultural resources are discovered during project construction, all work will be immediately suspended and Alberta Culture and Tourism and the Royal Tyrrell Museum will be contacted for further direction. Based on this information, impacts to historical resources will remain negligible.

5.3.1.2 Disturbance to Paleontological Resources

Impact

A monitoring program for paleontological resources will be undertaken during deep excavations (>2 m) for construction of the proposed Groat Road bridges rehabilitation project, pursuant to the requirements in the *Historical Resources Act* Requirements (Schedule A) provided by ACT in June 2016 (Appendix H of this report). Monitoring will be undertaken by a professional paleontological consultant. Following completion of the monitoring program a pHRIA report will be prepared and submitted to ACT.

As construction on the proposed bridge rehabilitation project has not commenced, the monitoring program pursuant to the pHRIA requirements has also not yet been undertaken. Consequently, there is currently no project-specific information on paleontological resources. Thus, the impact of the proposed project on paleontological resources is currently unknown.

Mitigation Measures and Residual Impact

No deep excavations (>2 m) will take place until a professional paleontological consultant is on-site to monitor the excavation work. If potential paleontological resources are discovered during construction activities, all work will be immediately suspended, and ACT and the Royal Tyrrell Museum will be contacted. The impacts to paleontological resources remain unknown, based on the present information, but the City is committed to ultimately having no adverse impact on paleohistorical resources.

6.0 SUMMARY ASSESSMENT

6.1 Summary of Impacts

With mitigation measures implemented, most impacts to Valued Environmental Components (VECs) identified in this assessment will be reduced to negligible; however, a few exceptions were identified. For the VECs examined, this EIA has identified five adverse residual impacts and two positive residual impacts. The following sections briefly discuss these exceptions.

6.2 Positive Impacts

Two positive residual impacts are anticipated as a result of the proposed project. These include:

- Improved pedestrian safety at Groat Road Bridge and Emily Murphy Bridge, as sidewalks at those two bridges will be widened. At Groat Road Bridge, the east sidewalk will be widened to a 3.0 m clear walkway, and at Emily Murphy Bridge, the north sidewalk will be widened to 4.2 m, with the addition of a bicycle railing and roadway barrier. Wider sidewalks will improve pedestrian and cyclist movement on these busy routes and minimize conflict between different modes of non-motorized transportation. Upon completion of construction, the residual impact to pedestrian safety at those two bridges is expected to be positive, major, permanent and predictable.
- Improved aesthetics, enhancing near and long-distance views of Groat Road Bridge. Proposed enhanced lighting at Groat Road Bridge will comprise light directed upwards from the girders to the underside of the cantilevered slab on both sides of the bridge, with low-level pedestrian lighting over the sidewalk on the east side of the bridge. Enhanced lighting will be consistent with other bridges in the river valley in Edmonton. Upon completion of construction, the residual impact to visual resources is expected to be positive, minor, permanent and predictable at Groat Road Bridge.

6.3 Adverse Impacts

With mitigation measures implemented, most of the potential adverse impacts identified in this assessment will be reduced to negligible. The following list briefly addresses those residual impacts that were not reduced to negligible. In general, these are short-term impacts and are expected to last only for the duration of project construction, or portions thereof. Anticipated adverse residual impacts are limited to the following:

- Proposed Groat Road Bridge rehabilitation works will comprise construction activities on the river banks and the establishment of instream berms; thus, there is a possibility of sediment generated from construction activities entering the North Saskatchewan River and affecting water quality in the short term. An ESC Plan will be developed and regular inspections by a CPESC will take place throughout the duration of construction and until such a time that vegetation is well established in areas that could pose a threat of erosion and sedimentation to the North Saskatchewan River. Catch basins in the vicinity of the project will be hoarded appropriately to avoid sediment entering the stormwater system and discharging to the North Saskatchewan River. The residual impact to hydrology from proposed rehabilitation activities at Groat Road Bridge remains adverse, major, short-term and predictable.

- The river is situated immediately adjacent and downslope of the Groat Road Bridge project area, and there is the possibility of deleterious substances entering the North Saskatchewan River during construction. Mitigation measures and best management practices eliminate the potential for large spills to occur and minimize the potential for small spills to occur. However, should a spill occur, the residual impact at Groat Road Bridge remains adverse, minor, short-term and predictable.
- Bridge rehabilitation work at Groat Road Bridge will require some clearing of native vegetation. Prior to construction, vegetation clearing limits will be clearly marked, and following construction, disturbed areas will be reclaimed using an appropriate native seed mix. The residual impact to vegetation remains adverse, minor, short-term and predictable.
- During construction, wildlife movement through the proposed Groat Road Bridges project area will be made more difficult, as staging areas will be fenced for the duration of their use. In some circumstances, this would create a temporary and minor potential for increased wildlife-vehicle collisions, and the residual impact to wildlife from the proposed project remains adverse, negligible to minor, short-term and predictable.
- Bridge rehabilitation work will temporarily affect recreational parking and traffic flow through the project area. All three bridges will retain traffic flow in both directions throughout construction, although reductions to single lanes in each direction will be required during certain stages. Some parking areas at Government House Park and Emily Murphy Park will be utilized during construction, but recreational parking spaces will be available for the public. Construction is anticipated to take approximately 27 months; during that time, the residual impact to traffic and parking remains adverse, minor, short-term and predictable.

6.4 City Follow-Up and Monitoring and Requirements

This EIA identifies several follow-up and monitoring commitments for the City:

- Pursuant to the City of Edmonton’s Enviso program, the City must undertake Environmental Construction Operations (ECO) Plan monitoring during site preparation and construction phases of the project.
- Monitoring is required by the Erosion and Sedimentation Control Plan, to be undertaken by a Certified Professional in Erosion and Sediment Control (CPESC) or equivalent.

- Under the proposed site access plan, the potential for fish to become stranded is unlikely; however as a precautionary measure, it is recommended that a Fish Capture and Release Plan be developed so it can be implemented if required.
- A turbidity monitoring program will be developed and implemented by a Qualified Aquatic Environment Specialist (QAES).
- The contractor will monitor river flows during construction to provide sufficient warning time to enable equipment to be moved to a higher location away from the river before flooding occurs.
- The Province requires a paleontology monitoring program, undertaken by a professional paleontological consultant, for all project excavations >2 m in depth to ensure no paleontological resources will be inadvertently directly impacted.
- Post-construction monitoring of revegetated areas will be required until desired vegetation becomes established. Where warranted, weed control measures, as prescribed in the contractor's ECO Plan will be implemented. The contractor will be responsible for all weed control during construction.

6.5 Permitting Requirements

In advance of construction, the following environmental approvals/permits and related submissions will be required:

- A self-assessment was conducted by a Qualified Aquatic Environment Specialist (QAES) to determine whether DFO review of the proposed project will be required. Based on that assessment, a Request for Review will be submitted to DFO before proceeding with the project.
- Notification pursuant to the Code of Practice for Watercourse Crossings must be submitted to AEP at least 14 days prior to initiation of construction at Groat Road Bridge.
- Temporary Field Authorization (TFA) from Alberta Public Lands is required prior to berm installation and access ramp construction as part of Groat Road Bridge rehabilitation.
- The existing Departmental License of Occupation (DLO #466) from Alberta Public Lands is in place for Groat Road Bridge and can be amended if bank protection, in addition to the existing bank protection, is required.
- A Notice of Works pursuant to the *Navigation Protection Act* is required to register the original Groat Road Bridge structure (constructed in 1955), with a follow-up Notice of Works required for the proposed bridge rehabilitation activities.
- An approval pursuant to the *Water Act* is required prior to berm installation and access ramp construction.
- Sign-off from City of Edmonton administration for this EIA, and approval from Edmonton's Urban Planning Committee and City Council, pursuant to Bylaw 7188.

6.6 Summary Assessment and Conclusions

The City of Edmonton proposes to undertake bridge rehabilitation work at three existing bridges situated in the North Saskatchewan River valley in Edmonton: Groat Road Bridge (B059), Victoria Bridge (B060) and Emily Murphy Bridge (B099) to extend or maintain the service life of the three bridges. The three bridges are components of important commuter and recreation routes, which are well used by all transportation modes. They provide access to downtown Edmonton to the east, the University of Alberta to the south, and numerous parks and recreation amenities along the river.

Proposed rehabilitation work at Victoria and Emily Murphy bridges will be relatively minor, while work at Groat Road Bridge will comprise superstructure replacement, with the construction of instream berms to accommodate construction. To ensure that Groat Road Bridge remains available to traffic during rehabilitation work, and to maximize construction efficiencies, a complex construction methodology was developed, which ensures that half the bridge will be available to north/south vehicular and pedestrian traffic during the construction period.

This EIA concluded that the anticipated rehabilitation activities at all three bridges have potential to result in various adverse impacts to the environment. In the majority of instances, the implementation of the mitigation measures described in this report will be effective in controlling potential impacts, reducing impact severity to negligible. Adverse impacts that will remain, despite mitigation, include impacts to hydrology, vegetation, wildlife and short-term traffic and parking disruptions during construction. Positive impacts that will remain following construction are improved pedestrian safety at Groat Road Bridge and Emily Murphy Bridge and improved aesthetics from the addition of enhanced lighting at Groat Road Bridge.

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7.2 Personal Communications

B. Moisey, Construction Consultant, DIALOG.

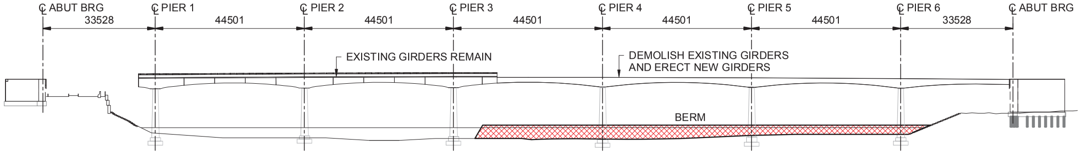
S. Oosterhof, Associate, Structural Engineering, DIALOG.

N. Robson. Principal, Structural Engineering. DIALOG.

Appendix A. Groat Road Bridge Berm Plans

BERM STAGE 1
(ESTIMATED CONSTRUCTION SCHEDULE)

1. INSTALL BERM FROM SOUTH SIDE - APPROX 60% OF RIVER WIDTH - LATE AUGUST 2018
2. DEMOLISH WEST GIRDERS FROM SOUTH ABUTMENT TO PIER #3 - SEPTEMBER 2018
3. ERECT WEST GIRDERS FROM SOUTH ABUTMENT TO PIER #4 - OCTOBER 2018



ELEVATION

1 : 750

NO.	REVISIONS	BY	DATE	APP'D

PROGRAM NO.

CONTRACT NO.

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THE CITY OF Edmonton

INTEGRATED INFRASTRUCTURE SERVICES

TRANSPORTATION INFRASTRUCTURE BRANCH

PROJECT

GROAT ROAD OVER N SASKATCHEWAN RIVER

REHABILITATION AND SUPERSTRUCTURE REPLACEMENT

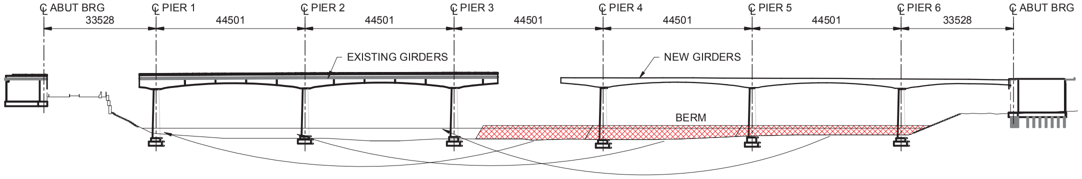
BERM STAGE 1

DRAWING

B059-BERM-1

BERM STAGE 2
(ESTIMATED CONSTRUCTION SCHEDULE)

1. MOVE BERM FROM SOUTH HALF OF THE RIVER TO NORTH HALF OF RIVER INSTREAM - NOVEMBER 2018



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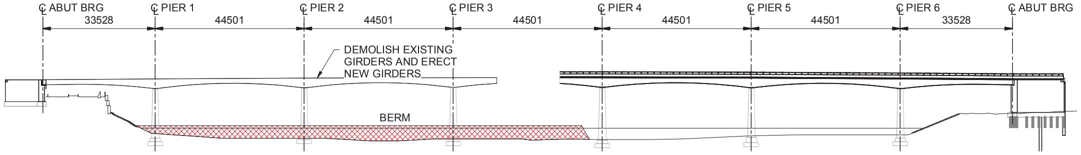
GROAT ROAD OVER N SASKATCHEWAN RIVER
REHABILITATION AND SUPERSTRUCTURE REPLACEMENT
BERM STAGE 2

DRAWING
B059-BERM-2

BERM STAGE 3
(ESTIMATED CONSTRUCTION SCHEDULE)

1. CONSTRUCT NORTH CONSTRUCTION ACCESS ROAD
2. DEMOLISH NORTHWEST GIRDERS - DECEMBER 2018
3. ERECT NORTHWEST STEEL GIRDERS - JANUARY 2019



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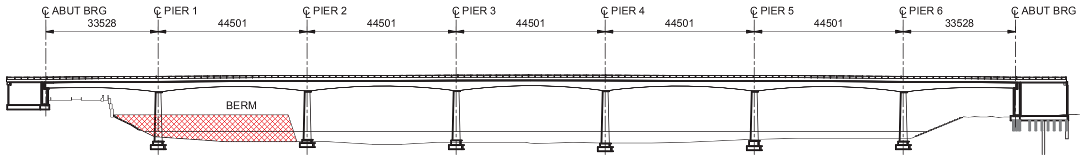
GROAT ROAD OVER N SASKATCHEWAN RIVER
REHABILITATION AND SUPERSTRUCTURE REPLACEMENT
BERM STAGE 3

DRAWING
B059-BERM-3

BERM STAGE 4
(ESTIMATED CONSTRUCTION SCHEDULE)

1. SHIFT BERM MATERIAL AGAINST NORTH BANK - FEBRUARY 2019
2. STORE BERM MATERIAL AGAINST NORTH BANK - FEBRUARY TO AUGUST 2019



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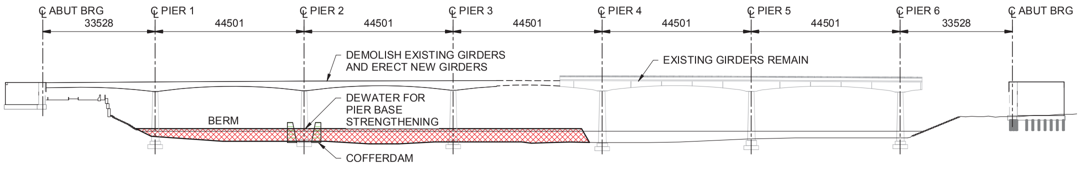
GROAT ROAD OVER N SASKATCHEWAN RIVER
REHABILITATION AND SUPERSTRUCTURE REPLACEMENT
BERM STAGE 4

DRAWING
B059-BERM-4

BERM STAGE 5
(ESTIMATED CONSTRUCTION SCHEDULE)

1. EXTEND BERM BELOW NORTHEAST GIRDERS - LATE AUGUST 2019
2. DEMOLISH EAST GIRDERS FROM NORTH ABUTMENT TO PIER #4 - SEPTEMBER 2019
3. ERECT EAST GIRDERS FROM NORTH ABUTMENT TO PIER #3 - OCTOBER 2019



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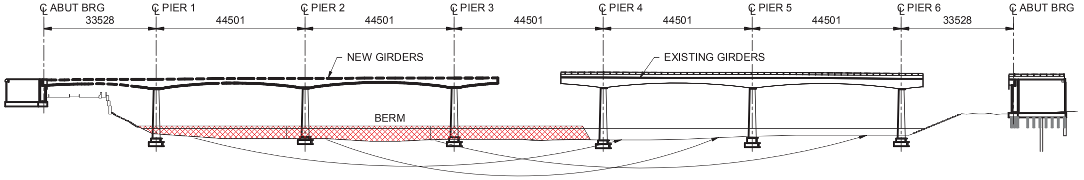
PROJECT
GROAT ROAD OVER N SASKATCHEWAN RIVER
REHABILITATION AND SUPERSTRUCTURE REPLACEMENT
BERM STAGE 5

DRAWING
B059-BERM-5

BERM STAGE 6
(ESTIMATED CONSTRUCTION SCHEDULE)

1. MOVE BERM FROM NORTH HALF OF THE RIVER TO SOUTH HALF OF RIVER INSTREAM - NOVEMBER 2019
2. REMOVE NORTH CONSTRUCTION ACCESS ROAD AND RAMP - DECEMBER 2019



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INTEGRATED INFRASTRUCTURE SERVICES

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GROAT ROAD OVER N SASKATCHEWAN RIVER

REHABILITATION AND SUPERSTRUCTURE REPLACEMENT

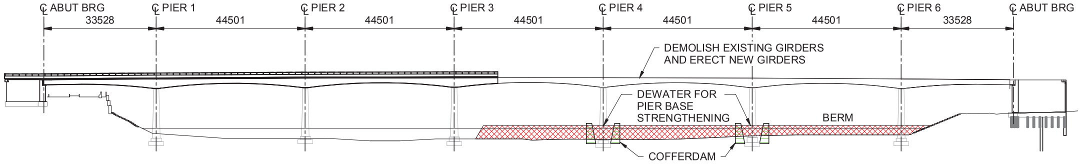
BERM STAGE 6

DRAWING

B059-BERM-6

BERM STAGE 7
(ESTIMATED CONSTRUCTION SCHEDULE)

1. DEMOLISH BALANCE OF BRIDGE - DECEMBER 2019
2. ERECT REMAINING STEEL GIRDERS - JANUARY 2020
3. REMOVE ALL BERM AND RAMP MATERIAL - FEBRUARY 2020



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INTEGRATED INFRASTRUCTURE SERVICES
TRANSPORTATION INFRASTRUCTURE BRANCH

PROJECT
GROAT ROAD OVER N SASKATCHEWAN RIVER
REHABILITATION AND SUPERSTRUCTURE REPLACEMENT
BERM STAGE 7

DRAWING
B059-BERM-7

Appendix B. Groat Road Bridges Rehabilitation: Public Feedback Summary

Groat Road Bridges Rehabilitation - Key Stakeholder Input Summary, December 2016

Stakeholder	Comments/Concerns/Feedback
City of Edmonton Stakeholders: Indigenous Relations Office Parks and Golf Courses Civic Events	• On-going discussions with these internal departments by Caroline Schettler and Jamie Bartsch
Royal Glenora Club	• Planned club renovations from late 2017 through 2019. • Many members coming from the north and west to facility. • Are used to major events closing River road - usually can have access from road through the legislative grounds • Is there any time that all the lanes over the river will be closed? No there will always be one lane of traffic in each direction although the lane width may be narrower than normal. • Would like to see bus service along River Road. Currently patrons must take LRT to Grandin Station, or bus to somewhere near that, and then walk down a lengthy flight of stairs. Not accessible for handicapped. • Would like to be kept informed of road closures/detours during construction.
Royal Mayfair Golf Club	• Busiest time April through October. In off-season still have food services for all meals, weddings and other functions, and winter programming. • Will the SB off-ramp from the bridge (access to RMGC) be used for traffic flow through (detour) at any point? No, there will always be one lane in each direction open over the bridge and on each side of the bridge. • Would like to be kept very up-to-date on traffic pattern changes during construction • Members and staff can and do access the club through the back gate - through Emily Murphy Park, under the bridge and then enter the grounds through the service yard. Would like at least enough room for a 3/4 ton truck to get through under the bridge during construction • No major tournaments planned for 2018 and 2019 • Some foot traffic so glad to hear that there will always be pedestrian access over the bridge during construction • Would like construction project manager to stay in close contact with them during construction to update on closures that will affect their access.

Edmonton Queen Riverboat	• Concerns with respect to clearance under the bridge during construction and flow rates when the berms are in. •
Royal Alberta Museum, Government of Alberta (location adjacent to project site is now closed)	• Offered to meet - gave website location and project information, sent Information Session invitation • Declined one-on-one interview • will contact project team if they need more information or have questions
University of Alberta	• Offered to meet - gave website location and project information, sent Information Session invitation • Declined one-on-one interview • will contact project team if they need more information or have questions
Government House, Government of Alberta	• Offered to meet - gave website location and project information, sent Information Session invitation • No response
Edmonton Canoe (private business - direct contact at November 29 2016 Information Session)	• the bridge and roadways need the work as presented • Edmonton Canoe operates a business which uses the hand-launch/canoe launch on the south side of the river under the Groat Road bridge • Use Emily Murphy Park to pick up and take out canoes as a shuttle service • The business depends on access to Emily Murphy Park and access to the hand launch/boat launch particularly Saturday and Sunday mornings between 8-9:30am, and afternoons between 2-7pm and weekdays between 6:30-8pm , May to October • The proposed project construction timeline could mean changing the business for up to three summers (2018, 2019 and 2020)- this is a major disruption to business. • Are aware that there are other parks and other boat launches however there are numerous reasons for choosing Emily Murphy Park • Need a better understanding of the scope of limited access to both Emily Murphy Park and to the existing boat launch area under the bridge • Pilings or changes to the river's path which may occur during construction could also make it difficult to reach the hand launch even if it's open.

Appendix C. Groat Road River Bridge Rehabilitation, Edmonton, Alberta: Geotechnical Investigation (Thurber Engineering Ltd. 2016)

THURBER ENGINEERING LTD.

GROAT ROAD RIVER BRIDGE REHABILITATION
EDMONTON, ALBERTA
GEOTECHNICAL INVESTIGATION

Report

to

DIALOG

STEPHEN E. COULTER
7/22/16

Stephen Coulter, P.Eng., P.E.
Project Engineer

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
Signature H El Ramly
Date 22 July 2016
PERMIT NUMBER: P 5186
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

HASSAN EL-RAMLY
H. El Ramly
22 July 2016

Hassan El-Ramly, Ph.D., P.Eng.
Review Principal

Date: July 22, 2016
File: 10298

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- Drawing No. 10298-3 – Surficial Geology Map

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- Modified Unified Soils Classification System
- Symbols and Terms Used on the Test Hole Logs
- Rock Material Description
- Test Hole Logs (2016)
- Test Hole Log (2015)

APPENDIX C

- Laboratory Test Results

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- Existing Bridge Design Drawings

APPENDIX E

- Slope Stability Plots – Figure E1

1. INTRODUCTION

This report presents the results of a geotechnical investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed rehabilitation of the Groat Road Bridge over the North Saskatchewan River, as well as the reconfiguration of adjacent roadways, in Edmonton, Alberta.

The geotechnical investigation was carried out in general accordance with our proposal to Mr. Neil Robson, P.Eng., of Dialog dated December 2, 2015. The detailed design of bridge and roadway rehabilitation works is being undertaken by Dialog on behalf of the City of Edmonton (City).

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. PROPOSED DEVELOPMENT

It is understood that the project comprises the following key components:

- The rehabilitation of the Groat Road Bridge over the North Saskatchewan River (B059). This 290 m long, 7 span, concrete girder bridge was built in 1955 and has subsequently undergone some rehabilitation in 1990. The key objectives of the proposed rehabilitation works are to strengthen the bridge structure such that its service life is extended by 75 years, and to replace the bridge deck with a slightly wider HPC deck.

- Limited reconfigurations of roadways on the north riverbank, including the realignment of the Victoria Park Road westbound to Groat Road northbound merge.

- The rehabilitation of the Groat Road Bridge over Victoria Park Road (B060). This 33 m long, 3 span, concrete girder bridge was built in 1954. The scope of proposed rehabilitation works is limited and aims at extending the service life of the bridge by 50 years.

- The rehabilitation of the Emily Murphy Park Road Bridge over Groat Road (B099). This 59 m long, 3 span, post-tensioned concrete bridge was built in 1963. Only minimal structural repair works are planned for this bridge with the intent of preserving the remaining service life of the bridge.

It is further understood that the proposed upgrades to the river bridge (B059) could result in additional structural loads on the abutment and pier foundations. The proposed rehabilitation works for the Victoria Park Road bridge (B060) and the Emily Murphy Park Road bridge (B099) will not exert any additional loading on the bridge foundations. Geotechnical assessments for these two bridges were not part of Thurber's scope of work.

The proposed realignment of the westbound Victoria Park Road to northbound Groat Road (refer to Drawing 10298-1) will require some earthworks to accommodate the planned grade changes. Initial design layout and cross-sections provided to Thurber by Al-Terra indicate that this reconfiguration will not impact the north slope of the North Saskatchewan River valley (north of Victoria Park Road), which has experienced slope instabilities in the past.

Minor re-alignments of the loops and ramps around the north end of the river bridge (herein referred to as Victoria Park Road/Groat Road Interchange) will also be undertaken to improve traffic flow. We understand that this will involve only minor grading works.

3. METHOD OF INVESTIGATION

3.1 Site Reconnaissance

A site reconnaissance was undertaken by Dr. Hassan El-Ramly, P.Eng. and Mr. Stephen Coulter, P.Eng. of Thurber; Mr. Corry Broks, P.Eng. and Ms. Dana Leithead, P.Eng. of Al-Terra Engineering; and Mr. Neil Robson, P.Eng. of Dialog on April 8, 2016. The objectives of the site visit were to examine the site conditions, review the proposed roadway reconfigurations, and assess drill rig access.

3.2 Drilling Investigation

Bedrock coring of two test holes for the evaluation of the bridge abutment foundations was undertaken between April 18 and 19, 2016. The test holes were advanced using a truck mounted wet rotary/coring drill operated by Garrity and Baker Drilling Ltd. of Edmonton, Alberta. The two test holes were advanced to depths ranging from 25.3 to 25.9 m below ground surface. No test holes were drilled at the pier locations in the river.

Six test holes were drilled on May 2, 2016 for the evaluation of the proposed roadway reconfigurations. The roadway test holes were advanced using a track mounted auger drill operated by All Service Drilling Ltd. of Nisku, Alberta. The test holes were advanced to depths ranging from 2.7 to 18.0 m. TH16-4 was terminated prior to its planned depth of 18.0 m due to auger refusal.

Prior to drilling, the test hole locations were cleared of underground utilities using the Alberta One Call system. An Initial Project Review (IPR) was also completed prior to drilling in accordance with the City of Edmonton River Valley Bylaws. Drawing No. 10298-1, Appendix A, shows the approximate test hole locations for the Groat Road river bridge (test holes TH16-1 and TH16-2) and associated roadway works (test holes TH16-3 to TH16-8).

Retrieved rock cores and soil samples were logged in the field by Thurber inspectors and then transferred to our Edmonton laboratory for further analysis and testing.

Standard Penetration Tests (SPT's) were carried out at selected depths in the overburden soils overlying the bedrock. Water and slough levels were noted during and immediately after the completion of the drilling prior to backfilling the test holes. Standpipe piezometers were installed in TH16-1 through TH16-4 for future monitoring of groundwater levels. Groundwater levels were subsequently measured on May 18, 2016.

Surveying of the test hole locations was conducted by Al-Terra Engineering Ltd.

The test hole logs are included in Appendix B.

3.3 Laboratory Testing

Laboratory testing included visual classification and the determination of the natural moisture content of all recovered soil samples. Detailed logging of bedrock cores and the determination of the moisture content of selected bedrock samples were also carried out. In addition, Atterberg Limits, grain size analysis tests, water soluble sulfate tests, and uniaxial compressive strength tests were conducted on select soil and bedrock samples. The results of the drilling program and laboratory testing are summarized on the attached test hole logs (Appendix B) and in Tables 3.1 to 3.3. Grain size analysis curves and stress-strain plots of compressive strength tests are provided in Appendix C.

TABLE 3.1
SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TESTS

TEST HOLE NO.	DEPTH (m)	BULK UNIT WEIGHT (kN/m^3)	UNDRAINED SHEAR STRENGTH [1] (kPa)
TH16-1	11.1-11.3	21.1	833
TH16-1	12.5-12.7	21.3	1449
TH16-1	16.0-16.2	19.0	700
TH16-1	19.3-19.4	21.1	397
TH16-1	21.1-21.3	22.1	2072
TH16-2	12.9-13.0	21.2	560
TH16-2	15.7-15.9	21.4	414
TH16-2	18.5-18.7	21.5	1661

[1] Equal to half the uniaxial compressive strength of the rock

TABLE 3.2
SUMMARY OF ATTERBERG LIMITS TESTS

TEST HOLE NO.	DEPTH (m)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)
TH16-1	4.9-5.3	26	23	3
TH16-1	10.6	72	25	47
TH16-1	16.0-16.2	95	41	54
TH16-2	4.6-5.0	45	22	26
TH16-2	12.9-13.0	91	36	55
TH16-3	1.5	79	29	50
TH16-3	11.4-11.9	31	21	10
TH16-3	13.7	64	24	40
TH16-4	4.6	61	26	35
TH16-4	7.6	44	17	27
TH16-5	1.5	38	19	19
TH16-6	1.5	45	23	22
TH16-8	1.5	68	26	42

TABLE 3.3
SUMMARY OF GRAIN SIZE ANALYSIS TESTS

TEST HOLE NO.	DEPTH (m)	GRAVEL (%)	SAND (%)	FINES [1] (%)
TH16-1	6.4-6.9	53.7	39.4	6.9
TH16-2	9.1	54.9	34.0	11.1
TH16-3	12.2	63.6	24.5	11.9

[1] Soil particles finer than 0.08 mm (silt and clay content)

3.4 Previous Investigations

In addition to the test holes completed in 2016, one test hole (TH15-2) was completed in the vicinity of the south abutment in 2015 as part of a City of Edmonton geotechnical investigation for a proposed boat launch at Emily Murphy Park. The log of this test hole is also included in Appendix B.

4. GEOLOGIC SETTING

An assessment of the geologic conditions at the project site was performed by reviewing existing available geological maps and LIDAR and satellite images, including the following:

- L. A. Bayrock. Surficial Geology Edmonton. NTS 83H. Alberta Research Council. 1972.
- L. D. Andriashek. Quaternary Stratigraphy of the Edmonton Map Area, NTS 83H. Open File Report # 198804. Terrain Sciences Department, Natural Resources Division, Alberta Research Council. 1988.
- L.D. Andriashek. Drift Thickness of the Edmonton Map Area NTS 83H. Alberta Energy 1987.
- C.P. Kathol and R.A. McPherson. Urban Geology of Edmonton. Bulletin 32. Alberta Research Council. 1975.
- Alberta Energy Regulator / Alberta Geological Survey. Bedrock Geology of Alberta. Map 600. Published 2013.

Based on the above sources, the valley uplands (top of river bank) are covered with approximately 6 m of glaciolacustrine deposits composed of bedded silts and clays, over 15 to 20 m of glacial till. The glacial till comprises unstratified mixture of clay, silt, sand, and gravel with cobbles and boulders. The till is underlain by the Saskatchewan Sand and Gravel (Kathol and McPherson, 1975), also referred to as the Empress Formation (Andriashek 1988). The Saskatchewan Sand and Gravel is approximately 10 m in thickness, with the top of the deposit at approximate elevation 645 m. The sand and gravel is underlain by bedrock of the Horseshoe Canyon Formation. The bedrock comprises a sequence of sandstone, siltstone, and clay shale with coal and bentonitic seams. As per the above sources, this geologic column was inferred from test holes located further to the north of the project area. Hence, the specific geologic conditions at the project site may vary from those described herein.

The above geologic column has been altered by the North Saskatchewan River as it dissected its present valley through surficial deposits and into the underlying bedrock. Alluvial sediments have been deposited on the valley floor forming a broad terrace that abuts the north river bank in the project area. The top of the river terrace is at approximate elevation 625 m. The terrace is composed of sand, gravel, silt and clay, and is approximately 10 m thick.

In the river channel, recent alluvial sand and gravel sediments are anticipated directly on top of the bedrock.

The north slope of the river valley is covered by relatively thick colluvium deposited by gravity as a result of slumping and erosion of overburden units at higher stratigraphic elevations. In some areas, the valley slope was graded to accommodate railway (no longer in use) and roadway construction, and fills of varying thicknesses cover parts of the slope

5. SURFACE CONDITIONS

5.1 General

At the project site, the North Saskatchewan river flows from east to west, then ultimately to the northeast towards Fort Saskatchewan. The Groat Road bridge crosses a relatively straight stretch of the river channel, and is situated on a broad alluvial terrace within the river valley.

5.2 North River Valley Slope

The north slope of the river valley is covered by relatively thick colluvium. Because colluvium is deposited in a loose state, it is often prone to sloughing and erosion, particularly upon wetting. A review of LiDAR imagery identified multiple scarps and zones of soil bulging along the north river bank upslope (north) of Victoria Park Road, including a relatively large area south of 125th Street. Drawing 10298-3 shows the approximate locations and extents of the identified scarps. These features are indicative of previous ground movements. Drawing 10298-3 also shows the approximate locations of three known slope failures that necessitated the implementation of mitigation measures, as per the City's records. Available information suggests that the observed ground movements are shallow within the colluvium cover. There are no visible indications of bedrock controlled instabilities.

As noted earlier, construction of the proposed westbound Victoria Park Road to northbound Groat Road will not require any alteration of the valley slopes (refer to Drawing 10298-3).

5.3 Bridge Abutments

The south abutment is located on the river terrace within Emily Murphy Park. The river terrace is approximately 8 m high above the riverbed elevation of ~614 m. The abutment is located approximately 20 m south of the edge of the river channel. In general, the area surrounding the abutment is vegetated parkland with gravel surfaced trails.

The river terrace at the location of the north abutment is approximately 13 m high above the riverbed elevation of ~614 m. The River Valley Road runs along the top of bank of the river channel in a southeast-northwest direction. It passes beneath the bridge immediately to the south of the north abutment. The abutment is located approximately 25 m north of the edge of the river channel. The area surrounding the abutment is landscaped with grass fields and trees.

5.4 Victoria Park Road/Groat Road Interchange

This component of the project is located at the north end of the Groat Road River Bridge. The area is generally gently sloping to the north. It has been extensively filled and graded to accommodate the development of the numerous loops and ramps that make up the interchange. The area is landscaped with trees and grass and is bounded by Victoria Park Golf Course to the east, Government House Park to the west, and the river valley slope to the north.

6. SUBSURFACE SOIL CONDITIONS

6.1 Bridge Abutments

A schematic of the subsurface stratigraphy at the abutment locations is presented on Drawing No. 10298-2, Appendix A. The stick logs of the recent test holes (TH16-1 and TH16-2) as well as the previous test hole (TH15-2) are shown on the drawing.

The generalized soil stratigraphy in the bridge area consists of surficial fill over layers of varying thicknesses of alluvial sand, clay, silt, and gravel, overlying interbedded clay shale and sandstone bedrock.

6.1.1 Overburden Soils

At the south abutment location (TH16-1), a 0.3 m thick layer of gravel fill was encountered at ground surface overlying, in descending order, silty sand, low plastic clay, silt, a relatively thin layer of wood chips and rootlets, and compact poorly graded gravel. The interface between overburden soils and the bedrock occurred at approximate elevation 614.1 m. In test hole TH15-2, the top of bedrock was encountered at approximate elevation 614.8 m.

At the north abutment location (TH16-2), a 0.2 m thick layer of topsoil was encountered at surface overlying low plastic clay, overlying poorly graded gravel. The soil-bedrock contact occurred at approximate elevation 614.9 m.

The natural moisture content of the clay and silt samples in test holes TH16-1 and TH16-2 ranged generally from approximately 25 percent to 47 percent. The moisture content of one sample near the ground surface in TH16-2 was 68 percent, possibly due to the presence of some organic material. The SPT “N” values in the clay and silt ranged generally from 5 to 8 blows for 300 mm of penetration, indicating a firm consistency. One lower ‘N’ value of 2 blows for 300 mm of penetration was recorded in the silt at 5 m depth in TH16-1, indicative of loose condition. The results of Atterberg Limits tests yielded liquid limits ranging from 26 to 45 percent, and plastic limits ranging from 23 to 36 percent, indicating a range from low to medium plastic soils.

The natural moisture content of samples of the underlying sand and gravel ranged from approximately 10 percent to 21 percent, and the SPT “N” values ranged from 29 to greater than 50 blows for 300 mm of penetration, indicating a compact to very dense state. The results of two grain size analysis tests conducted on gravel samples indicated 54 to 55 percent gravel, 34 to 39 percent sand, and 7 to 11 percent fines content (silt plus clay sizes).

A total of six water soluble sulphate tests were carried out on selected soil samples. The test results are noted on the test hole logs and are summarized in Table 6.1. The “degree of exposure” of subsurface concrete to sulphate attack is also noted in Table 6.1, based on the categories recommended by the Canadian Standards Association (CSA, 2014).

TABLE 6.1
WATER SOLUBLE SULPHATE ION CONTENT

TEST HOLE	DEPTH BELOW GROUND SURFACE (m)	SOIL TYPE	WATER SOLUBLE SULPHATE CONTENT (PFRA Method)	POTENTIAL FOR SULPHATE ATTACK ON SUBSURFACE CONCRETE [1]
TH16-1	3.3	Clay	0.02 %	Negligible
TH16-1	7.9	Clay Shale	0.02 %	Negligible
TH16-2	3.5	Clay	0.00 %	Negligible
TH16-2	11.0	Clay Shale	0.02%	Negligible
TH16-3	9.2	Clay	0.02 %	Negligible
TH16-4	1.5	Clay Fill	0.42 %	Severe

[1] Based on the Canadian Standards Association (CSA A23.1-14)

6.1.2 Bedrock

The bedrock at the project site consisted of alternating layers of siltstone, sandstone, and clay shale. Occasional zones of clay infill within the bedrock joints, bentonitic zones, bentonite seams, and coal inclusions and layers were also encountered.

The strength of the bedrock varied generally from extremely weak to very weak, in rock mechanics terminology, with uniaxial compressive strengths between 0.8 and 3.3 MPa (Table 3.1). One test on a thin indurated siltstone stringer indicated a compressive strength of 4.1 MPa. Localized softer zones comparable in strength to hard soils were also encountered. For example, SPT 'N' blow counts in the upper 5 m of the bedrock in TH15-2 ranged between 15 and 60 blows per 300 mm of spoon penetration, indicative of very stiff to hard consistency in soil mechanics terminology.

The results of Atterberg Limits tests indicated that the clay shale facies of the bedrock are highly plastic with liquid limits in the range of 90 to 100 percent and plastic limits in the range of 36 to 41 percent.

It should be noted that compressive strength tests are performed on intact core samples and may not necessarily represent the strength of the rockmass, which is typically governed by the presence of fissures and fractures. Such defects are common in the Edmonton Formation bedrock, particularly in the upper, weathered horizons.

The quality of the bedrock mass may be assessed empirically via the Rock Quality Designation (RQD) index, which is the ratio of the aggregate length of core pieces over 100 mm in length to the total length of core recovered, expressed as a percentage. RQD of 100 percent indicates a very good quality rockmass with joint spacing in excess of 100 mm. RQD of zero indicates a highly fractured rockmass with closely spaced joints. A statistical assessment of RQD values recorded at the south and north abutments is presented in Table 6.2. The information suggests that the quality of the rockmass at the north abutment is better than that at the south abutment. A review of test hole logs also indicates that the RQD values improve with depth, with the “very poor” and the “poor” horizons occurring in the upper 4 m of the bedrock.

TABLE 6.2
RQD CORE CLASSIFICATION

RQD 1 VALUE (%)	Rockmass Quality	% of All Core Runs At South Abutment (TH16-1)	% of All Core Runs At North Abutment (TH16-2)
0 – 25	Very Poor	29	0
25 – 50	Poor	29	20
50 – 75	Fair	42	80
75 – 90	Good	0	0
90 – 100	Very Good	0	0

1 Rock Quality Designation

6.2 Victoria Park Road/Groat Road Interchange

Six test holes were advanced to characterize the subsurface conditions along the proposed new alignment of the westbound Victoria Park Road, and in the area of the Victoria Park Road/Groat Road interchange which will be reconfigured.

The generalized soil stratigraphy in the area consists of surficial topsoil over layers of clay fill, clay, and clay shale/sandstone bedrock. Relatively thin layers of gravel and clay till were also encountered in the deeper test holes (TH16-3 and TH16-4).

Along the proposed alignment of the westbound Victoria Park Road (TH16-3 and TH16-4) overburden soils consisted primarily of clay fill, clay, clay till and some gravel. The interface between overburden soils and bedrock was encountered at elevations 618.8 and 624.4 m in TH16-3 and TH16-4, respectively.

In the area of the Victoria Park Road/Groat Road interchange (TH16-5 to TH16-8) at the north end of the river bridge, clay fill was encountered either beneath a 0.1 m thick layer of topsoil or at the ground surface. The clay fill extended to the bottom of all test holes at depths of 2.7 m below existing grade.

The natural moisture content of the clay fill in all test holes ranged from 12 to 38 percent, and the SPT “N” values ranged from 4 to 22 blows for 300 mm of penetration indicating firm to very stiff consistency. The results of Atterberg Limits tests yielded liquid limits ranging from 38 to 79 percent, and plastic limits ranging from 19 to 29 percent, indicating a range of medium to high plastic clays.

The natural moisture content of the native clay and clay till (in TH16-3 and TH16-4) ranged from 24 to 46 percent, and the SPT “N” values ranged from 7 to 33 blows for 300 mm of penetration indicating firm to hard consistency. The results of Atterberg Limits tests yielded liquid limits ranging from 32 to 44 percent, and plastic limits ranging from 17 to 21 percent, indicative of medium plastic clay.

The natural moisture content of the gravel deposit in TH16-3 was in the order of 10 percent. One SPT “N” value of 48 blows for 300 mm of penetration was recorded in the gravel, indicating a dense state. The results of one grain size analysis test indicated 64 percent gravel, 25 percent sand, and 12 percent fines content (silt plus clay sizes).

The natural moisture content of the bedrock ranged from approximately 9 percent to 30 percent. SPT “N” values were all greater than 50 blows for 300 mm of penetration, indicating hard consistency in soil mechanics terminology. The results of an Atterberg Limits test on a clay shale sample yielded a liquid limit of 64 percent and a plastic limit of 24 percent, indicative of high plasticity.

7. GROUNDWATER CONDITIONS

Groundwater levels were measured in the installed standpipe piezometers following the drilling then again on May 2 or May 3, 2016 and on May 18, 2016. The measured water levels (and groundwater elevations) are summarized in Table 7.3. It is expected that groundwater conditions in the river terrace, particularly at the abutment locations, will closely mirror the river level.

TABLE 7.3
SUMMARY OF SLOUGH AND GROUNDWATER LEVELS

TEST HOLE	TEST HOLE DEPTH B.G.S. (m)	SLOUGH ON COMPLETION B.G.S. (m)	GROUNDWATER ON COMPLETION B.G.S. (m)	STANDPIPE WATER LEVELS May 2/3, 2016		STANDPIPE WATER LEVELS May 18, 2016	
				B.G.S. (m)	ELEV. (m)	B.G.S. (m)	ELEV. (m)
TH16-1	25.3	N/A	N/A	5.8	616.2	5.9	616.1
TH16-2	25.9	N/A	N/A	7.9	618.0	8.4	617.5
TH16-3	18.0	17.8	12.1	15.8	616.4	10.7	621.5
TH16-4	8.4	8.4	None	Dry	N/A	Dry	N/A
TH16-5	2.7	None	None	N/A			
TH16-6	2.7	None	None	N/A			
TH16-7	2.7	None	None	N/A			
TH16-8	2.7	None	None	N/A			

B.G.S. = Below Ground Surface

It should be noted that groundwater levels can vary in response to seasonal factors, precipitation, and river levels. Hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation. Water levels should be measured again just prior to construction, if possible.

8. GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

8.1 Bridge Foundations

The purpose of the assessments presented in the following sections is to provide estimates of the ultimate bearing capacity and the elastic modulus of the foundation bedrock at the pier locations, and the ultimate bearing and skin friction resistances of the abutment piles. The assessments presented herein are based on the results of recent test holes advanced at the abutment locations, historical geotechnical data for the bridge, design drawings of bridge foundations, and local experience with similar bridge projects in the Edmonton area.

8.1.1 Background

A copy of the design drawings of the existing Groat Road river bridge, which were issued on August 10, 1953, is provided in Appendix D. The drawings show the general layout of the bridge and its foundation elements. They also include basic subsurface stratigraphy from five test holes, but no physical or mechanical properties of soil/bedrock units.

The bridge was constructed in 1955. It is approximately 290 m long, 7-span, cast-in-place concrete girder bridge. The bridge abutments are supported on precast concrete piles while the six piers are supported on spread footings.

A summary of information pertinent to the pier footings, based on the bridge design drawings, is provided in Table 8.1. It appears that the pier footings are founded on the bedrock surface with little or no embedment below top of bedrock. A 1989 survey of the riverbed by Alberta Underwater Contractors Ltd. noted that the tops of Piers 2 and 3 footings were exposed. A 2001 survey by Hydroconsult EN3 Services reported 0.4 to 0.6 m deep scour holes at the nose (i.e. upstream side) of each pier. Neither of these surveys reported any exposure of the bases of the footings.

TABLE 8.1
BRIDGE PIER FOOTINGS – PERTINENT INFORMATION

PIER NO.	BASE OF FOOTING ELEVATION 1 (m)	FOOTING DIMENSIONS (m x m)	MINIMUM RIVERBED ELEVATION 2 (m)	DEPTH OF FOOTING BELOW RIVERBED (APPROX.) (m)
1 (north)	611.43	4.0 x 20.1	616.4	5.0 3
2	612.04	4.0 x 20.1	613.8	1.8
3	611.43	4.0 x 20.1	613.8	2.4
4	610.82	4.0 x 20.2	613.4	2.6
5	611.12	4.0 x 20.1	614.0	2.9
6 (south)	611.43	4.0 x 20.1	615.7	4.3 3

1 Based on bridge design drawing 1057P by Structural Engineering Services dated August 10, 1953
2 Based on river survey data by Hydroconsult EN3 Services dated December 12, 2001
3 Pier situated partially below river bank

As noted earlier, information pertaining to the bedrock conditions at the pier locations is scarce. Based on previous experience with similar projects in the Edmonton area, it is expected that the upper few meters of bedrock will be weathered and weak. The bridge design drawing 1057P indicated that the pier footings were designed based on an allowable bearing pressure of 479 kPa (5 tons/sq. ft.). Assuming a factor of safety of 3, that corresponds to an ultimate bearing pressure of about 1440 kPa.

In 2005, Thurber conducted a concept level geotechnical assessment of the capacity of the pier foundations. The review was based on geotechnical information available at the time and previous experience on similar projects. The findings were presented in a letter to CH2M Hill Canada Ltd., dated May 25, 2005.

In terms of the abutment foundations, it is understood that the abutments are supported on driven, precast reinforced concrete piles. The pile cross-section was 305 mm x 305 mm square, and the piles featured a 0.9 m long tapered section at their tips. A summary of information pertinent to the abutment piles is provided in Table 8.2. The design embedment lengths of piles below top of bedrock were notably short, amounting to 3.3 and 2.6 m for the north and south abutments, respectively. These embedment lengths include the 0.9 m long tapered pile tips. It is unknown if the piles were driven to the full length of design embedment.

TABLE 8.2
BRIDGE ABUTMENT PILES – PERTINENT INFORMATION

ABUTMENT	BASE OF PILE CAP ELEVATION [1] (m)	DESIGN PILE LENGTH (m)	DESIGN PILE TIP ELEVATION (m)	BEDROCK ELEVATION [2] (m)	DESIGN EMBEDMENT BELOW TOP OF BEDROCK (m)
North	623.2	11.6	611.6	614.95	3.3 [3]
South	620.0	8.5	611.5	614.13	2.6 [3]

1 Based on bridge design drawing 1060P by Structural Engineering Services dated August 10, 1953
2 Based on test holes drilled by Thurber in 2016
3 Embedment length into bedrock includes 0.9 m long tapered pile tip

Based on the above review, the condition and the degree of weathering of the foundation bedrock at the pier locations are unknown and inferences will have to be made based on the results of the abutment test holes. Furthermore, the as-built lengths of the abutment piles are also unknown. The missing information will introduce additional elements of uncertainty and warrant a cautious approach to the design of rehabilitation works.

8.1.2 Pier Foundations

8.1.2.1 General Assessment

A brief review of available information about bridges constructed across the North Saskatchewan River in the general vicinity of the Groat road river bridge was undertaken. The review focused solely on bridges whose river piers were supported on footings. A summary of key information is presented in Table 8.3. It should be noted that the reviewed documents were incomplete and, as a result, some of the presented information is approximate and some information is missing.

The summary in Table 8.3 indicates that pier footings were embedded, generally, about 2 to 5 m below top of bedrock. The likely objective was to support the footing bases on competent bedrock below the upper weathered zone. The existing Groat Road river bridge is the only exception, where the pier footings appear to have been founded on the bedrock surface with no embedment below top of bedrock.

The ultimate bearing capacity used in footing design ranged generally between 2000 and 2200 kPa. The exceptions were the LRT Dudley Menzies bridge where a higher ultimate bearing capacity of 3000 kPa was used and the subject Groat Road river bridge where a lower ultimate bearing capacity of 1440 kPa was used. The lower bearing capacity of the Groat Road piers is justifiable given the lack of any footing embedment below top of bedrock.

The results of the recent geotechnical investigation carried out at the abutment locations indicate that the bedrock is extremely weak to very weak (R0 to R1) in rock mechanics classification, with uniaxial compressive strengths in the order of 0.80 MPa to 3.32 MPa. It should be noted, however, that the shallowest test sample was recovered at 2 m depth below top of bedrock. The upper 2 m of bedrock were generally fractured and no intact samples suitable for strength testing were recovered. SPT ‘N’ blow counts in the upper 4 m of the bedrock (from recent and previous test holes) ranged generally from 24 to 64 blows per 300 mm of spoon penetration. One lower SPT ‘N’ value of 15 blows was recorded in TH15-2 at 4 m depth below top of bedrock. The bedrock at that elevation was described as bentonitic clay shale and was characterized by a high moisture content of 49 percent.

TABLE 8.3
SUMMARY OF RIVER PIER FOUNDATIONS OF SELECT BRIDGES IN EDMONTON

BRIDGE	DISTANCE FROM GROAT ROAD BRIDGE (km)	YEAR BUILT	NUMBER OF RIVER PIERS	FOUNDATION SYSTEM[1] (m)	FOOTING SIZE (m x m)	EMBEDMENT BELOW TOP OF BEDROCK (APPROX.) (m)	DESIGN BEARING PRESSURE (kPa)
Groat road river bridge	0.0	1955	4	Spread footings	4.0 m x 20.1 m	0	479 (allowable)
Buena Vista Park Pedestrian Bridge	1.7	1996	4	Spread footings with belled piles on upstream side (for overturning)	N/A	1.8	2000 (ultimate)
Dudley Menzies LRT bridge	1.9	1992	2	Spread footings	N/A	> 3.0	1000 (allowable)
105 Street (existing Walterdale truss bridge)	2.5	1913	2	Spread footings	6.5 m x 23.0 m	4.5 to 5.5	718 (allowable)[2]
Whitemud Quesnell Bridge	4.5	1967/2011[1]	4	Spread footings	7.6 m x 13.7 m to 9.1 m x 15.2 m	2.1 to 3.1	2000 (ultimate)
Cloverdale pedestrian bridge (Louise McKinney park)	5.0	1976	3	Spread footings with ground anchors (for overturning)	4.6 m x 13.7 m to 7.0 m x 14.0 m	2.4 (min.)	N/A

N/A Information not available.

[1] Bridge was originally constructed in 1967 and subsequently widened in 2011.

[2] Based on 1970 design recommendations by R.M. Hardy & Associates for a replacement 105 Street bridge (bridge was never built).

8.1.2.2 Bearing Capacity

Based on the assessment presented earlier, it is anticipated that the ultimate bearing capacity of the pier footings of the Groat Road river bridge is in the order of 1800 kPa. The magnitude of the ultimate bearing capacity was estimated based on an undrained shear strength of rockmass of 350 kPa. A geotechnical resistance factor of 0.5 should be applied to the estimated ultimate bearing capacity to compute the factored Ultimate Limit State (ULS) bearing capacity.

In assessing the capacity of footings subjected to eccentric loads, the eccentricities of the resultant Serviceability Limit State (SLS) reaction force at the foundation level in the direction of the footing width, e_B, and in the direction of the footing length, e_L, should be less than:

$e_B \leq B/6$, and

$e_L \leq L/6$

where B and L are the footing width and length, respectively. This condition is intended for the footing to remain in full contact with the bearing surface, and eliminate situations where zero contact pressure may exist beneath any portion of the footing.

In ULS design, the eccentrically loaded footing should be considered to have an effective concentrically loaded area of width B' and length L', where $B'=B-2e_B$ and $L'=L-2e_L$. The maximum factored ULS bearing pressure at the base of the 'effective' footing should be less than the ultimate bearing capacity times a geotechnical resistance factor of 0.5. Additionally, the Canadian Highway Bridge Design Code (2014) and the AASHTO LRFD Bridge Design Specifications (2012) require that the eccentricities of the resultant factored ULS reaction force be limited to one third the corresponding footing dimension (i.e. B/3 or L/3).

8.1.2.3 Elastic Modulus and Poisson's Ratio of Bedrock

Foundation settlement due to the compressibility of bedrock under typical design bearing pressures is predominantly time independent (i.e. elastic deformation) and is governed by the elastic properties of the bedrock. The bedrock elastic modulus depends on the rock type and strength, the quality of the rockmass (degree of fracturing), and the depth below surface. Given the shallow depth of the pier footings and the uncertainty surrounding the quality of the underlying rockmass, it is recommended that a conservative range of elastic moduli be considered in the design.

A review of bedrock elastic modulus data from pressuremeter tests at a few projects in the Edmonton area was undertaken (Walterdale bridge, E.L. Smith Water Treatment Plant, CN Tower, and Alberta Government Building). Based on this data, it is recommended that an elastic modulus in the range of 160 to 240 MPa be used in assessing the serviceability of the existing pier footings under the anticipated structural loads. A Poisson's ratio of 0.35 may be used for bedrock underlying the project site.

8.1.2.4 Other Considerations

Given the age of the bridge, it is recommended that underwater inspections of the pier footings be undertaken. The key objectives of the inspections should be to assess the scour conditions of the riverbed and to examine the physical conditions of the exposed footings (e.g. condition of concrete, etc.).

Should the structural evaluation of the proposed rehabilitation works indicate that additional loads will be exerted on the footings, the structural engineer should review and confirm that stresses in the footings' reinforced concrete remain within acceptable limits in accordance with applicable design codes.

8.1.3 Abutment Foundations

8.1.3.1 General Assessment

Design information pertaining to the abutments' precast concrete piles are summarized in Table 8.2. Owing to their solid cross-section, driven precast concrete piles are considered "high displacement" piles and are capable of developing relatively high load carrying capacities. Having said that, the pile design embedments below top of bedrock (excluding the length of tapered pile tips) are only 2.4 and 1.7 m for the north and south abutments, respectively. In other words, the piles are bearing on the upper weathered horizons of the bedrock. These relatively short embedment depths may have been chosen to limit driving stresses in the pile concrete. It should be noted, though, that no construction records are available and it is not known if the piles were in fact driven to the full design embedments. The driving resistances (number of hammer blows for a given pile penetration) at the termination of pile driving are also unknown.

Based on the information collected from the geotechnical investigation, estimates of the skin friction and end bearing resistances of subsurface strata can be developed, as discussed in the following section. The load carrying capacities of the existing piles may be determined based on the estimated resistances and assumed pile embedments.

Thurber cannot determine the as-built lengths of constructed piles from available information. However, available test hole information indicates thinner gravel layer and more fractured/weaker bedrock at the south abutment than at the north abutment. Coupled with a shorter design pile embedment into bedrock, it is possible that the south abutment piles were driven to the design tip elevation of 611.5 m. The north abutment is underlain by 5.2 m thick layer of very dense gravel over more competent bedrock. It is uncertain if the piles could have been driven to the design length of 11.5 m.

8.1.3.2 Axial Pile Capacity

The axial capacity of the existing precast concrete piles may be estimated based on a combination of shaft friction and end bearing resistance. The ultimate skin friction and end bearing values provided in Table 8.4 may be used to estimate the pile capacities. The skin friction values should be applied to the surface area of the straight shaft portion of the pile only (i.e. not along the tapered end of the pile). The end bearing resistance should be applied to the square cross-sectional area of the pile (0.305 m x 0.305 m).

For Ultimate Limit State (ULS) design, the factored ULS pile capacity is obtained by multiplying the ultimate value with the appropriate geotechnical resistance factor. As per the Canadian Highway Bridge Design Code (2014), a geotechnical resistance factor of 0.4 should be used for piles subjected to axial compression. For piles subjected to axial tension, a geotechnical resistance factor of 0.3 should be used and the end bearing component should be ignored.

The computed load carrying capacity of the pile (both in compression and in tension) should not exceed the structural capacity of the pile section.

TABLE 8.4
ESTIMATED ULTIMATE SKIN FRICTION AND END BEARING VALUES FOR DRIVEN PRECAST CONCRETE PILES

ELEVATION (M)	SOIL UNIT	ULTIMATE SKIN FRICTION (KPA)	ULTIMATE END BEARING (KPA)
NORTH ABUTMENT			
623.2 – 620.2	Clay	30	-
620.2 - 615.0	Gravel	90	5000
Below 615.0	Weathered Clay Shale	90	5000
SOUTH ABUTMENT			
620.0 – 615.6	Clay / Silt	20	-
615.6 - 614.1	Gravel	90	-
Below 614.1	Weathered Clay Shale	90	5000

The skin friction and end bearing values in Table 8.4 are based on the assumption that the piles were properly constructed in accordance with conventional engineering practice.

8.1.3.3 Other Considerations

We understand that the proposed rehabilitation works can result in some limited increase in the structural loads applied onto the piles. The structural engineer should confirm the adequacy of the concrete pile sections to withstand any increase in compressive, tensile, or bending stresses as a result of the anticipated additional loads.

It is expected that the existing piles have fully settled under the applied structural loads. The increase in pile loads may, however, result in some limited additional settlement.

8.2 Roadway Reconfiguration

8.2.1 General

It is understood that the westbound Victoria Park road, and various ramps of the Victoria Park Road/Groat Road/River Valley Road interchange will be reconfigured to improve traffic conditions. The drilled test holes were situated along the proposed new road/ramp alignments, as follows:

- RAMP 1 – Westbound Victoria Park Road to Northbound Groat Road (TH16-3 and TH16-4)

- RAMP 2 - Westbound River Valley Road to Northbound Groat Road (TH16-5, TH16-6 and TH16-7)
- RAMP 3 - Westbound River Valley Road to Southbound Groat Road (TH16-8)

All test holes indicated surficial topsoil over stiff to very stiff, medium to high plastic clay fill. The fill extended to the termination depths of test holes drilled along the alignments of Ramps 2 and 3 at 2.7 m below existing ground. Along the alignment of Ramp 1, fills extending to a depth of 7.6 m below ground surface were encountered.

Preliminary information regarding the horizontal and vertical alignments of the proposed roads/ramps were provided by Al-Terra Engineering. It is understood that construction of the new Ramps 2 and 3 will require limited grading and the placement of minor amounts of fill. Construction of Ramp 1 will be primarily in cut, with cut depths up to about 2 m. The cuts will be undertaken along the north fill slope of the eastbound Victoria Park road. As discussed in Section 2, the proposed cuts will not impact the north river valley slope. Some minor fills (on the order of 1 m) will also be required for the construction of Ramp 1. The design inclination of fill sideslopes and excavation backslopes is 3H:1V.

From a geotechnical standpoint, the proposed alignments of the new roads/ramps are deemed feasible. Recommendations for the development of these roadways are provided in the following sections. The design of pavement sections and resurfacing strategy will be provided by the City.

8.2.2 Subgrade Preparation

Site preparation should include the removal of all topsoil, soft or organic materials and deleterious fill from within the footprints of the proposed roads/ramps. It should be emphasized that the topsoil thicknesses reported in this investigation were measured at the discrete test hole locations. It is likely that the thickness of topsoil at other locations not investigated could be different. If an accurate estimate of topsoil volume is required for stripping quantity calculations, additional hand augered holes should be advanced.

The exposed clay soils should be examined by qualified geotechnical personnel to confirm that all deleterious materials have been removed. The exposed surface should then be proof rolled with at least 2 passes of a loaded gravel truck or water truck to detect soft/weak areas. Any soft/yielding areas should be sub-excavated and replaced with compacted inorganic clay. The exposed soils should be scarified to a minimum depth of 150 mm and compacted to at least 95 percent of the Standard Proctor Maximum Dry Density (SPMDD) at a moisture content within ±2 percent of the Optimum Moisture Content (OMC).

Additional fill required to raise the grade to the design subgrade level may consist of inorganic, low to medium plastic clay placed in 150 mm thick lifts and compacted to at least 98 percent of the SPMDD at a moisture content within ±2 percent of the OMC. The upper 300 mm of soil below the subgrade level should be compacted to 100 percent of the SPMDD at a moisture content within ± 2 percent of the OMC.

Consistent with the City Standards, it is recommended that the upper 150 mm of the subgrade be modified with Portland cement. A minimum application rate of 10 kg/m^2 of cement would be required per 150 mm lift of soil. Additional cement may be required if weaker soils are encountered.

Permanent site drainage should be developed at early stages of construction in order to improve site trafficability and reduce future frost effects in the subgrade. It is recommended that the finished clay subgrade surface be sloped at a minimum of 2 percent towards catch basins or perimeter ditches. The purpose of this is to drain surface water from the subgrade and minimize the risk of swelling, softening or frost heave.

8.2.3 Slope Stability

Construction of the proposed roads/ramps will involve cuts up to a maximum depth of 2 m and fills up to a maximum height of 1 m. The proposed inclination of 3H:1V for both cut and fill slopes is deemed adequate.

The stability of the deepest cut was analyzed using the Slope/W software, based on the method of limit equilibrium, and soil parameters derived from the results of this investigation and previous experience in similar projects in Edmonton. The analysis results are presented on Figure E1 in Appendix E. The minimum long term factor of safety of the cut slope was estimated to be 1.51, and is deemed acceptable.

All cut and fill slopes should be covered with topsoil and vegetated to minimize the risk of erosion due to surface runoff.

9. CONSTRUCTION INSPECTIONS

The performance of roadway structures will depend upon the quality of workmanship during construction. This is particularly important in regard to earthworks where variations in soil conditions could occur. Therefore, it is recommended that construction inspections be provided by qualified geotechnical personnel to ensure that embankment fills are constructed in accordance with the City specifications and that pavement sections are installed on competent subgrade. Compaction testing for fill soils should be carried out on a regular basis.

10. LIMITATION AND USE OF REPORT

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before the final design or construction details have been prepared or issued. Therefore differences may exist between the report recommendations and the final design, contract documents, or conditions encountered during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on to the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedule, safety, and equipment capabilities.

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

APPENDIX A

Drawing No. 10298-1 – Site Plan Showing Test Hole Locations
Drawing No. 10298-2 – Stratigraphic Cross-Section
Drawing No. 10298-3 – Surficial Geology Map

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BASE PLAN PROVIDED BY CITY OF EDMONTON TRANSPORTATION DEPARTMENT

LEGEND

- ⊕ APPROXIMATE TEST HOLE LOCATION (2016)
- ⊕ APPROXIMATE TEST HOLE LOCATION (2015)
- - - - PROPOSED WESTBOUND VICTORIA PARK ROAD TO NORTHBOUND GROAT ROAD RAMP

0 25 50 75 100 150 200 m

SCALE 1:3000

DIALOG™

GROAT ROAD BRIDGE REHABILITATION

SITE PLAN SHOWING TEST HOLE LOCATIONS

DWG No. 10298-1

DRAWN BY	ML
DESIGNED BY	SEC
APPROVED BY	HER
SCALE	1:3000
DATE	JUNE 2016
FILE No.	10298

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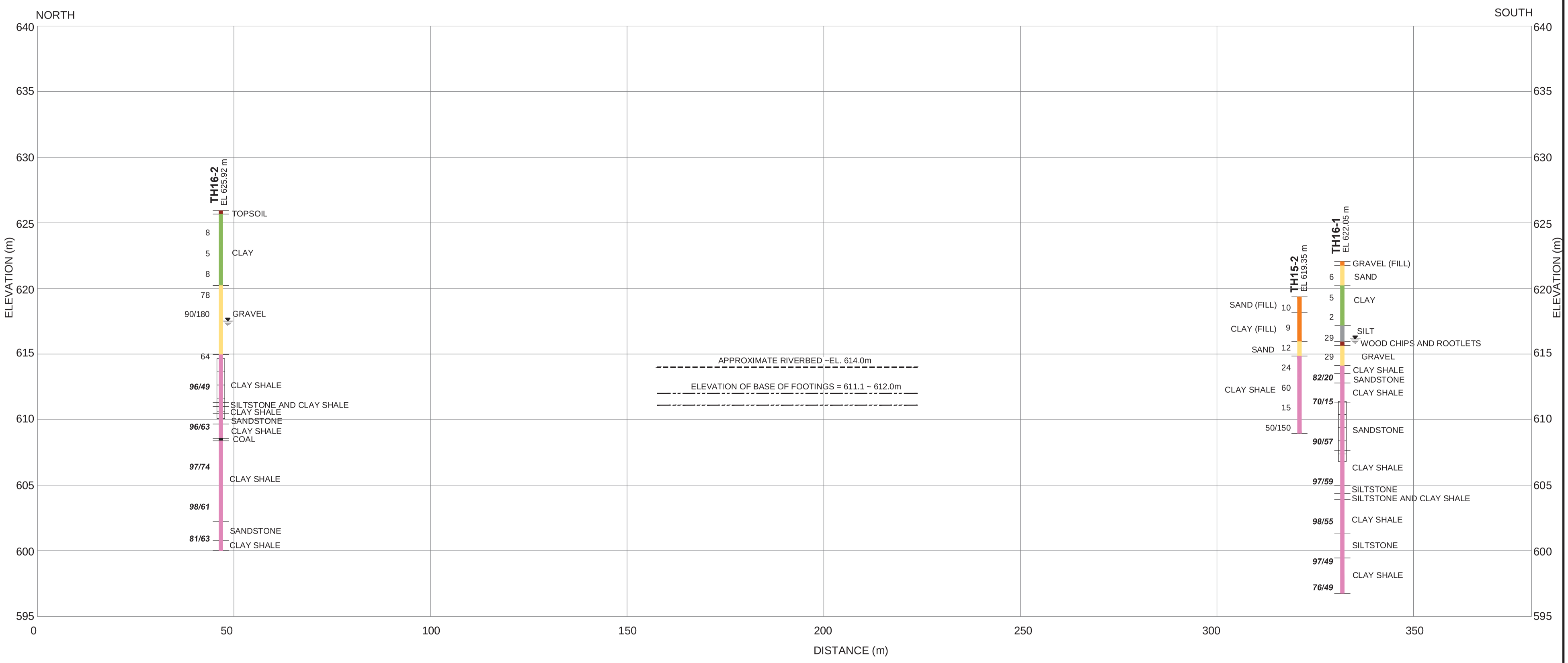

LEGEND

15 ▌ SPT N VALUE

13/38 ▌ RQD / RECOVERY %

▼ WATER LEVEL IN PIEZOMETER

▥ STANDPIPE PIEZOMETER SCREENED INTERVAL

NOTE

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

DIALOG

GROAT ROAD BRIDGE REHABILITATION

STRATIGRAPHIC CROSS - SECTION

DWG No. 10298-2

DRAWN BY	ML
DESIGNED BY	SEC
APPROVED BY	HER
SCALE	H 1:1000 V 1:300
DATE	JUNE 2016
FILE No.	10298

THURBER ENGINEERING LTD.

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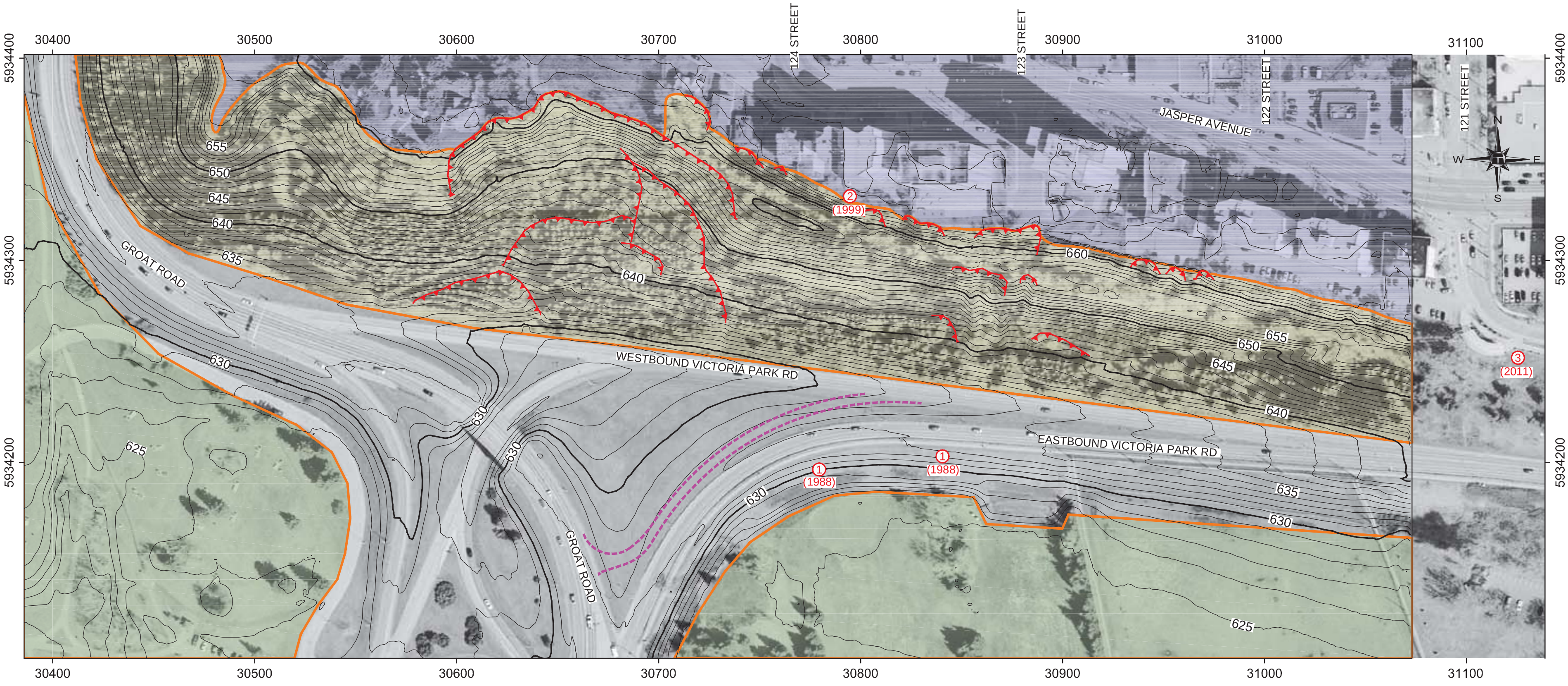

LEGEND

☐	ROADS, FILL
🟩	ALLUVIUM DEPOSITS
🟨	COLLUVIUM
🟪	GLACIOLACUSTRINE DEPOSITS; SILT, CLAY, SAND
▲▲▲▲	SCARP
630 ⁓	GROUND SURFACE (CONTOURS 1m)
① (1988)	SLOPE INSTABILITY REPORTED IN 1988
- - - -	PROPOSED WESTBOUND VICTORIA PARK ROAD TO NORTHBOUND GROAT ROAD RAMP

Reference:
L. A. Bayrock. Surficial Geology Edmonton. NTS 83H Alberta Research 1972.

0 20 40 60 80 100 120m
SCALE 1:2000

DIALOG™

GROAT ROAD BRIDGE REHABILITATION

SURFICIAL GEOLOGY MAP

DWG NO. 10298-3

DRAWN BY	ML
DESIGNED BY	MJB
APPROVED BY	HER
SCALE	1:2000
DATE	JUNE 2016
FILE No.	10298

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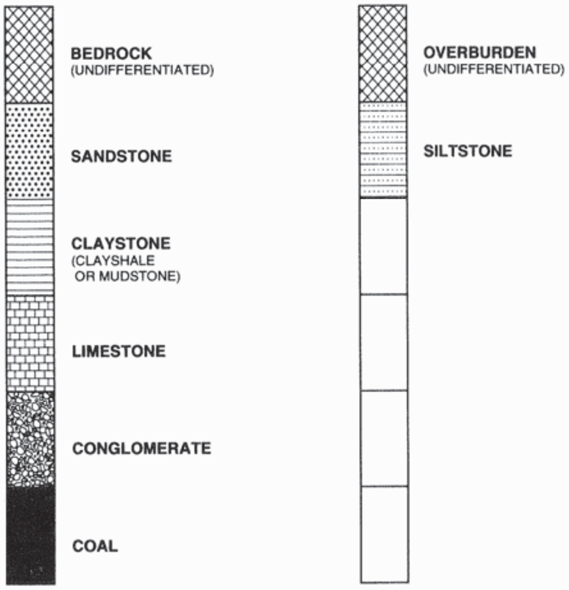
APPENDIX B

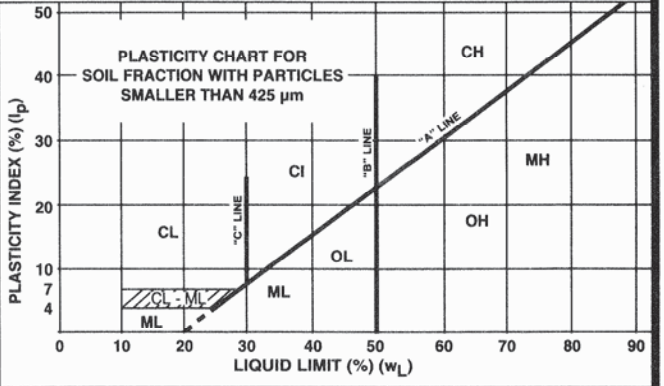
Modified Unified Soils Classification System
Symbols and Terms Used on the Test Hole Logs
Rock Material Description
Test Hole Logs (2016)
Test Hole Log (2015)

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	△▽△	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP	▲▼▲	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	▥	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	SW	⁘	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP	oooo	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	▦	SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	▩	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML	‖	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)		
		$w_L > 50\%$	MH	‖	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS			
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 30\%$	CL	▨	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS			
		$30\% < w_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS			
		$w_L > 50\%$	CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$w_L < 50\%$	OL	┆	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY			
		$w_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS			Pt	〰	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS





THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

Z:_Edmonton office\Soil_Rock classification\Symbols & Terms-2012.dwg

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from National Building Code	15 to 30
Hard	200 - 300 kPa		Greater than 30
Very Hard	Greater than 300 kPa		

* SPT 'N' Value Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from National Building Code
Dense	30 - 50	
Very Dense	Over 50	

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

◩	Shelby Tube	▤	A-Casing
⧄	SPT	▥	Grab
☒	No Recovery	◫	Core

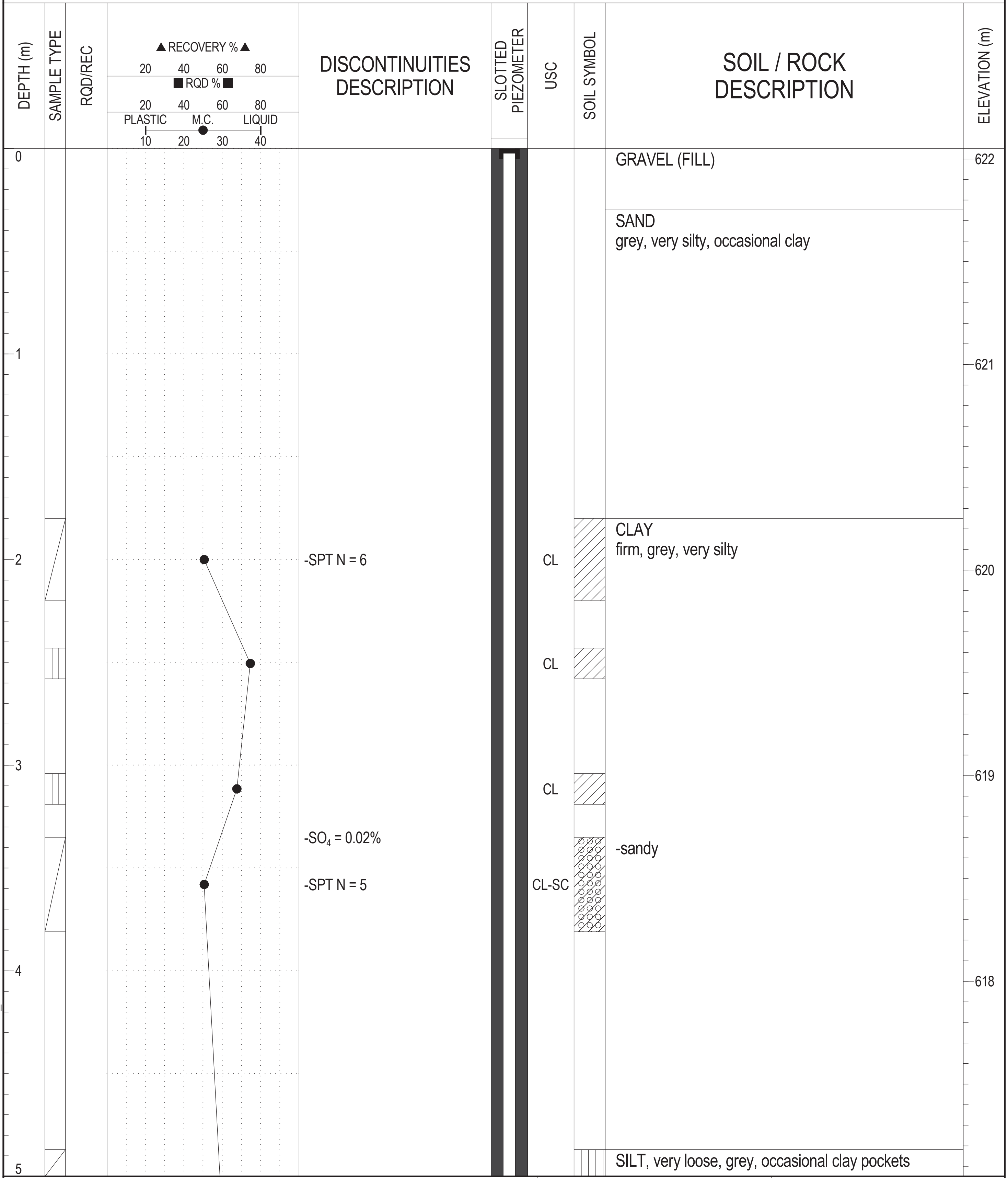
SYMBOLS USED FOR TEST HOLE LOGS

●		MC - Moisture Content (% by weight) of soil sample
▼		Water Level
■	SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲	CPen	Shear Strength determined by pocket penetrometer
	CVane	Shear Strength determined by pocket vane
	Cu	Undrained Shear Strength determined by unconfined compression test
	SO_4%	Percent (%) of water soluble sulphate ions

THURBER ENGINEERING LTD.

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 18, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933748.01, E30508.17	ELEVATION: 622.05 (m)

SAMPLE TYPE	▱ SPT	▥ GRAB SAMPLE	▮ CORE
BACKFILL TYPE	■ BENTONITE	▒ SAND	



DEPTH (m)	DISCONTINUITIES DESCRIPTION	USC	SOIL / ROCK DESCRIPTION
0			GRAVEL (FILL)
0.3			SAND grey, very silty, occasional clay
1.8			CLAY firm, grey, very silty
2	-SPT N = 6	CL	
2.5		CL	
3.1		CL	
3.3	-SO$_4$ = 0.02%		-sandy
3.6	-SPT N = 5	CL-SC	
4.9			SILT, very loose, grey, occasional clay pockets

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
PREPARED BY: SEC	COMPLETION DATE: 4/18/16
REVIEWED BY: HER	Page 1 of 6

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 18, 2016	PROJECT NO: 10298
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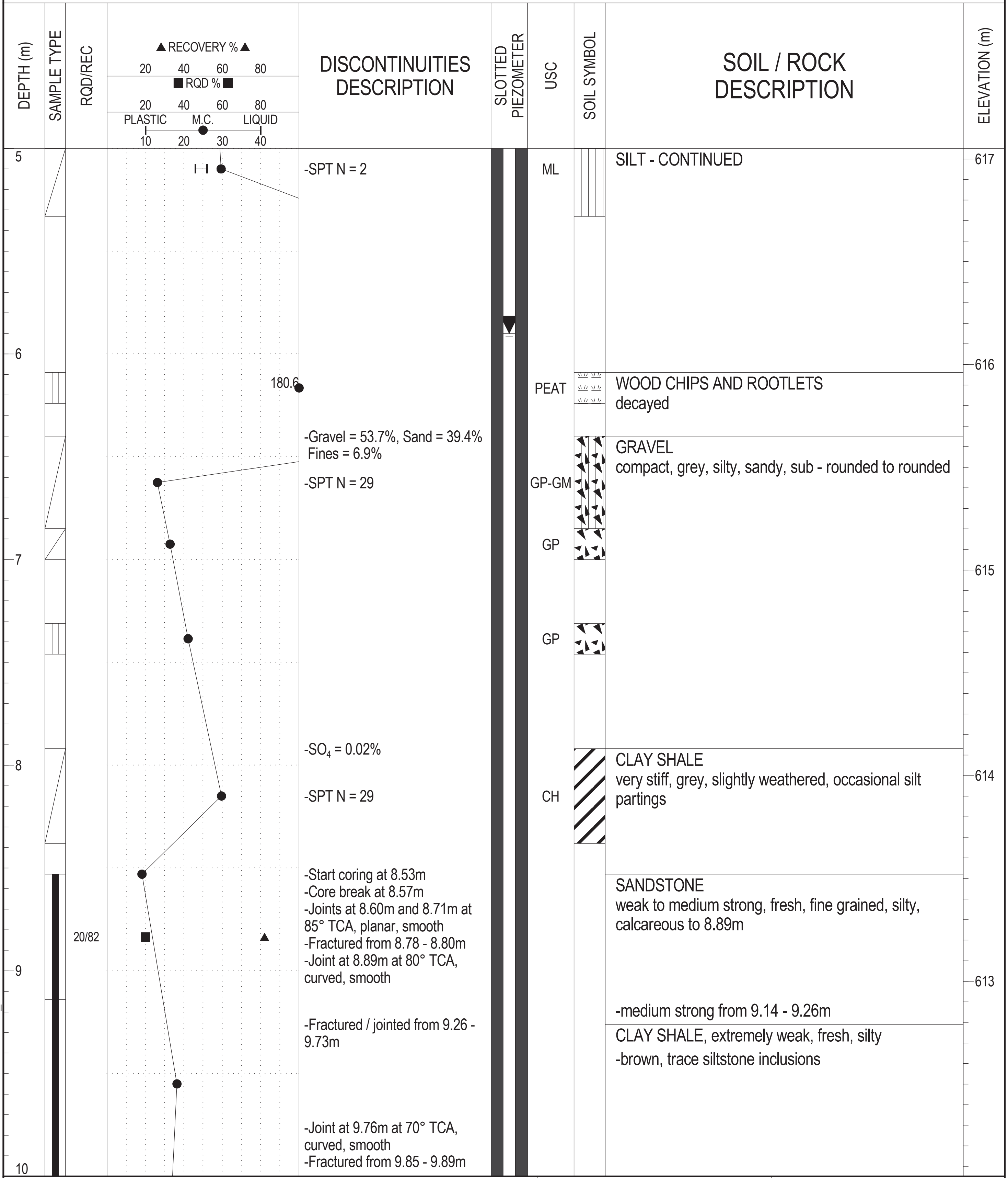
SAMPLE TYPE ▨ SPT ▥ GRAB SAMPLE ▮ CORE

BACKFILL TYPE ■ BENTONITE ░ SAND



DISCONTINUITIES DESCRIPTION

-SPT N = 2

-Gravel = 53.7%, Sand = 39.4%
Fines = 6.9%

-SPT N = 29

-SO_4 = 0.02%

-SPT N = 29

-Start coring at 8.53m
-Core break at 8.57m
-Joints at 8.60m and 8.71m at 85° TCA, planar, smooth
-Fractured from 8.78 - 8.80m
-Joint at 8.89m at 80° TCA, curved, smooth

-Fractured / jointed from 9.26 - 9.73m

-Joint at 9.76m at 70° TCA, curved, smooth
-Fractured from 9.85 - 9.89m

SOIL / ROCK DESCRIPTION

SILT - CONTINUED

WOOD CHIPS AND ROOTLETS
decayed

GRAVEL
compact, grey, silty, sandy, sub - rounded to rounded

CLAY SHALE
very stiff, grey, slightly weathered, occasional silt partings

SANDSTONE
weak to medium strong, fresh, fine grained, silty, calcareous to 8.89m

-medium strong from 9.14 - 9.26m

CLAY SHALE, extremely weak, fresh, silty
-brown, trace siltstone inclusions

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
PREPARED BY: SEC	COMPLETION DATE: 4/18/16
REVIEWED BY: HER	

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
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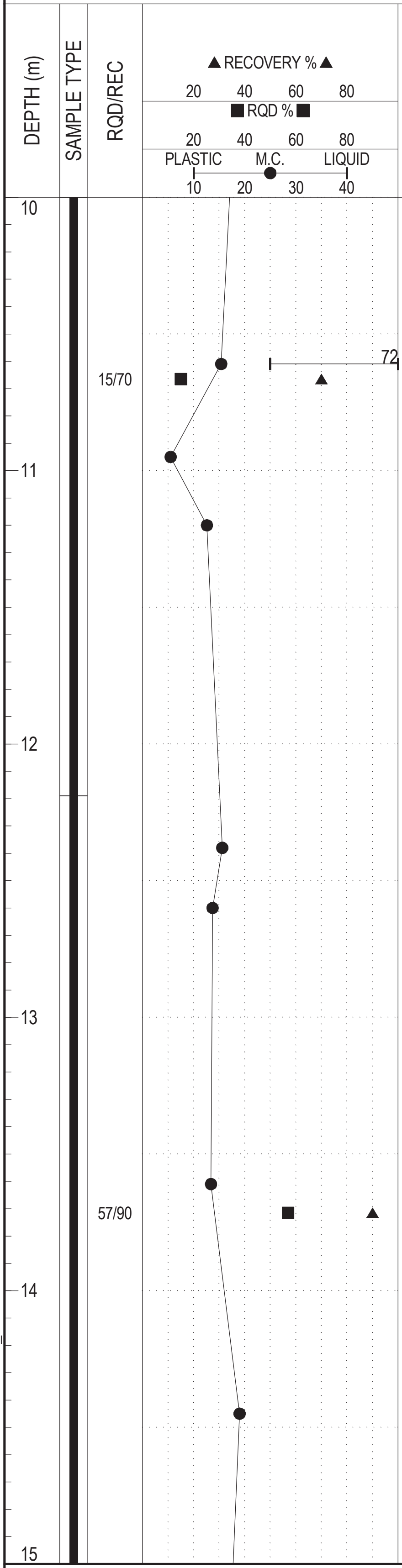
SAMPLE TYPE ▨ SPT ▥ GRAB SAMPLE ▮ CORE

BACKFILL TYPE ■ BENTONITE ░ SAND



DISCONTINUITIES DESCRIPTION	SOIL / ROCK DESCRIPTION	ELEVATION (m)
-Fractured / jointed from 10.00 - 10.10m -Joint at 10.10m at 70° TCA, planar, smooth -Fractured / rubbled from 10.21 - 10.55m and 10.66 - 10.69m	CLAY SHALE - CONTINUED	612
-Core break at 10.61m	-trace carbonaceous laminations	
-Joints from 10.75 - 10.95m at 5° TCA, curved, rough	SANDSTONE, medium strong, fresh, fine grained, cemented, calcareous to 11.08m	
-Joint at 10.95m at 85° TCA, irregular, rough -Joint at 11.08m at 85° TCA, planar, rough **-At 11.2m:** **Bulk unit weight = 21.1KN/m³** **Cu = 833kPa**	-extremely weak, bentonitic from 11.08 - 11.23m	611
	-very weak, bentonitic	610
-Core break at 12.38m		
-Joint at 12.51m at 80° TCA, planar, smooth **-At 12.6m:** **Bulk unit weight = 21.3KN/m³** **Cu = 1449kPa**	-trace thin coal laminations from 12.51 - 12.55m -cemented, calcareous from 12.64 - 12.83m	
-Fractured from 12.70 - 12.78m	Siltstone, weak, fresh	
-Core break at 12.86m -Joints from 12.95 - 13.05m at 10° TCA, curved, smooth	-extremely weak -cemented siltstone laminations	609
-Joint at 13.21m at 80° TCA, curved, smooth -Joint at 13.38m at 85° TCA, curved, smooth	-trace siltstone / coal laminations from 13.32 - 14.42m	
-Joint at 13.56m at 40° TCA, planar, smooth -Joint at 13.61m at 60° TCA, curved, smooth -Core break at 13.70m	Siltstone, medium strong, fresh, cemented	
	Siltstone, extremely weak, fresh, cemented	608
	-trace siltstone / coal inclusions	
-Rubble from 14.41 - 14.42m -Core break at 14.45m -Joint at 14.50m at 70° TCA	CLAY SHALE extremely weak, fresh, carbonaceous -greyish brown from 14.68 - 14.86m	

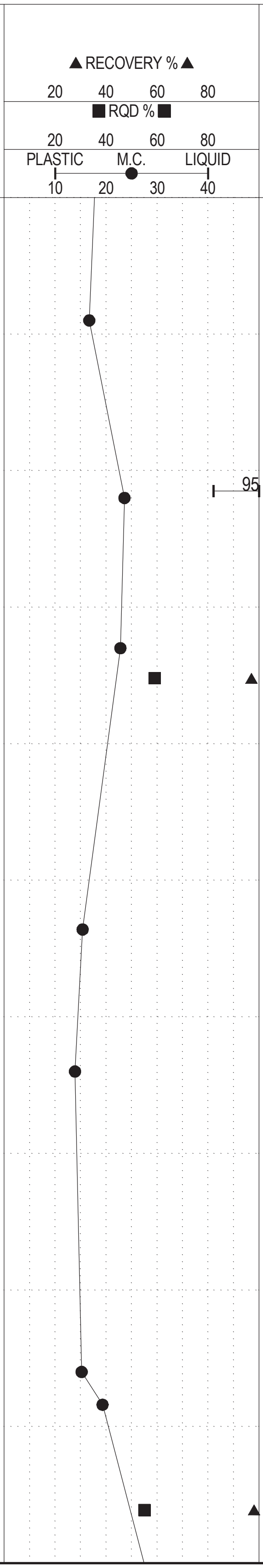
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
PREPARED BY: SEC	COMPLETION DATE: 4/18/16
REVIEWED BY: HER	

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 18, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933748.01, E30508.17	ELEVATION: 622.05 (m)

SAMPLE TYPE ▨ SPT ▥ GRAB SAMPLE ▮ CORE

BACKFILL TYPE ■ BENTONITE ░ SAND



DEPTH (m)	SAMPLE TYPE	RQD/REC	DISCONTINUITIES DESCRIPTION	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
15							CLAY SHALE - CONTINUED	607
			-Fractured from 15.34 - 15.44m				-trace coal inclusions	
			-Core break at 15.61m -Joint at 15.76m at 70° TCA					
16			-Core breaks at 15.99m and 17.06m **-At 16.1m:** **Bulk unit weight = 19.0KN/m^3** **Cu = 700kPa**				-highly carbonaceous with coal	606
		59/97					-greyish brown	
17							SILTSTONE extremely weak, fresh, trace clay shale laminations	605
			-Joint at 17.27m at 85° TCA, planar, smooth -Joint at 17.29m at 60° TCA, curved, smooth -Core breaks at 17.49m,17.67m, 17.79m, and 18.00m				-trace thin coal laminations from 17.58 - 17.64m	
							SILTSTONE AND CLAY SHALE INTERBEDDED, extremely weak, fresh	
18			-Joints from 18.06 - 18.20m at 20° TCA, curved, smooth					604
			-Joint at 18.28m at 40° TCA, curved, smooth -Core breaks at 18.33m, 18.43m, 18.47m, and 18.66m				CLAY SHALE extremely weak, fresh, brown -very weak -extremely weak, highly carbonaceous, some coal inclusions -very weak	
			-Fractured / jointed from 18.79 - 19.06m					
19			-Joint at 19.06m at 80° TCA, curved, smooth					603
			-Rubble from 19.21 - 19.23m -Joint at 19.23m at 70° TCA, curved, smooth **-At 19.3m:** **Bulk unit weight = 21.1KN/m^3** **Cu = 397kPa**				-slightly carbonaceous from 19.23 - 19.41m -brownish grey -siltstone laminations from 19.46 - 19.49m	
		55/98	-Core breaks at 19.41m, 19.58m, 19.66m, 19.77m, and 19.91m				-extremely weak, brown - grey, slightly bentonitic	
20								

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
	PREPARED BY: SEC	COMPLETION DATE: 4/18/16
	REVIEWED BY: HER	Page 4 of 6

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 18, 2016	PROJECT NO: 10298
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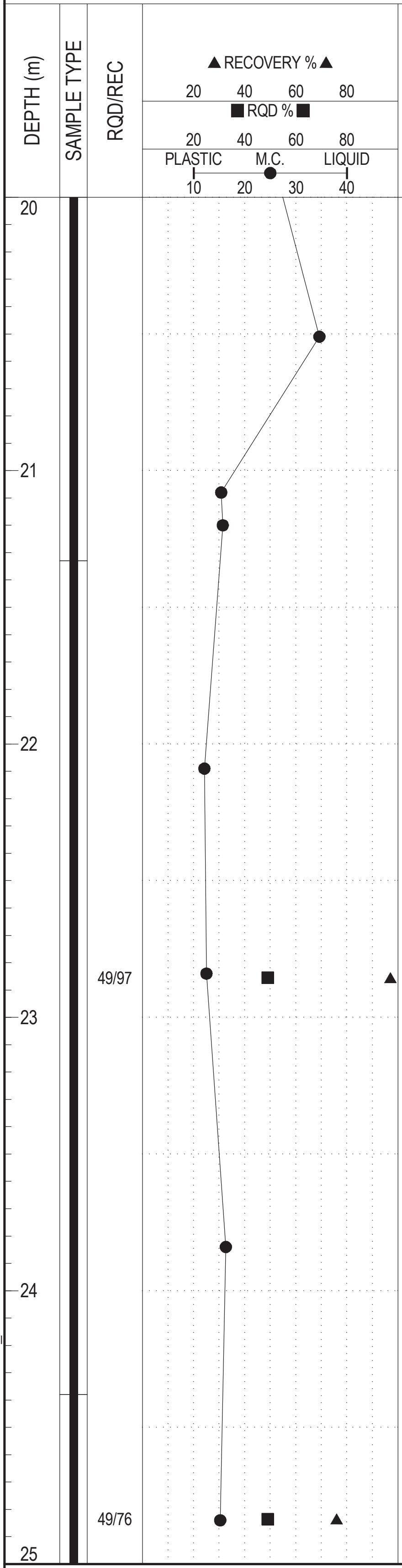
SAMPLE TYPE ▨ SPT ▥ GRAB SAMPLE ▮ CORE

BACKFILL TYPE ■ BENTONITE ░ SAND



DISCONTINUITIES DESCRIPTION

-Joint at 20.07m at 60° TCA, curved, smooth
-Joints from 20.24 - 20.33m at 15° TCA, planar, smooth
-Jointed from 20.47 - 20.51m
-Joint at 20.90m at 70° TCA, curved, smooth
-Joint at 20.95m at 50° TCA, curved, smooth
-Core breaks at 21.02m, 21.06m, 21.08m,and 21.43m
-**At 21.2m:**
Bulk unit weight = 22.1KN/m³
Cu = 2072kPa
-Joint at 21.77m at 70° TCA, curved, smooth
-Joint at 21.81m at 70° TCA, closed
-Core breaks at 22.09m and 22.19m
-Joints from 22.41 - 22.53m at 10° TCA, irregular, rough
-Fractured / jointed from 22.62 - 22.70m
-Joints from 22.70 - 22.84m at 30° TCA, curved, smooth
-Fractured from 22.84 - 23.20m
-Joint at 23.50m at 80° TCA, curved, smooth
-Joint at 23.59m at 60° TCA, curved, rough
-Core break at 23.62m
-Joint at 23.66m at 60° TCA, curved, smooth
-Joint at 23.80m at 80° TCA, curved, smooth
-Joint at 23.84m at 70° TCA, curved, rough
-Joint at 23.89m at 30° TCA, curved, rough
-Joint at 23.95m at 70° TCA, planar, smooth
-Joint at 23.99m at 80° TCA, curved, rough
-Joint at 24.05m at 30° TCA,

SLOTTED PIEZOMETER

USC

SOIL SYMBOL

SOIL / ROCK DESCRIPTION

CLAY SHALE - CONTINUED
-very weak, brown, silty from 20.11 - 20.45m

-highly bentonitic from 20.51 - 20.74m

-bentonite laminations from 20.74 - 20.76m

SILTSTONE, very weak, fresh, interbedded with clay shale laminations, trace cemented siltstone clasts

-interbedded with sandstone laminations

-cemented / calcareous from 22.34 - 22.56m

CLAY SHALE
very weak, fresh, brown, trace cemented siltstone inclusions

Coal, very weak, fresh

-extremely weak, grey - green, bentonitic

-very weak, slightly carbonaceous, trace coal inclusions

-brown - green

ELEVATION (m)
602
601
600
599
598

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
PREPARED BY: SEC	COMPLETION DATE: 4/18/16
REVIEWED BY: HER	Page 5 of 6

THURBER ENGINEERING LTD.

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-1**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 18, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933748.01, E30508.17	ELEVATION: 622.05 (m)

SAMPLE TYPE ▨ SPT ▥ GRAB SAMPLE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⬚ SAND

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲RECOVERY %▲ 20 40 60 80 ■RQD %■ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	DISCONTINUITIES DESCRIPTION	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
25	▮			curved, smooth -Joint at 24.14m at 80° TCA, planar, smooth -Joint at 24.27m at 70° TCA, curved, smooth -Joint at 24.38m at 60° TCA, stepped, smooth -Joint at 24.47m at 85° TCA, planar, smooth -Core break at 24.67m -Joint at 24.76m at 70° TCA, undulating, smooth -Core breaks at 24.81m, 24.86m, and 24.97m	■			CLAY SHALE - CONTINUED	597
								END OF TEST HOLE AT 25.3m UPON COMPLETION: Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -May 3, 2016 = 5.8m -May 18, 2016 = 5.9m	
26									596
27									595
28									594
29									593
30									

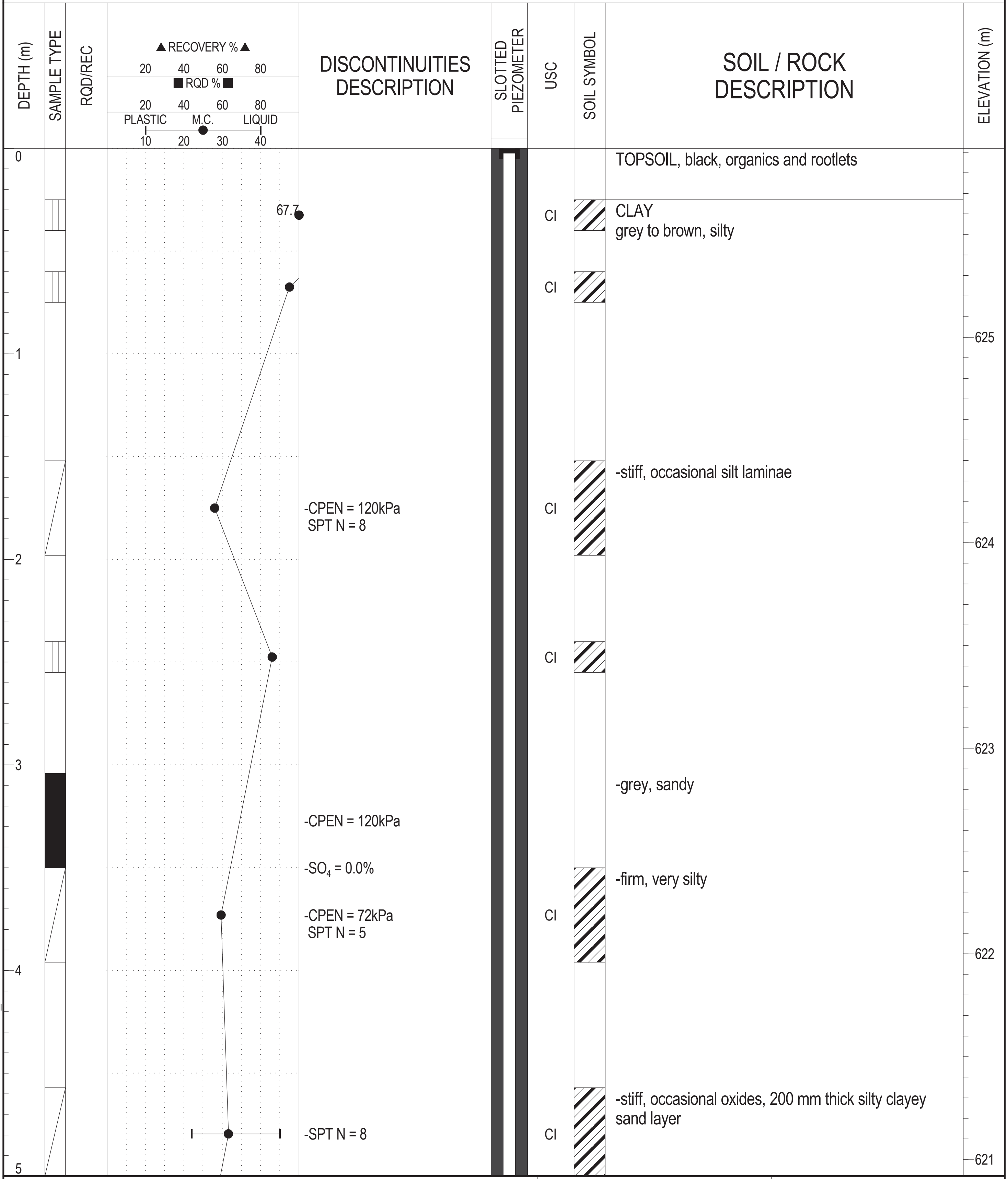
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.3 m
PREPARED BY: SEC	COMPLETION DATE: 4/18/16
REVIEWED BY: HER	Page 6 of 6

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE ◧ CORE

BACKFILL TYPE ■ BENTONITE ░ SAND



TOPSOIL, black, organics and rootlets

CLAY
grey to brown, silty

-stiff, occasional silt laminae

-CPEN = 120kPa
SPT N = 8

-grey, sandy

-CPEN = 120kPa

-SO$_4$ = 0.0%

-firm, very silty

-CPEN = 72kPa
SPT N = 5

-stiff, occasional oxides, 200 mm thick silty clayey sand layer

-SPT N = 8

BOREHOLE LOG 10298-ROCK.GPJ THRBR_AB.GDT 7/21/16- REGULAR LIBRARY-ROCK - VW.GLB

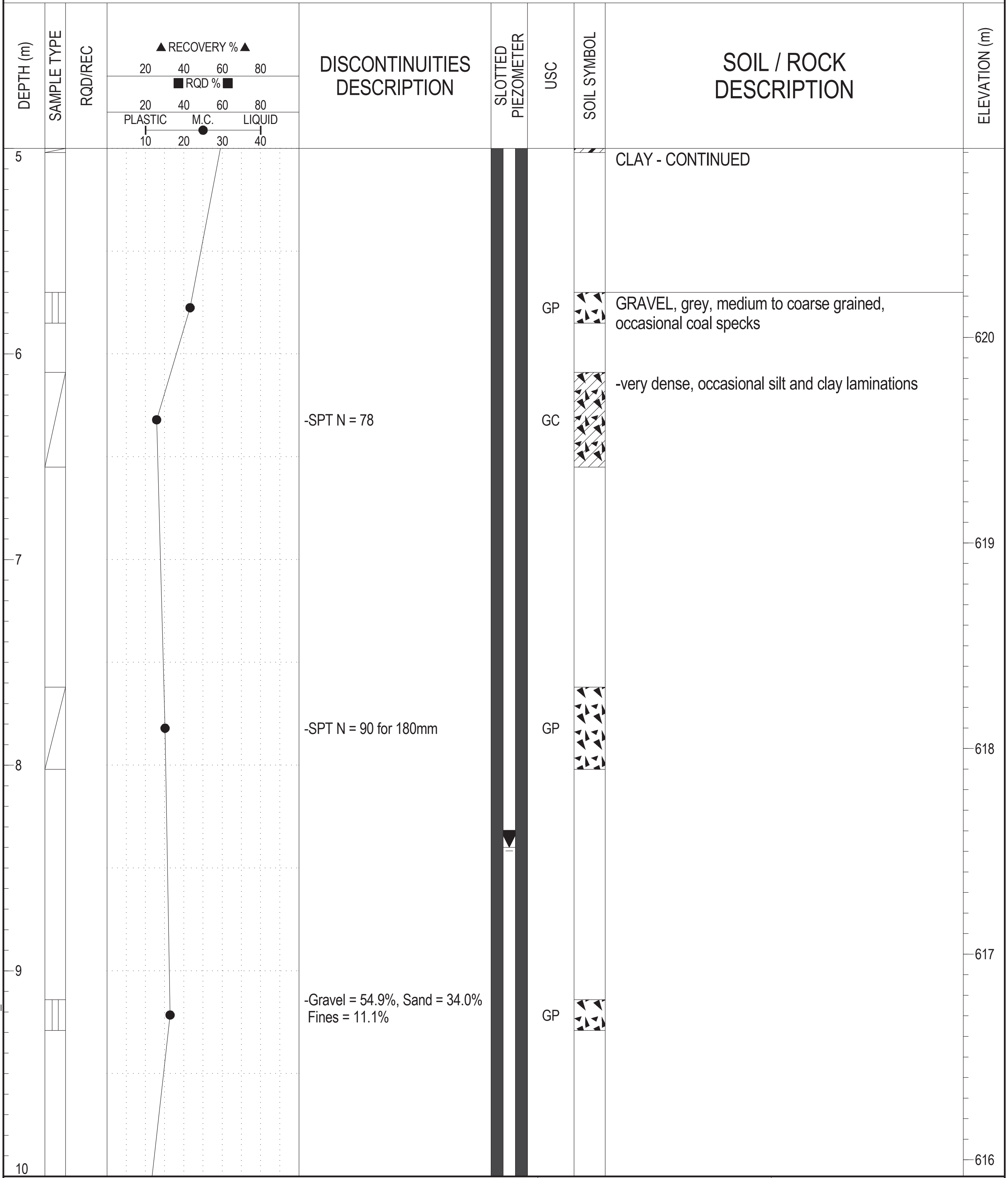
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
PREPARED BY: SEC	COMPLETION DATE: 4/19/16
REVIEWED BY: HER	

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ◧ CORE

BACKFILL TYPE: ■ BENTONITE ▨ SAND



DEPTH (m)	DISCONTINUITIES DESCRIPTION	USC	SOIL / ROCK DESCRIPTION
5			CLAY - CONTINUED
		GP	GRAVEL, grey, medium to coarse grained, occasional coal specks
	-SPT N = 78	GC	-very dense, occasional silt and clay laminations
	-SPT N = 90 for 180mm	GP	
	-Gravel = 54.9%, Sand = 34.0% Fines = 11.1%	GP	

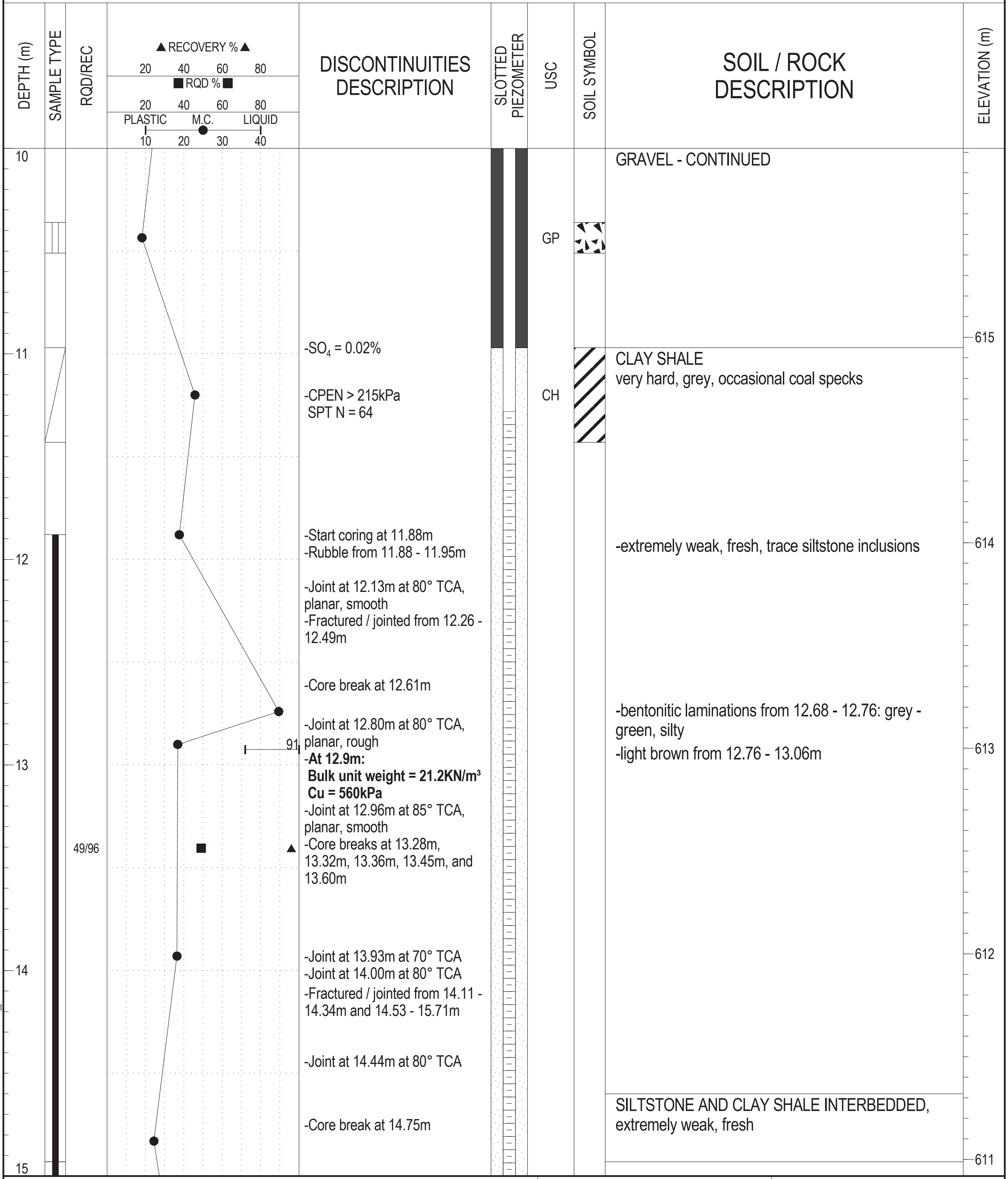
FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
PREPARED BY: SEC	COMPLETION DATE: 4/19/16
REVIEWED BY: HER	Page 2 of 6

THURBER ENGINEERING LTD.

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ▨ SAND



DISCONTINUITIES DESCRIPTION

-SO_4 = 0.02%

-CPEN > 215kPa
SPT N = 64

-Start coring at 11.88m
-Rubble from 11.88 - 11.95m

-Joint at 12.13m at 80° TCA, planar, smooth
-Fractured / jointed from 12.26 - 12.49m

-Core break at 12.61m

-Joint at 12.80m at 80° TCA, planar, rough
-**At 12.9m:**
Bulk unit weight = 21.2KN/m³
Cu = 560kPa
-Joint at 12.96m at 85° TCA, planar, smooth
-Core breaks at 13.28m, 13.32m, 13.36m, 13.45m, and 13.60m

-Joint at 13.93m at 70° TCA
-Joint at 14.00m at 80° TCA
-Fractured / jointed from 14.11 - 14.34m and 14.53 - 15.71m

-Joint at 14.44m at 80° TCA

-Core break at 14.75m

SOIL / ROCK DESCRIPTION

GRAVEL - CONTINUED

CLAY SHALE
very hard, grey, occasional coal specks

-extremely weak, fresh, trace siltstone inclusions

-bentonitic laminations from 12.68 - 12.76: grey - green, silty
-light brown from 12.76 - 13.06m

SILTSTONE AND CLAY SHALE INTERBEDDED, extremely weak, fresh

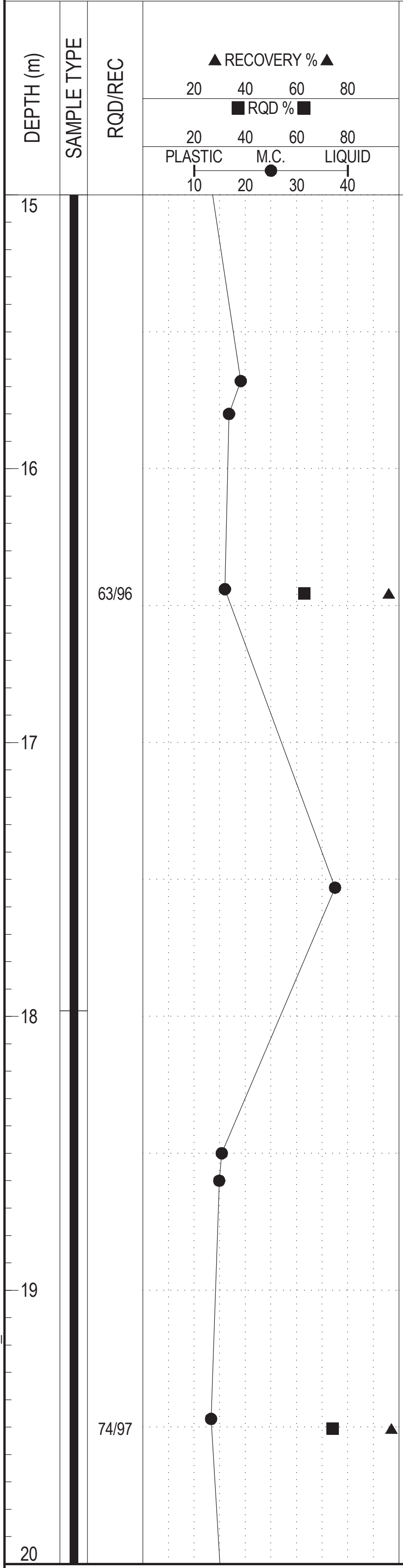
FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
PREPARED BY: SEC	COMPLETION DATE: 4/19/16
REVIEWED BY: HER	Page 3 of 6

THURBER ENGINEERING LTD.

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ▨ SAND



DISCONTINUITIES DESCRIPTION

-Joint at 15.10m at 60° TCA

-Core breaks at 15.41m, 15.68m, 15.70m, 15.93m, and 16.44m

-**At 15.8m:**
Bulk unit weight = 21.4KN/m³
Cu = 414kPa

-Joint at 16.58m at 80° TCA, planar, smooth

-Joint at 16.78m at 70° TCA, curved, rough

-Rubble from 16.92 - 16.98m

-Joint at 17.06m at 70° TCA, curved, smooth

-Joint at 17.17m at 80° TCA, planar, smooth

-Core break at 17.29m

-Joint at 17.35m at 70° TCA, curved, smooth

-Rubble from 17.35 - 17.53m

-Core break at 17.59m

-Fractured from 17.70 - 17.85m

-Joints at 18.29m, 18.38m, 18.50m, and 18.72m at 80° TCA

-**At 18.6m:**
Bulk unit weight = 21.5KN/m³
Cu = 1661kPa

-Joint at 18.91m at 70° TCA, irregular, rough

-Joint at 18.98m at 80° TCA, curved, smooth

-Joint at 19.23m at 80° TCA, planar, smooth

-Core breaks at 19.47m, 19.75m, 19.89m, and 20.22m

SLOTTED PIEZOMETER | USC | SOIL SYMBOL

SOIL / ROCK DESCRIPTION

CLAY SHALE, extremely weak, fresh, brown, trace siltstone / sandstone inclusions and siltstone clasts

SANDSTONE
extremely weak, fresh, fine grained, silty, bentonitic, trace clay shale laminations and thin coal laminations

CLAY SHALE
extremely weak, fresh, brown

COAL
extremely weak, fresh

CLAY SHALE, very weak, fresh, highly carbonaceous, some coal

-trace bentonite lenses

-brown, trace coal inclusions and siltstone clasts

Siltstone, very weak, fresh, cemented

-grey, trace siltstone clasts and coal inclusions from 19.47 - 20.50m

ELEVATION (m)

610
609
608
607
606

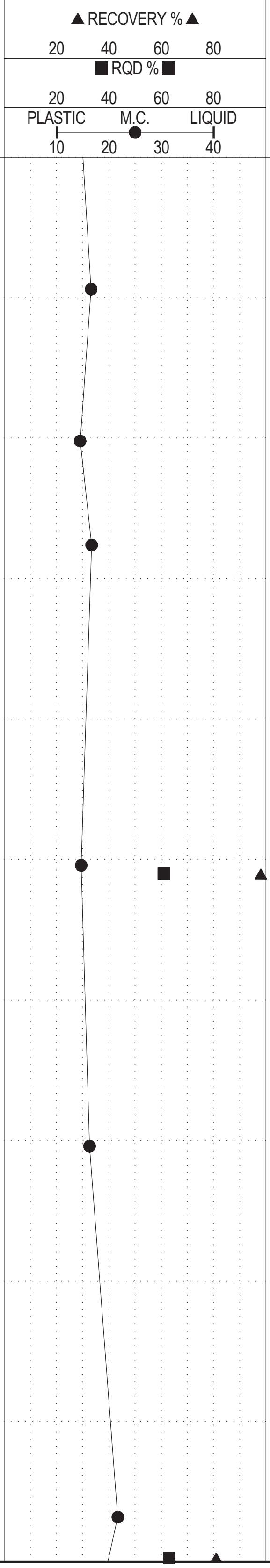
THURBER ENGINEERING LTD.	FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
	PREPARED BY: SEC	COMPLETION DATE: 4/19/16
	REVIEWED BY: HER	Page 4 of 6

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE ◧ CORE

BACKFILL TYPE: ■ BENTONITE ░ SAND

DEPTH (m)	SAMPLE TYPE	RQD/REC	DISCONTINUITIES DESCRIPTION	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
20	CORE			■			CLAY SHALE - CONTINUED	
			-Joint at 20.30m at 60° TCA, curved, rough, slickensided -Joint at 20.38m at 60° TCA, curved, smooth -Joint at 20.47m at 50° TCA, curved, smooth -Core break at 20.60m -Joint at 20.84m at 80° TCA, curved, smooth -Joints at 20.93m and 21.38m at 70° TCA, stepped, smooth				Siltstone, medium strong, fresh, cemented	605
21							-trace siltstone and coal inclusions	
			-Fractured / jointed from 21.78 - 21.98m -Joint at 21.84m at 50° TCA, curved, smooth -Joint at 21.93m at 40° TCA, curved, smooth -Joints from 21.98 - 22.15m at 10° TCA, irregular, rough				-carbonaceous	
22							-highly carbonaceous from 21.98 - 22.15m	604
		61/98	-Joint at 22.16m at 80° TCA, planar, rough -Joints from 22.16 - 22.31m at 15° TCA, closed -Joint at 22.33m at 60° TCA, curved, smooth -Joints from 22.37 - 22.52m at 25° TCA, curved, smooth -Core break at 22.60m -Joint at 22.64m at 60° TCA, undulating, smooth				Sandstone very weak, fresh, fine grained, bentonitic, trace coal inclusions and clay shale / siltstone laminations	603
23			-Joint at 23.20m at 80° TCA, planar, smooth -Core break at 23.25m -Joint at 23.52m at 80° TCA, curved, rough -Joint at 23.89m at 80° TCA				SANDSTONE very weak, fresh, fine grained, bentonitic, trace thin coal laminations	602
24			-Core break at 24.27m				-trace siltstone inclusions and clay shale laminations -calcareous from 24.27 - 24.43m	
			-Joint at 24.63m at 85° TCA, planar, smooth -Joint at 24.84m at 70° TCA, curved, rough					601
25								



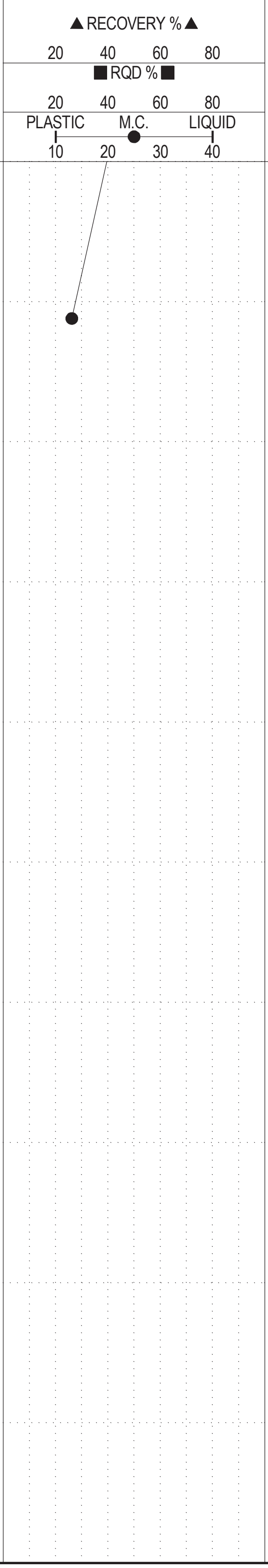
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
PREPARED BY: SEC	COMPLETION DATE: 4/19/16
REVIEWED BY: HER	Page 5 of 6

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-2**
DRILLING COMPANY: Garritty & Baker	DATE DRILLED: April 19, 2016	PROJECT NO: 10298
DRILL/METHOD: Wet Rotary / Coring	LOCATION: N5933991.67, E30656.47	ELEVATION: 625.92 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE ▮ CORE

BACKFILL TYPE: ■ BENTONITE ⬚ SAND



DEPTH (m)	SAMPLE TYPE	RQD/REC	DISCONTINUITIES DESCRIPTION	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
25	▮	63/81	-Joints from 24.99 - 25.12m at 5° TCA, closed -Fractured / jointed from 25.12 - 25.22m -Joint at 25.56m at 40° TCA, curved, smooth	■			-medium strong, cemented, calcareous from 24.99 - 25.12m CLAY SHALE, very weak, fresh, brown - grey -cemented siltstone clasts	
26							END OF TEST HOLE AT 25.9m UPON COMPLETION: Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -May 3, 2016 = 7.9m -May 18, 2016 = 8.4m	600
27								599
28								598
29								597
30								596

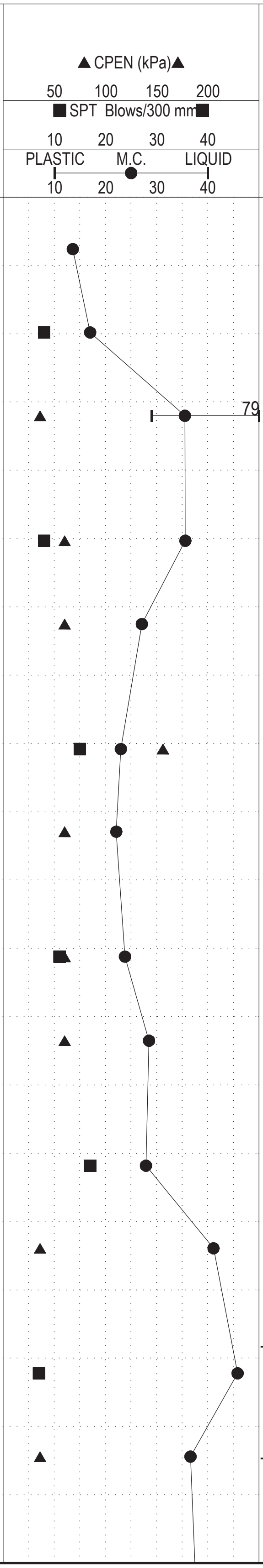
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NR	COMPLETION DEPTH: 25.9 m
PREPARED BY: SEC	COMPLETION DATE: 4/19/16
REVIEWED BY: HER	

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-3**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5934185, E30710.99	ELEVATION: 632.22 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ▨ DRILL CUTTINGS ▥ SLOUGH



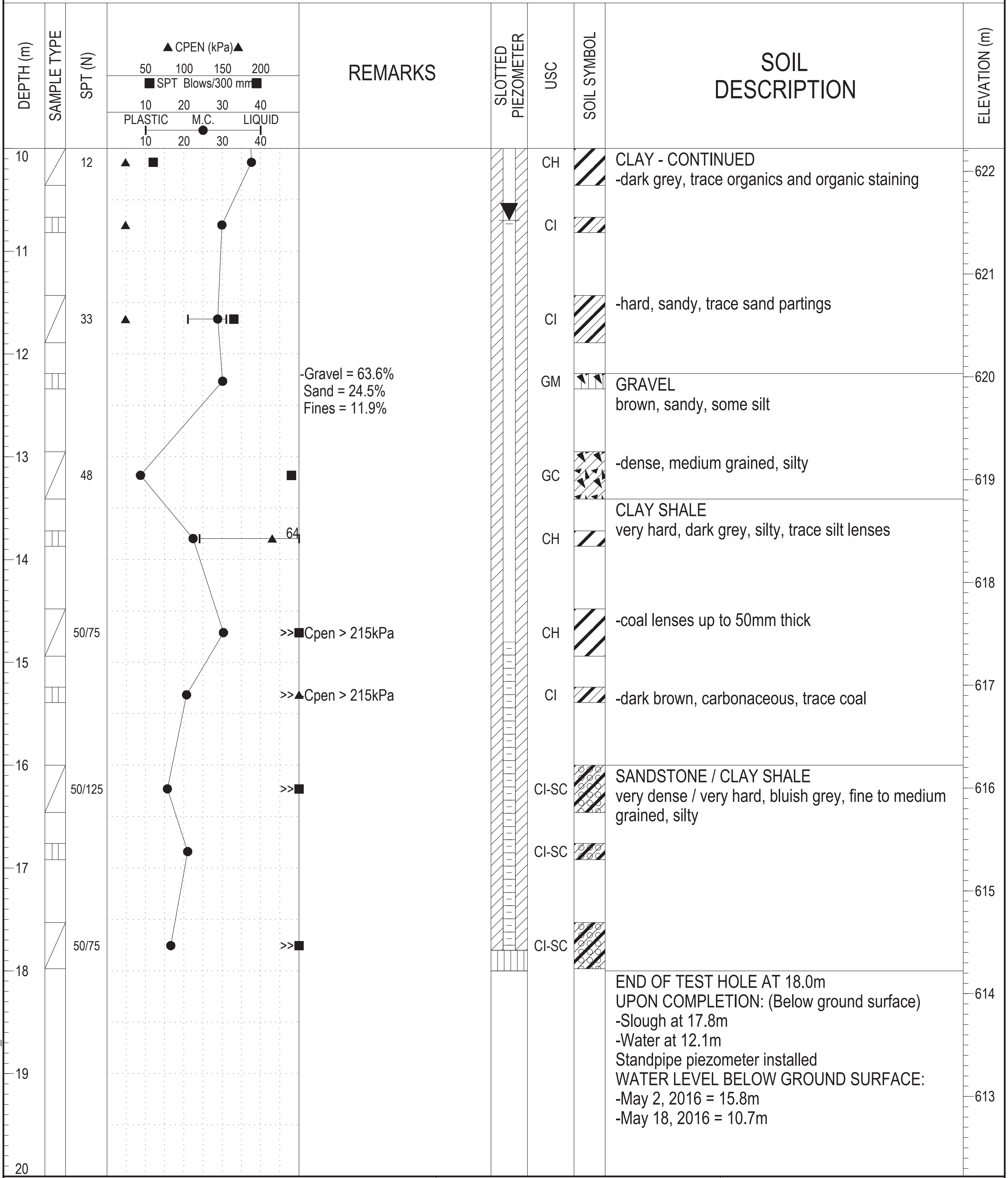
DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL DESCRIPTION	ELEVATION (m)
0						TOPSOIL	632
	GRAB				CI	CLAY (FILL) dark brown, silty, some sand, trace oxides and gravel	
1	SPT	8			CI	-stiff	631
	GRAB				CH	-trace sand	
2							630
	SPT	8			CH		
3	GRAB				CI-CH	-some sand, trace organic staining	629
4	SPT	15			CH	-very stiff, dark grey - dark brown	628
	GRAB				CI-CH	-brown, some silt lenses and high plastic clay lenses	
5							627
	SPT	11			CI	-stiff	
6	GRAB				CI	-trace high plastic clay lenses	626
7	SPT	17			CI	-very stiff, brown - grey, some high plastic clay lenses, trace topsoil lenses	625
	GRAB				CI	CLAY bluish grey, silty	
8							624
	SPT	7	-Seepage		CI-SM	Calcareous, firm, whitish brown, some oxide staining, weathered	
9						-stiff, brown, silty, trace oxides	
	GRAB		-SO_4 = 0.02%		CH		623
10	SPT						

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 18.0 m
	PREPARED BY: SEC	COMPLETION DATE: 5/2/16
	REVIEWED BY: HER	

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-3**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5934185, E30710.99	ELEVATION: 632.22 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT

BACKFILL TYPE ▨ DRILL CUTTINGS ▥ SLOUGH



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
12		CH	CLAY - CONTINUED -dark grey, trace organics and organic staining
		CI	
33		CI	-hard, sandy, trace sand partings
	-Gravel = 63.6% Sand = 24.5% Fines = 11.9%	GM	GRAVEL brown, sandy, some silt
48		GC	-dense, medium grained, silty
		CH	CLAY SHALE very hard, dark grey, silty, trace silt lenses
50/75	>>■Cpen > 215kPa	CH	-coal lenses up to 50mm thick
	>>▲Cpen > 215kPa	CI	-dark brown, carbonaceous, trace coal
50/125	>>■	CI-SC	SANDSTONE / CLAY SHALE very dense / very hard, bluish grey, fine to medium grained, silty
		CI-SC	
50/75	>>■	CI-SC	

END OF TEST HOLE AT 18.0m
UPON COMPLETION: (Below ground surface)
-Slough at 17.8m
-Water at 12.1m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-May 2, 2016 = 15.8m
-May 18, 2016 = 10.7m

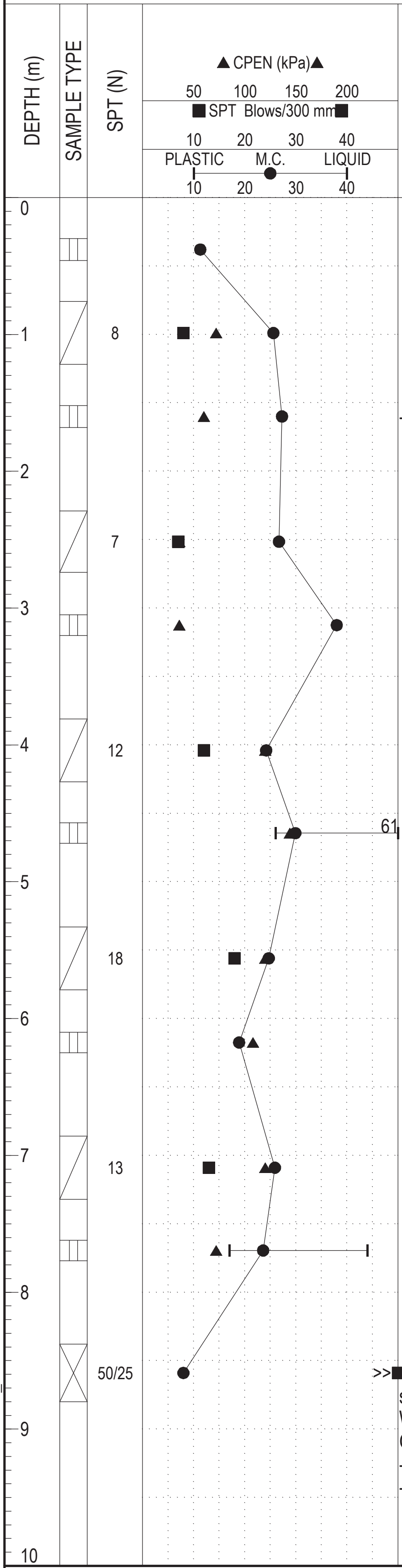
THURBER ENGINEERING LTD.

FIELD LOGGED BY: NNM	COMPLETION DEPTH: 18.0 m
PREPARED BY: SEC	COMPLETION DATE: 5/2/16
REVIEWED BY: HER	Page 2 of 2

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-4**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5934216, E30756.97	ELEVATION: 632.76 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ▥ SLOUGH



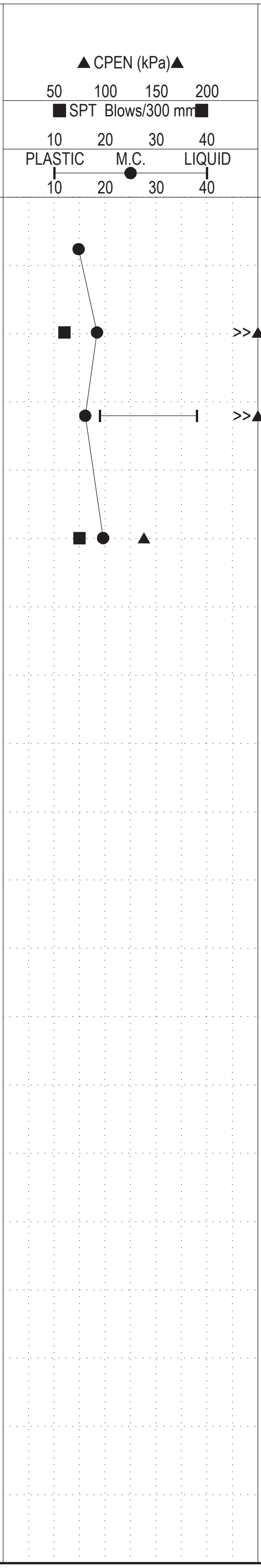
SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
			TOPSOIL	
		CI	CLAY (FILL), dark brown, sandy, silty, some topsoil, trace gravel	
8		CH	-stiff, brown, some sand	632
	-SO_4 = 0.42%	CH		631
7		CH	-firm	630
		CH	-trace sand	
12		CH	-stiff, trace high plastic clay pockets	629
		CH	-some sand, trace organics and organic staining	628
18		CH	-very stiff, some organic staining, trace rootlets	627
		CI-CH	-trace organic staining	626
13		CH	-stiff, trace topsoil lenses	
		CI	CLAY (TILL) brown, silty, some sand, trace oxides and gravel	625
50/25	>>■No recovery in SPT, grab sample taken	CI	SILTSTONE / CLAY SHALE, very hard, light grey	624
	WATER LEVEL BELOW GROUND SURFACE: -May 2, 2016 = Dry -May 18, 2016 = Dry		AUGER REFUSAL AT 8.8m UPON COMPLETION: (Below ground surface) -Slough at 8.4m Standpipe piezometer installed	623

SLOTTED PIEZOMETER

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 8.8 m
	PREPARED BY: SEC	COMPLETION DATE: 5/2/16
	REVIEWED BY: HER	Page 1 of 1

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-5**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5934038, E30698.15	ELEVATION: 630.45 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT

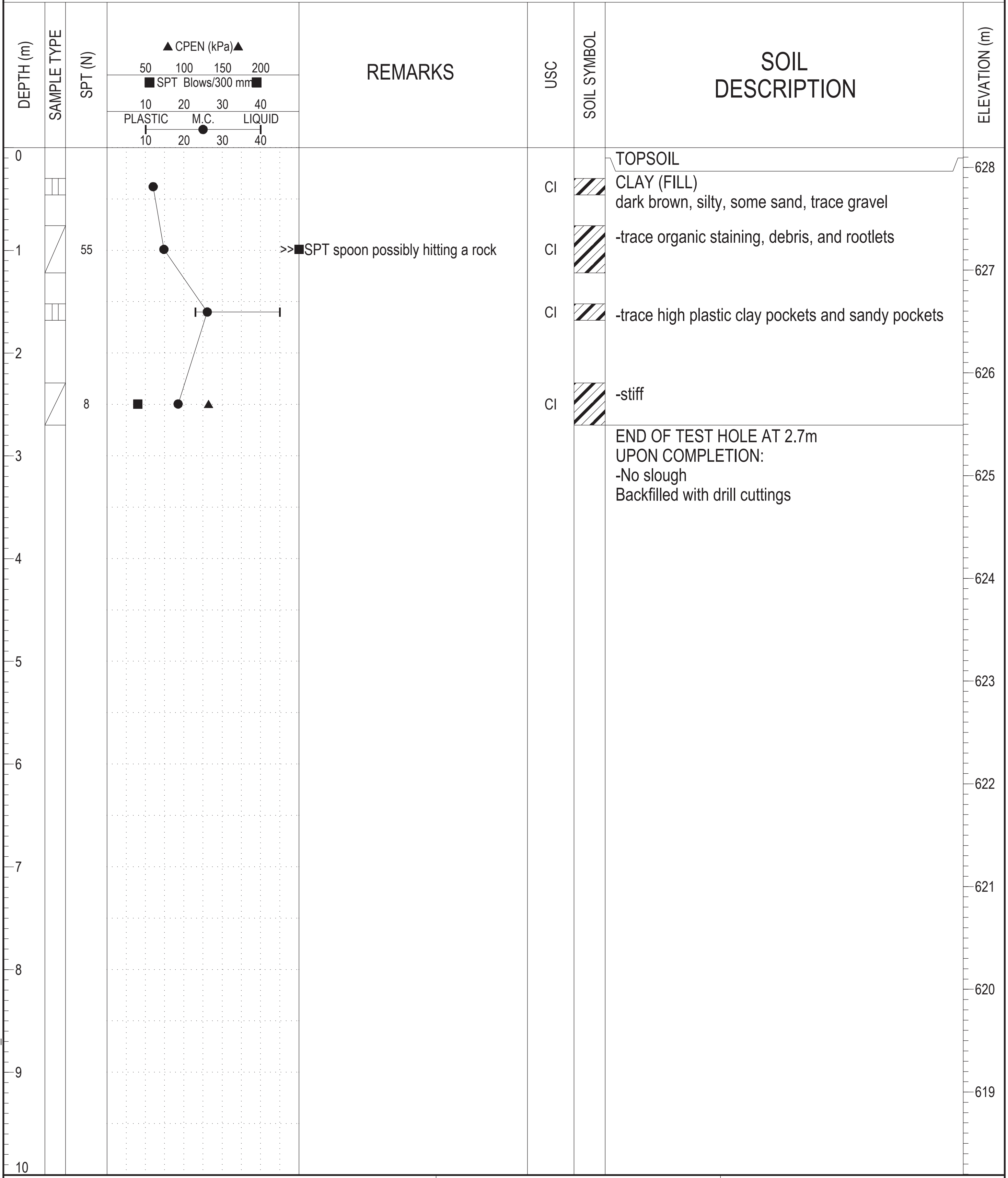


DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0						TOPSOIL	
	▥			CI	▨	CLAY (FILL) brown, silty, some sand	630
1	◺	12	>>▲Cpen > 215kPa	CI	▨	-stiff, trace organic stains and gravel	
	▥		>>▲Cpen > 215kPa	CI	▨		629
2							
	◺	15		CI	▨	-very stiff	628
						END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough Backfilled with drill cuttings	
3							627
4							626
5							625
6							624
7							623
8							622
9							621
10							

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 2.7 m
	PREPARED BY: SEC	COMPLETION DATE: 5/2/16
	REVIEWED BY: HER	Page 1 of 1

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-6**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5933994, E30732.26	ELEVATION: 628.19 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT



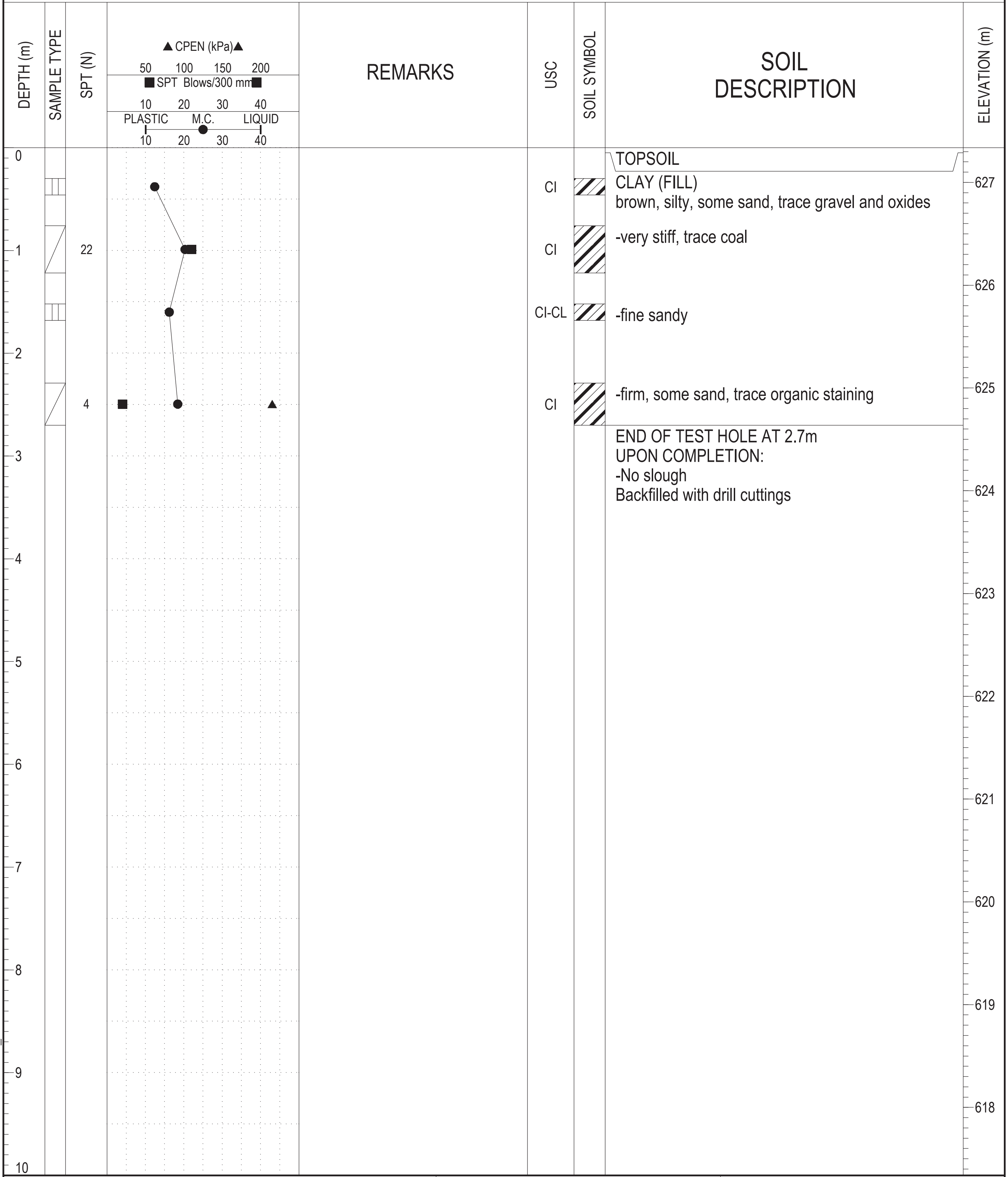
SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
				TOPSOIL
GRAB SAMPLE			CI	CLAY (FILL) dark brown, silty, some sand, trace gravel
SPT	55	>>■SPT spoon possibly hitting a rock	CI	-trace organic staining, debris, and rootlets
GRAB SAMPLE			CI	-trace high plastic clay pockets and sandy pockets
SPT	8		CI	-stiff

END OF TEST HOLE AT 2.7m
UPON COMPLETION:
-No slough
Backfilled with drill cuttings

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 2.7 m
	PREPARED BY: SEC	COMPLETION DATE: 5/2/16
	REVIEWED BY: HER	Page 1 of 1

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-7**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5933945, E30746.52	ELEVATION: 627.34 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT



SPT (N)	USC	SOIL DESCRIPTION
		TOPSOIL
	CI	CLAY (FILL) brown, silty, some sand, trace gravel and oxides
22	CI	-very stiff, trace coal
	CI-CL	-fine sandy
4	CI	-firm, some sand, trace organic staining

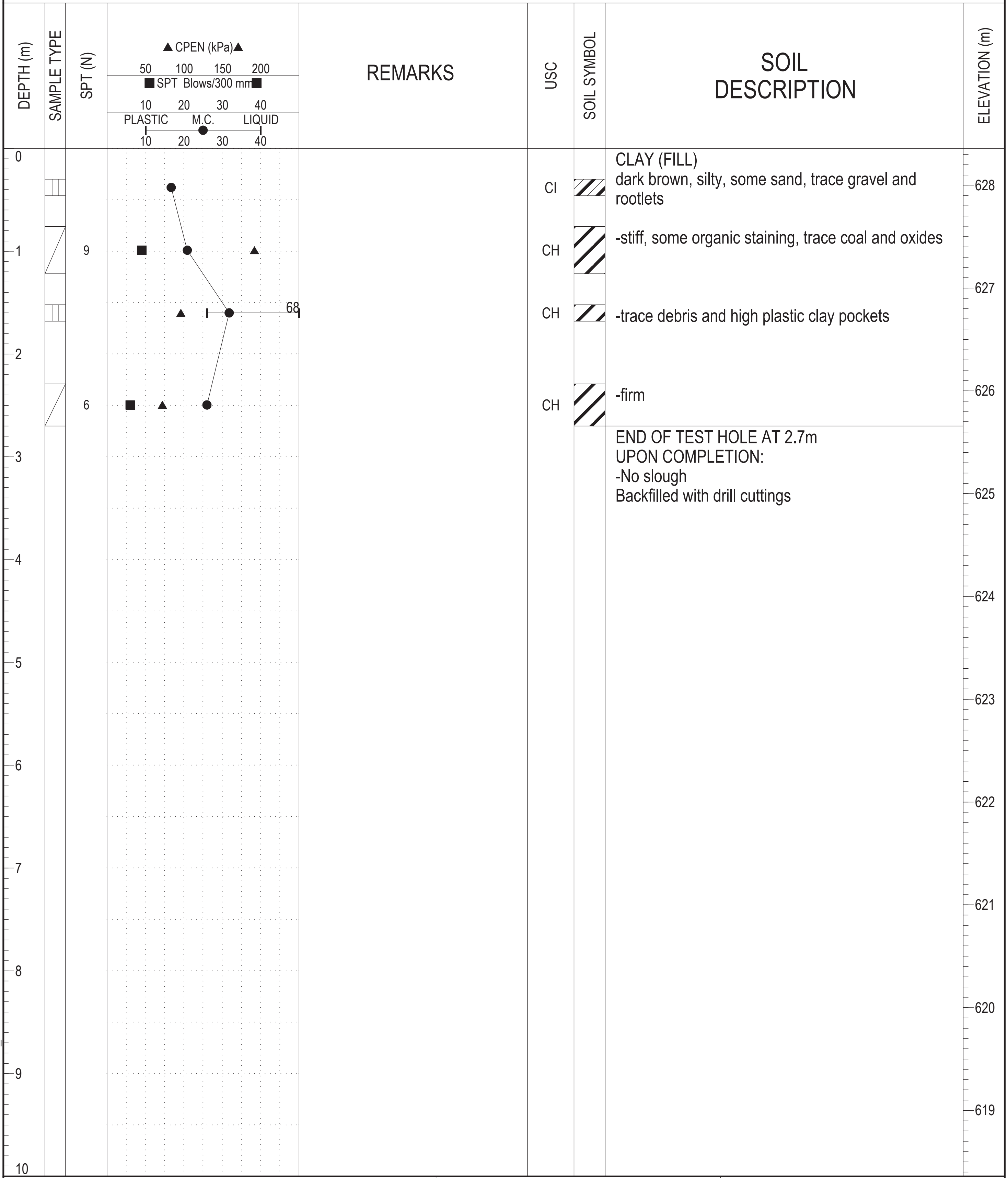
END OF TEST HOLE AT 2.7m
UPON COMPLETION:
-No slough
Backfilled with drill cuttings

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NNM	COMPLETION DEPTH: 2.7 m
PREPARED BY: SEC	COMPLETION DATE: 5/2/16
REVIEWED BY: HER	Page 1 of 1

CLIENT: DIALOG	PROJECT: Groat Road River Bridge Rehabilitiation & Associated Road Work	BOREHOLE NO: **TH16-8**
DRILLING COMPANY: ALL SERVICE DRILLING INC	DATE DRILLED: May 2, 2016	PROJECT NO: 10298
DRILL/METHOD: D50 T / Solid Stem Augers	LOCATION: N5934117, E30599.56	ELEVATION: 628.36 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT



SPT (N)	USC	SOIL DESCRIPTION
	CI	CLAY (FILL) dark brown, silty, some sand, trace gravel and rootlets
9	CH	-stiff, some organic staining, trace coal and oxides
	CH	-trace debris and high plastic clay pockets
6	CH	-firm

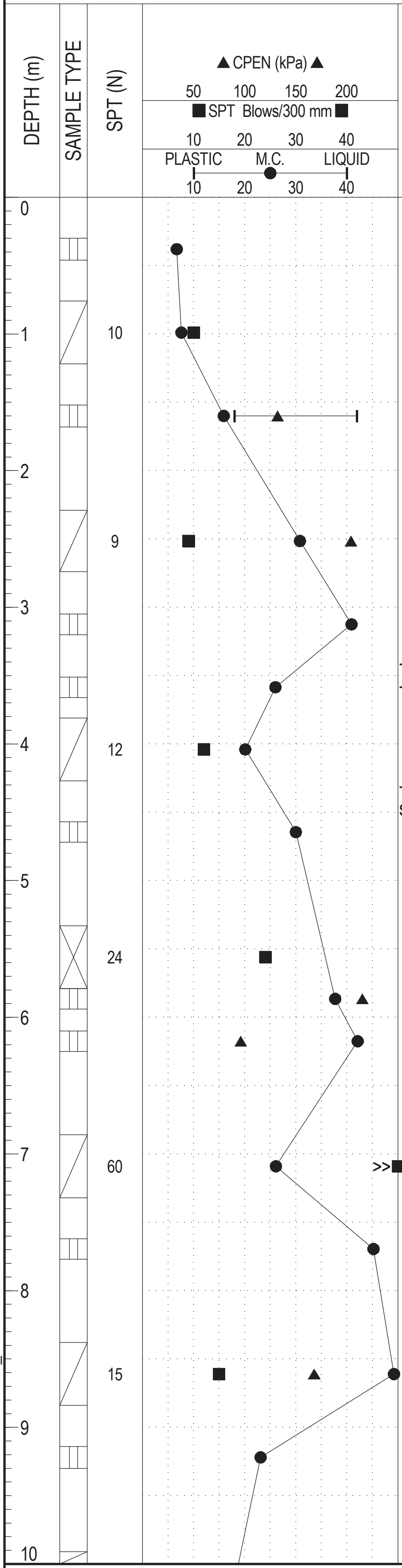
END OF TEST HOLE AT 2.7m
UPON COMPLETION:
-No slough
Backfilled with drill cuttings

THURBER ENGINEERING LTD.

FIELD LOGGED BY: NNM / BWN	COMPLETION DEPTH: 2.7 m
PREPARED BY: SEC	COMPLETION DATE: 5/2/16
REVIEWED BY: HER	Page 1 of 1

CLIENT: EDA COLLABORATIVE	PROJECT: CITY OF EDMONTON BOAT DOCKS AND LAUNCHES	BOREHOLE NO: **TH15-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 15, 2015	PROJECT NO: 19-1052-7
DRILL/METHOD: M4T / Solid Stem Augers	LOCATION: N5934875, E331713	ELEVATION: 619.35 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ☒ NO RECOVERY



REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
		SAND (FILL) compact, brown, fine grained, silty, trace fine gravel	
	SC		619
	SM		
		CLAY (FILL) stiff, dark brown, silty, some sand and gravel, trace high plastic clay lenses and sand lenses	618
	CI		
	CI	-green, trace sand, organic staining, and organics	617
	CI	-grey, some sand, trace wood	
-Trace seepage -Gravel = 0.0% Sand = 60.5% Fines = 39.5%	SC	SAND compact, brown, fine grained, silty, trace clay	616
	SM	-medium grained	
-Seepage in gravel lense at base of sand			615
	CI-CH	CLAY SHALE dark grey, silty	
			614
	CH	-light bluish grey, bentonitic	
	CH		613
>>■Cpen > 215kPa	CH	-very hard, grey, trace silt laminations	612
	CH		
	CH	-very stiff, light green, bentonitic	611
	CH	-dark grey	610

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 10.4 m
	PREPARED BY: NFR	COMPLETION DATE: 10/15/15
	REVIEWED BY: RWT	Page 1 of 2

CLIENT: EDA COLLABORATIVE	PROJECT: CITY OF EDMONTON BOAT DOCKS AND LAUNCHES	BOREHOLE NO: **TH15-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 15, 2015	PROJECT NO: 19-1052-7
DRILL/METHOD: M4T / Solid Stem Augers	LOCATION: N5934875, E331713	ELEVATION: 619.35 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ☒ NO RECOVERY

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲ CPEN (kPa) ▲ 50 100 150 200 ■ SPT Blows/300 mm ■ 10 20 30 40 PLASTIC M.C. ● LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10	◿	50/150	● >>	■Cpen > 215kPa	CH	▨	CLAY SHALE - CONTINUED -very hard	609
							END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -Slough at 9.5m -Water at 8.8m Backfilled with drill cuttings and bentonite chips at surface	
11								608
12								607
13								606
14								605
15								604
16								603
17								602
18								601
19								600
20								

BOREHOLE LOG 19-1052-7.GPJ THRBR_AB.GDT 11/3/15- LIBRARY-NEW LOGO - N E.GLB

THURBER ENGINEERING LTD.	FIELD LOGGED BY: NNM	COMPLETION DEPTH: 10.4 m
	PREPARED BY: NFR	COMPLETION DATE: 10/15/15
	REVIEWED BY: RWT	Page 2 of 2

THURBER

APPENDIX C

Laboratory Test Results

THURBER

ATTERBERG LIMITS

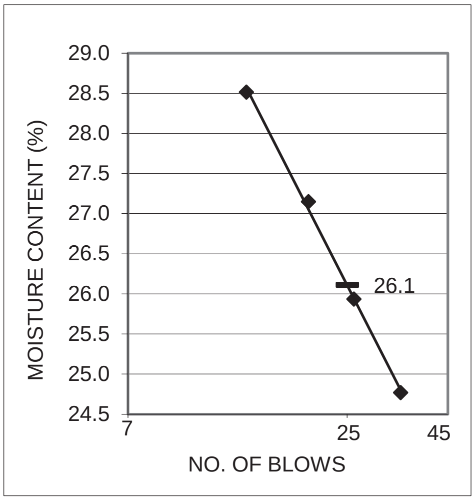
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: 16 - 1
Sample No: P5
Depth: 4.87 - 5.33 m

Date Tested: 5-May-16
Tested By: JAP
Checked By:

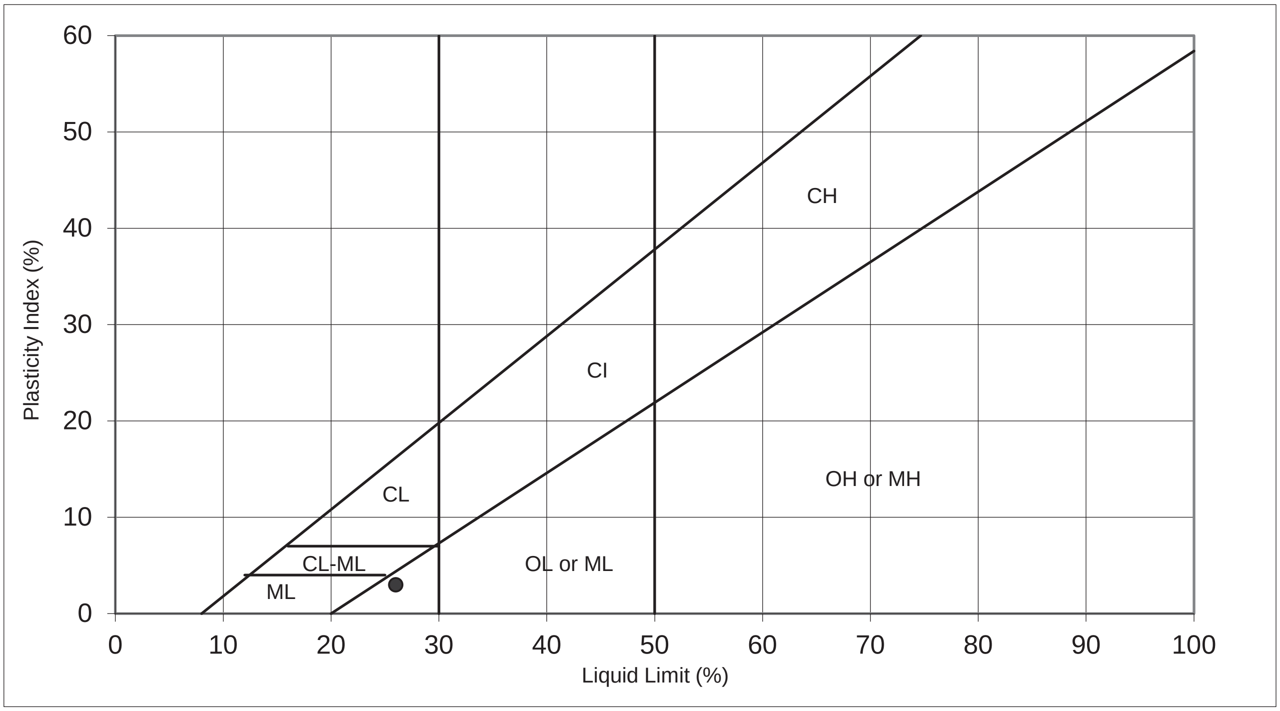
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	34	26	20	14
Container No.	1	2	3	4
Wet Soil + Container	19.09	16.46	13.3	16
Dry Soil + Container	15.3	13.07	10.46	12.45
Wt. Of Container	0	0	0	0
Moisture Content	24.8	25.9	27.2	28.5



PLASTIC LIMIT

	1	2		**AVERAGE**
Container No.	5	6		
Wet Soil + Container	29.52	28.72		
Dry Soil + Container	27.56	26.87		
Wt. Of Container	19.01	18.8		
Moisture Content	22.9	22.9		**22.9**



REMARKS

Liquid Limit:	**26**
Plastic Limit:	**23**
Plasticity Index:	**3**
USC Classification:	**ML**

ATTERBERG LIMITS

ASTM D4318

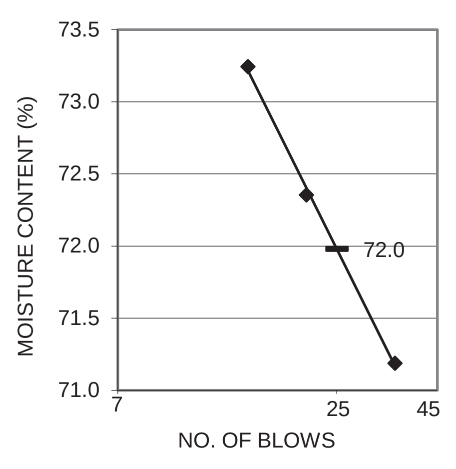
THURBER

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: 16-1
Sample No: RUN 2
Depth: 10.6 m

Date Tested: 1-May-31
Tested By: JAP
Checked By:

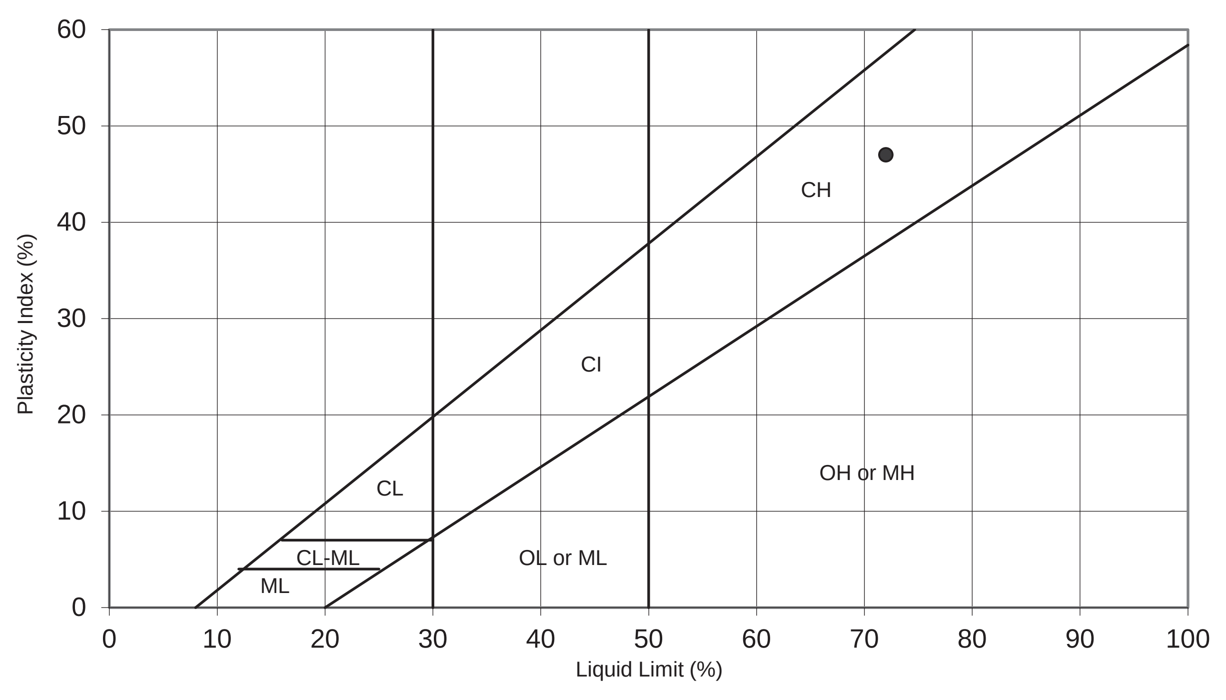
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	35	21	15	
Container No.	1	2	3	
Wet Soil + Container	16.16	15.96	12.82	
Dry Soil + Container	9.44	9.26	7.4	
Wt. Of Container	0	0	0	
Moisture Content	71.2	72.4	73.2	



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	29.14	28.89		
Dry Soil + Container	27.08	26.88		
Wt. Of Container	18.9	18.9		
Moisture Content	25.2	25.2		**25.2**



REMARKS : Blenderized Limit

Liquid Limit:	**72**
Plastic Limit:	**25**
Plasticity Index:	**47**
USC Classification:	**CH**

ATTERBERG LIMITS

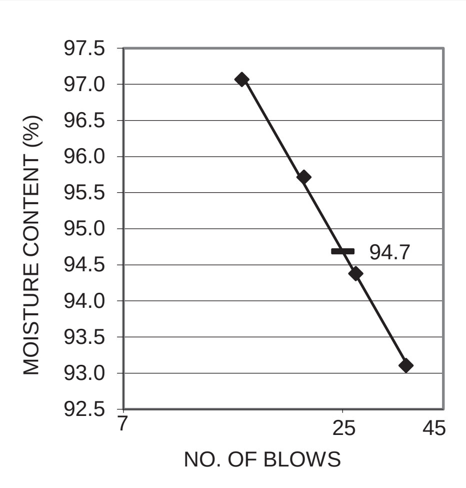
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 1
Sample No:
Depth: 16.00 - 16.15 m

Date Tested: 10-May-16
Tested By: NM
Checked By:

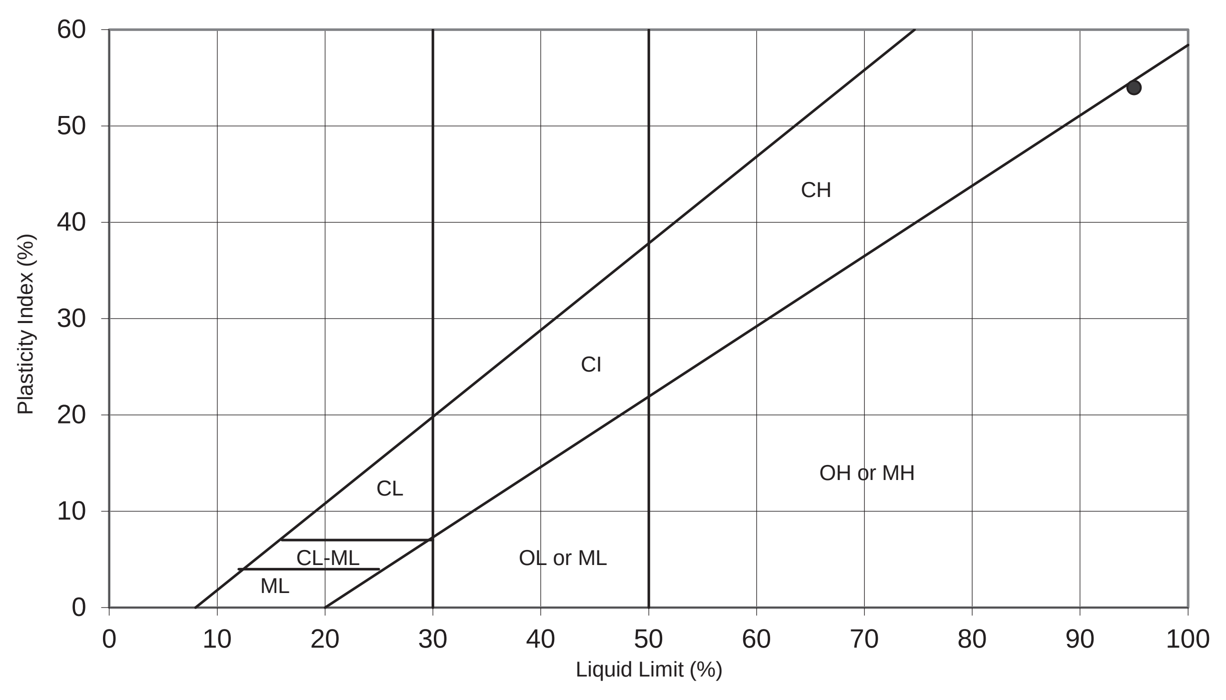
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	36	27	20	14
Container No.	1	2	3	4
Wet Soil + Container	12.32	13.49	13.7	13.44
Dry Soil + Container	6.38	6.94	7	6.82
Wt. Of Container	0	0	0	0
Moisture Content	93.1	94.4	95.7	97.1



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.12	27.92		
Dry Soil + Container	25.43	25.32		
Wt. Of Container	18.81	18.92		
Moisture Content	40.6	40.6		**40.6**



REMARKS : Blenderized Limit

Liquid Limit:	**95**
Plastic Limit:	**41**
Plasticity Index:	**54**
USC Classification:	**MH**

ATTERBERG LIMITS

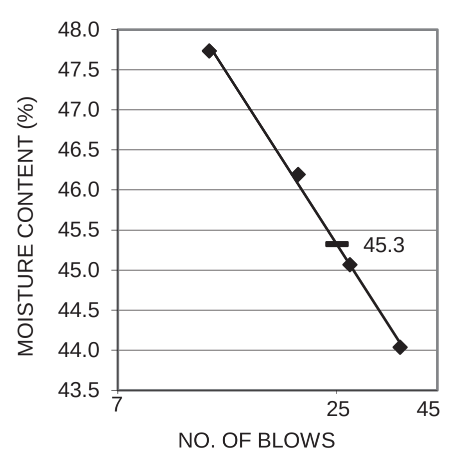
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: 16 - 2
Sample No: P7
Depth: 4.57 - 5.02 m

Date Tested: 5-May-16
Tested By: JAP
Checked By:

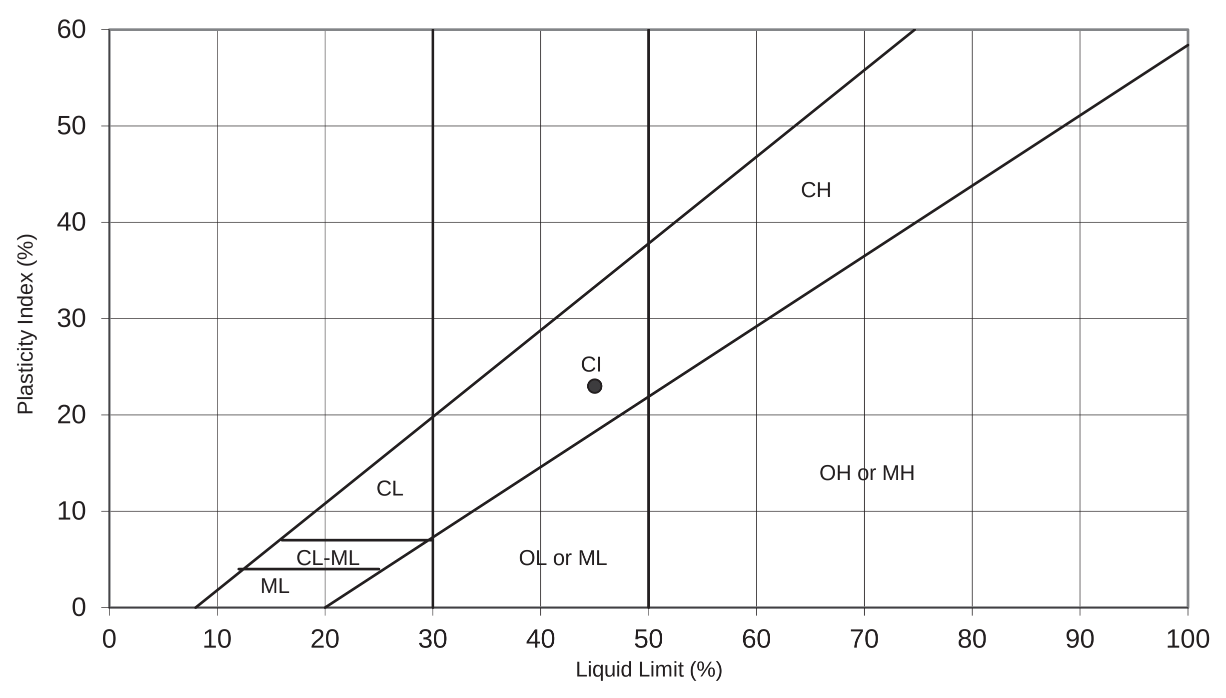
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	36	27	20	12
Container No.	1	2	3	4
Wet Soil + Container	14.49	13.97	14.78	13.37
Dry Soil + Container	10.06	9.63	10.11	9.05
Wt. Of Container	0	0	0	0
Moisture Content	44.0	45.1	46.2	47.7



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.72	28.99		
Dry Soil + Container	26.97	27.18		
Wt. Of Container	18.81	18.79		
Moisture Content	21.4	21.6		**21.5**



REMARKS

Liquid Limit:	**45**
Plastic Limit:	**22**
Plasticity Index:	**23**
USC Classification:	**CI**

THURBER

ATTERBERG LIMITS

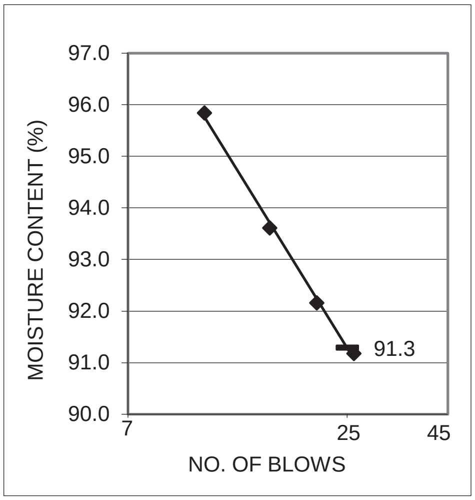
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 2
Sample No:
Depth: 12.85 - 13.00 m

Date Tested: 10-May-16
Tested By: NM
Checked By:

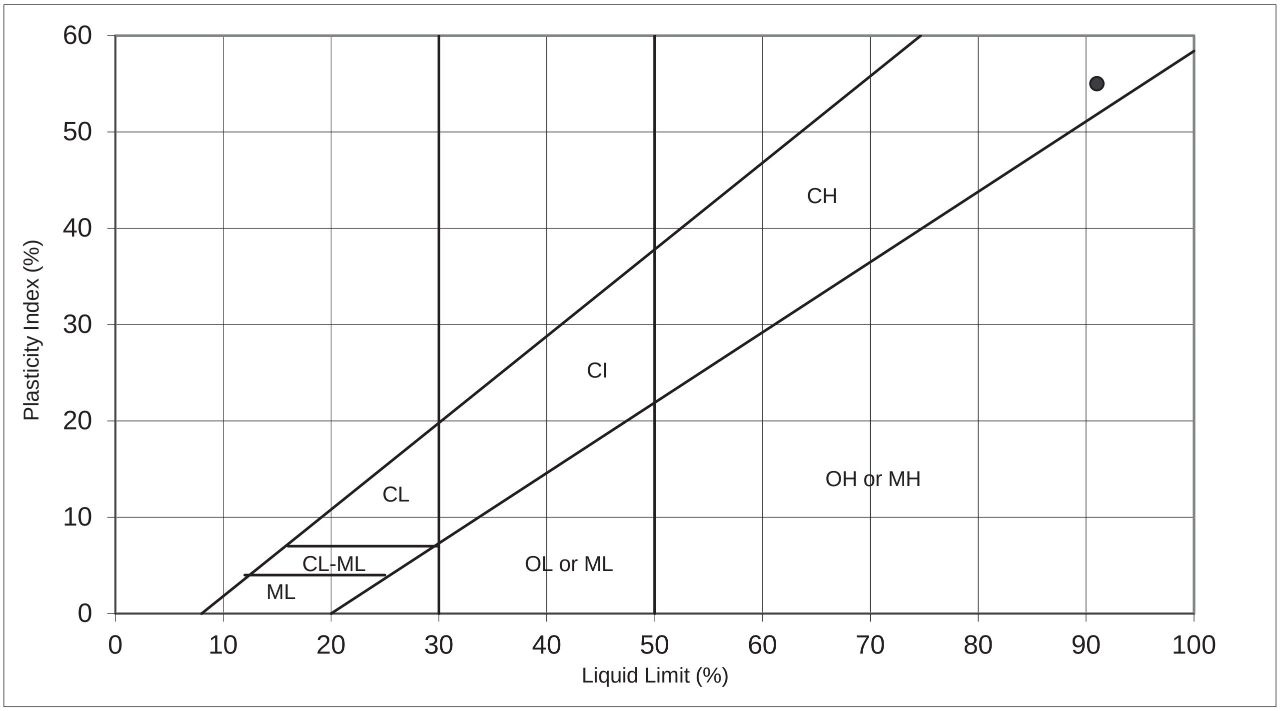
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	26	21	16	11
Container No.	1	2	3	4
Wet Soil + Container	13	12.99	13.34	14.12
Dry Soil + Container	6.8	6.76	6.89	7.21
Wt. Of Container	0	0	0	0
Moisture Content	91.2	92.2	93.6	95.8



PLASTIC LIMIT

	1	2		**AVERAGE**
Container No.	5	6		
Wet Soil + Container	27.95	28.31		
Dry Soil + Container	25.53	25.83		
Wt. Of Container	18.87	19.01		
Moisture Content	36.3	36.4		**36.3**



REMARKS : Blenderized Limit

Liquid Limit:	**91**
Plastic Limit:	**36**
Plasticity Index:	**55**
USC Classification:	**CH**

ATTERBERG LIMITS

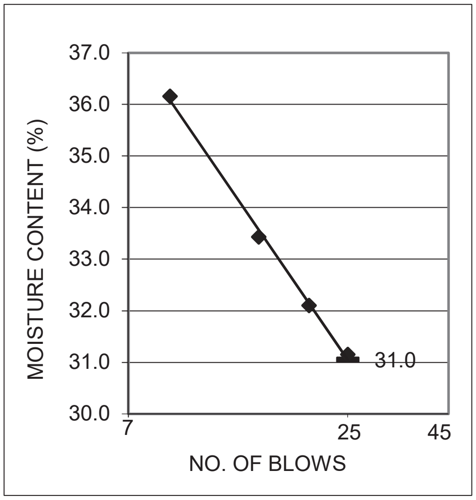
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 3
Sample No: P16
Depth: 11.43 - 11.89 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

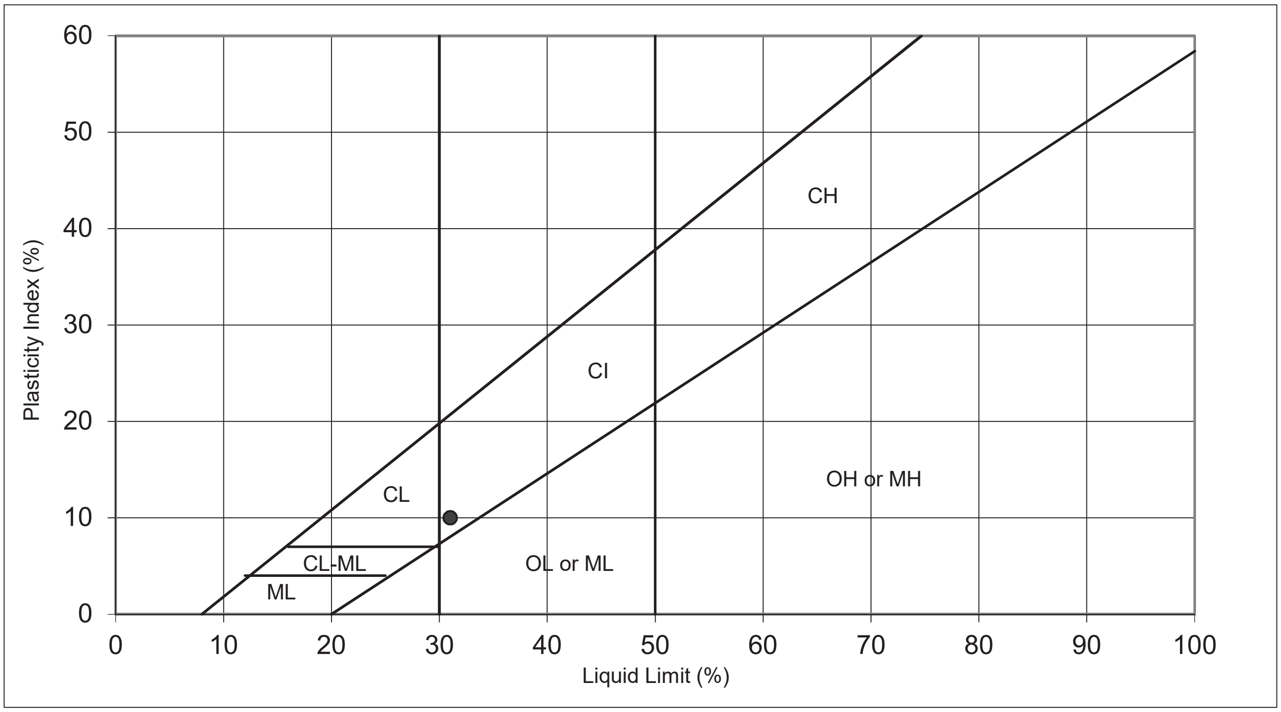
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	25	20	15	9
Container No.	1	2	3	4
Wet Soil + Container	12.21	13.95	13.33	14.31
Dry Soil + Container	9.31	10.56	9.99	10.51
Wt. Of Container	0	0	0	0
Moisture Content	31.1	32.1	33.4	36.2



PLASTIC LIMIT

	1	2		**AVERAGE**
Container No.	5	6		
Wet Soil + Container	27.87	28.03		
Dry Soil + Container	26.28	26.40		
Wt. Of Container	18.79	18.79		
Moisture Content	21.2	21.4		**21.3**



REMARKS

Liquid Limit:	**31**
Plastic Limit:	**21**
Plasticity Index:	**10**
USC Classification:	**CI**

ATTERBERG LIMITS

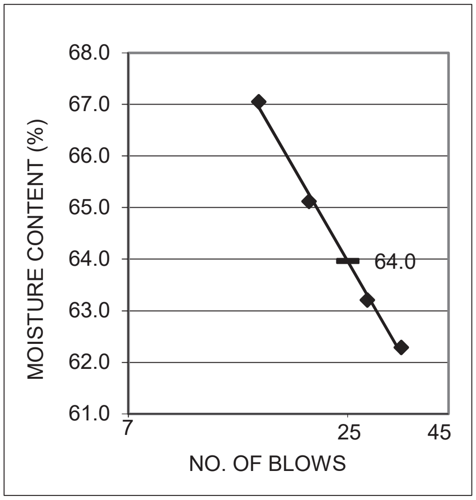
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 3
Sample No: G19
Depth: 13.72 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

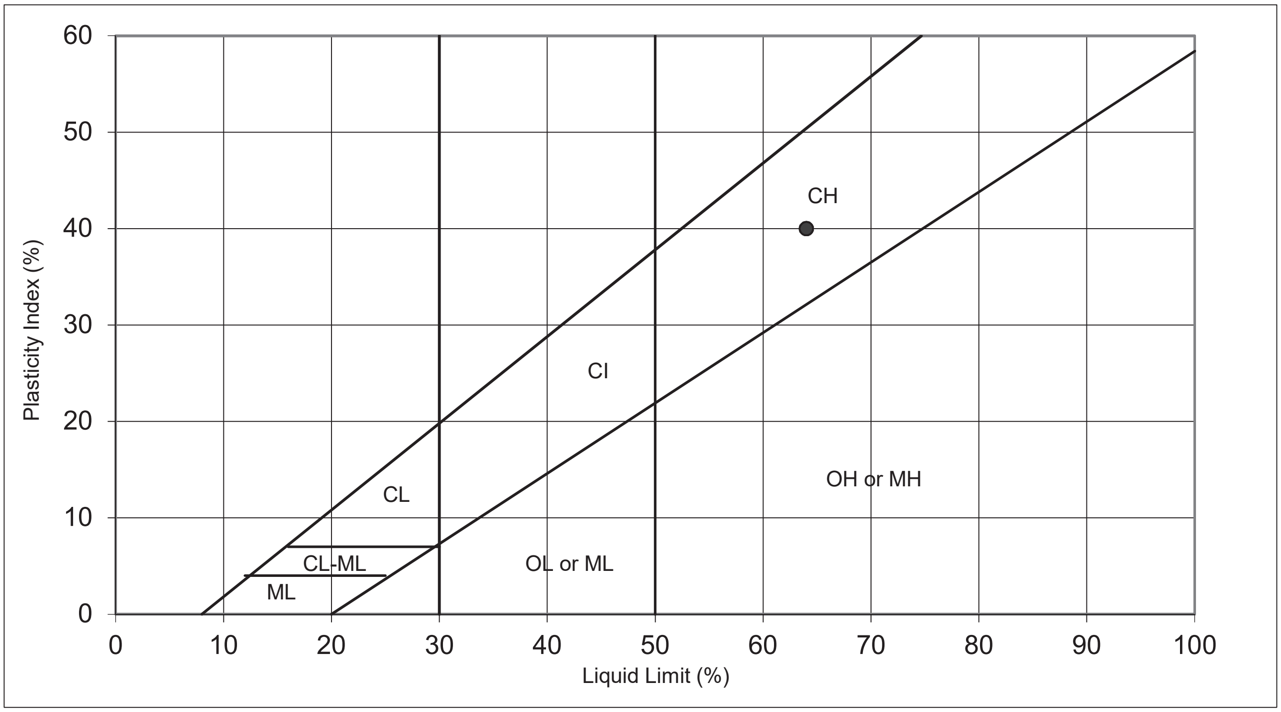
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	34	28	20	15
Container No.	1	2	3	4
Wet Soil + Container	12.61	13.53	13.54	14.35
Dry Soil + Container	7.77	8.29	8.2	8.59
Wt. Of Container	0	0	0	0
Moisture Content	62.3	63.2	65.1	67.1



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.26	28.01		
Dry Soil + Container	26.46	26.26		
Wt. Of Container	18.82	18.88		
Moisture Content	23.6	23.7		**23.6**



REMARKS

Liquid Limit:	**64**
Plastic Limit:	**24**
Plasticity Index:	**40**
USC Classification:	**CH**

THURBER

ATTERBERG LIMITS

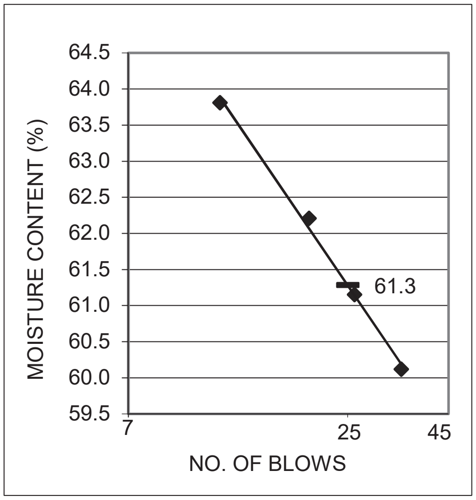
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 4
Sample No: G7
Depth: 4.57 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

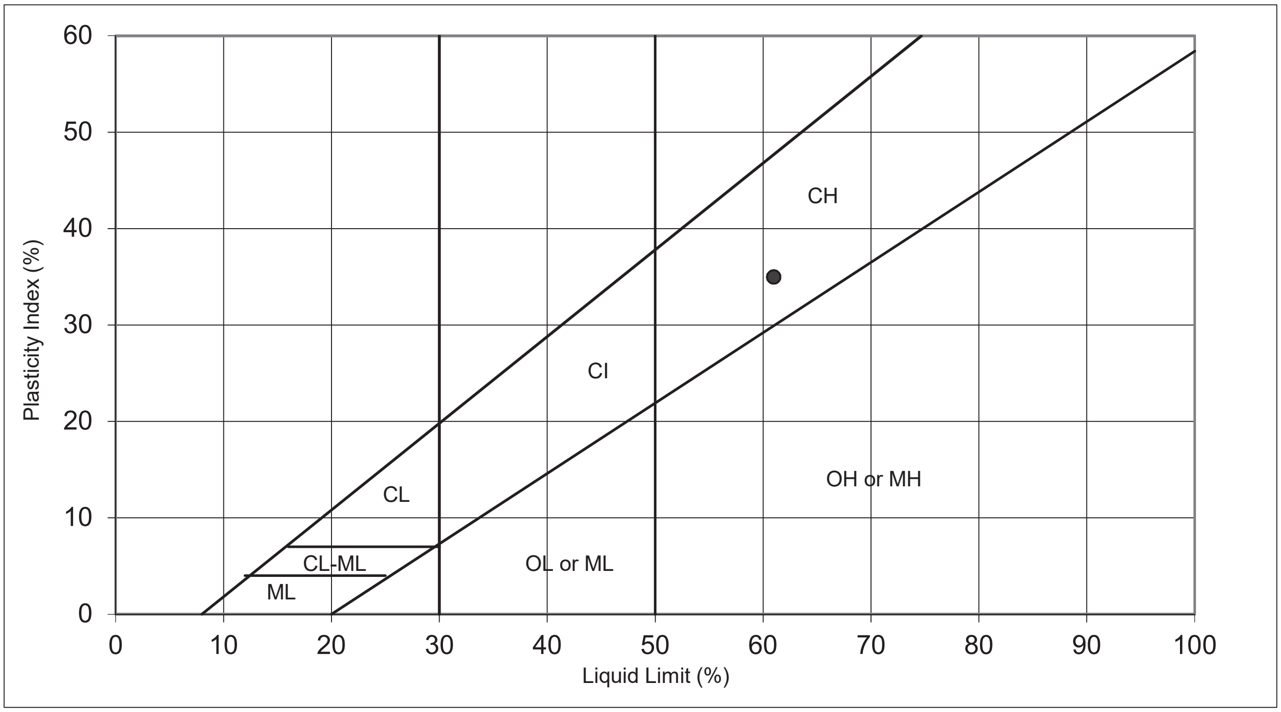
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	34	26	20	12
Container No.	1	2	3	4
Wet Soil + Container	13.53	13.44	13.22	13.76
Dry Soil + Container	8.45	8.34	8.15	8.4
Wt. Of Container	0	0	0	0
Moisture Content	60.1	61.2	62.2	63.8



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.89	28.21		
Dry Soil + Container	26.87	26.29		
Wt. Of Container	19.02	18.75		
Moisture Content	25.7	25.5		**25.6**



REMARKS

Liquid Limit:	**61**
Plastic Limit:	**26**
Plasticity Index:	**35**
USC Classification:	**CH**

THURBER

ATTERBERG LIMITS

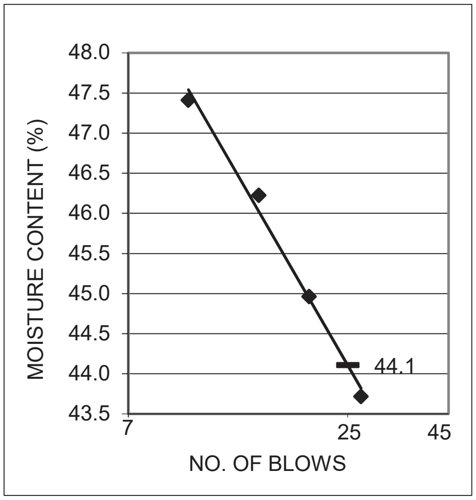
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 4
Sample No: G11
Depth: 7.62 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

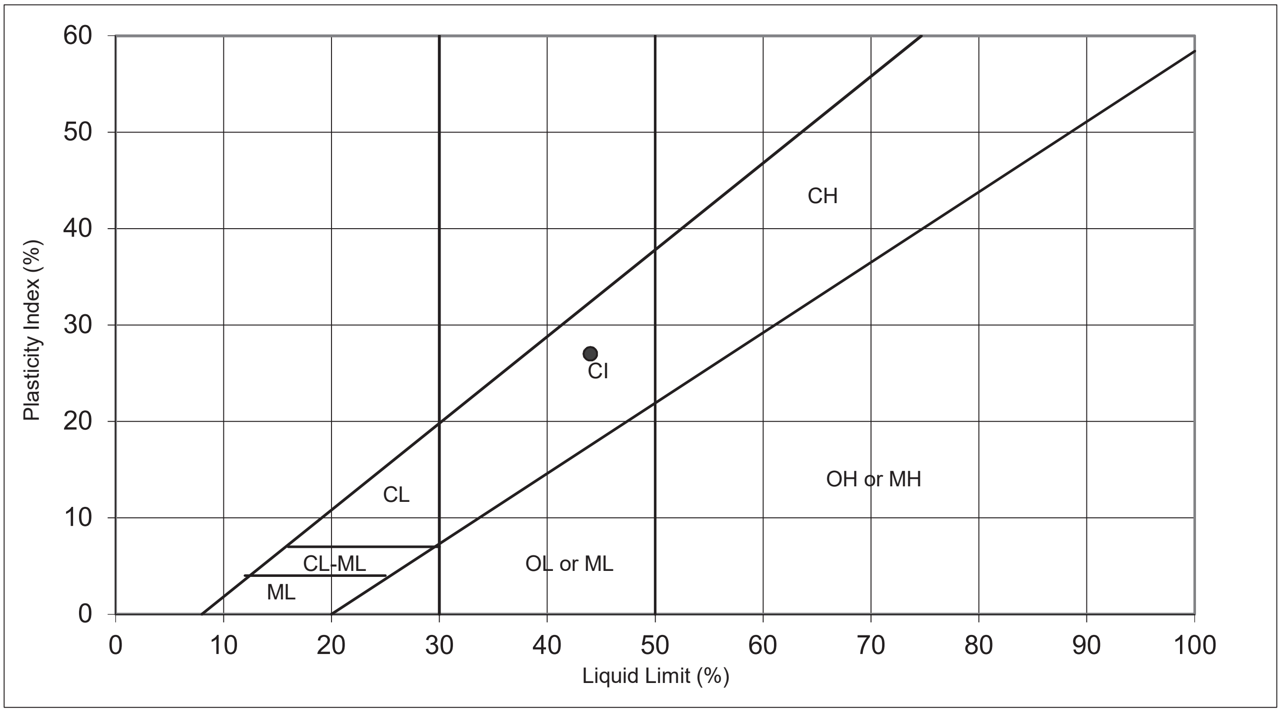
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	27	20	15	10
Container No.	1	2	3	4
Wet Soil + Container	14.3	14.25	15.88	13.96
Dry Soil + Container	9.95	9.83	10.86	9.47
Wt. Of Container	0	0	0	0
Moisture Content	43.7	45.0	46.2	47.4



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.12	28.04		
Dry Soil + Container	26.75	26.68		
Wt. Of Container	18.81	18.76		
Moisture Content	17.3	17.2		**17.2**



REMARKS

Liquid Limit:	**44**
Plastic Limit:	**17**
Plasticity Index:	**27**
USC Classification:	**CI**

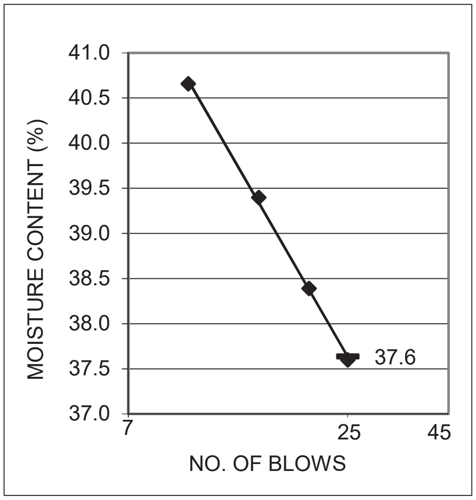
ATTERBERG LIMITS
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 5
Sample No: G3
Depth: 1.52 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

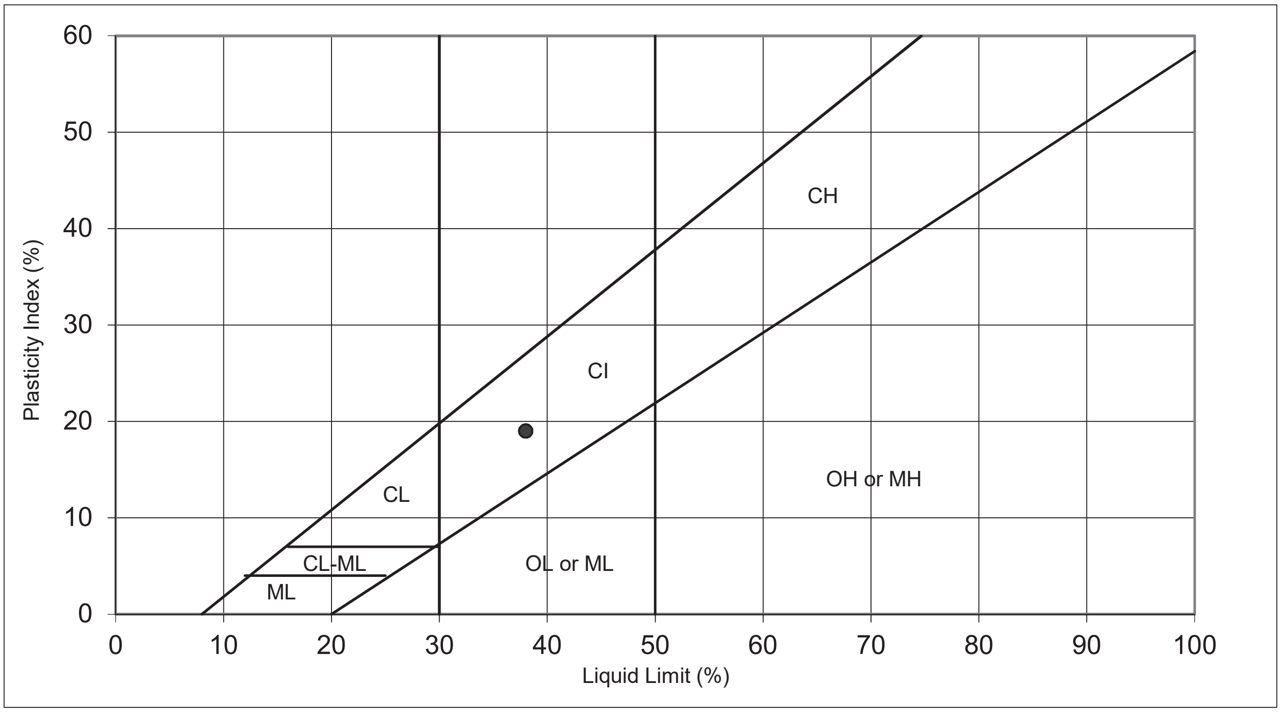
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	25	20	15	10
Container No.	1	2	3	4
Wet Soil + Container	15.7	13.05	14.79	14.98
Dry Soil + Container	11.41	9.43	10.61	10.65
Wt. Of Container	0	0	0	0
Moisture Content	37.6	38.4	39.4	40.7



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.79	28.21		
Dry Soil + Container	27.21	26.73		
Wt. Of Container	18.83	18.91		
Moisture Content	18.9	18.9		**18.9**



REMARKS

Liquid Limit:	**38**
Plastic Limit:	**19**
Plasticity Index:	**19**
USC Classification:	**CI**

ATTERBERG LIMITS

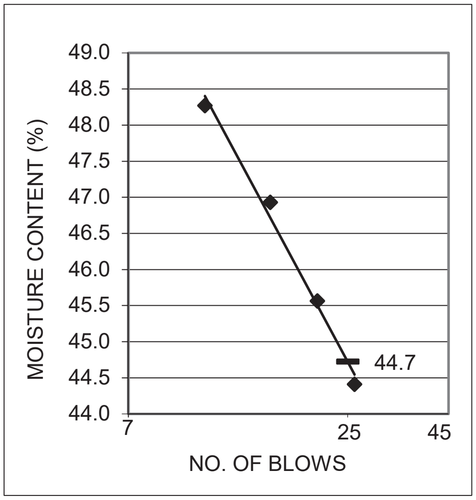
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 6
Sample No: G3
Depth: 1.52 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

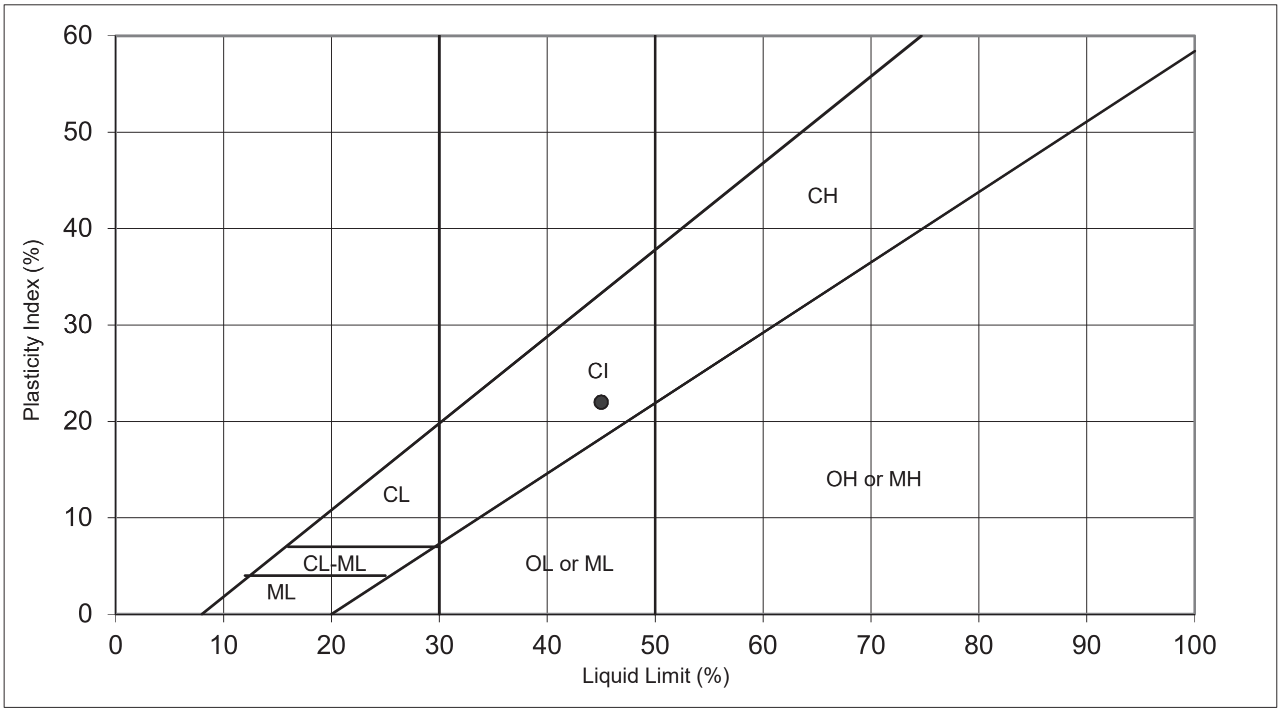
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	26	21	16	11
Container No.	1	2	3	4
Wet Soil + Container	13.56	14.60	15.31	14.56
Dry Soil + Container	9.39	10.03	10.42	9.82
Wt. Of Container	0	0	0	0
Moisture Content	44.4	45.6	46.9	48.3



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.08	28.39		
Dry Soil + Container	26.3	26.57		
Wt. Of Container	18.76	18.75		
Moisture Content	23.6	23.3		**23.4**



REMARKS

Liquid Limit:	**45**
Plastic Limit:	**23**
Plasticity Index:	**22**
USC Classification:	**CI**

TH16-6 G3 @ 1.52 m

ATTERBERG LIMITS

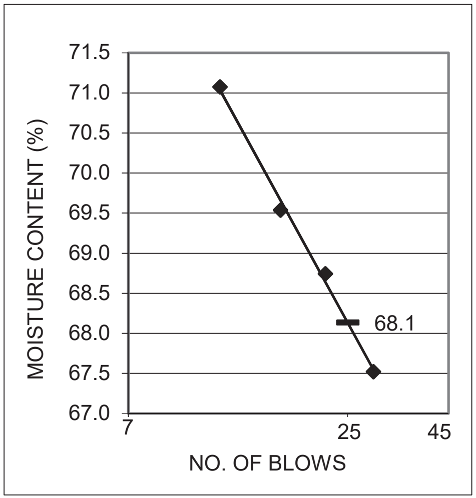
ASTM D4318

Client: Dialog
Project: Groat Road River Bridge
Project No: 10298
Test Hole: TH16 - 8
Sample No: G3
Depth: 1.52 m

Date Tested: 09-May-16
Tested By: NM
Checked By:

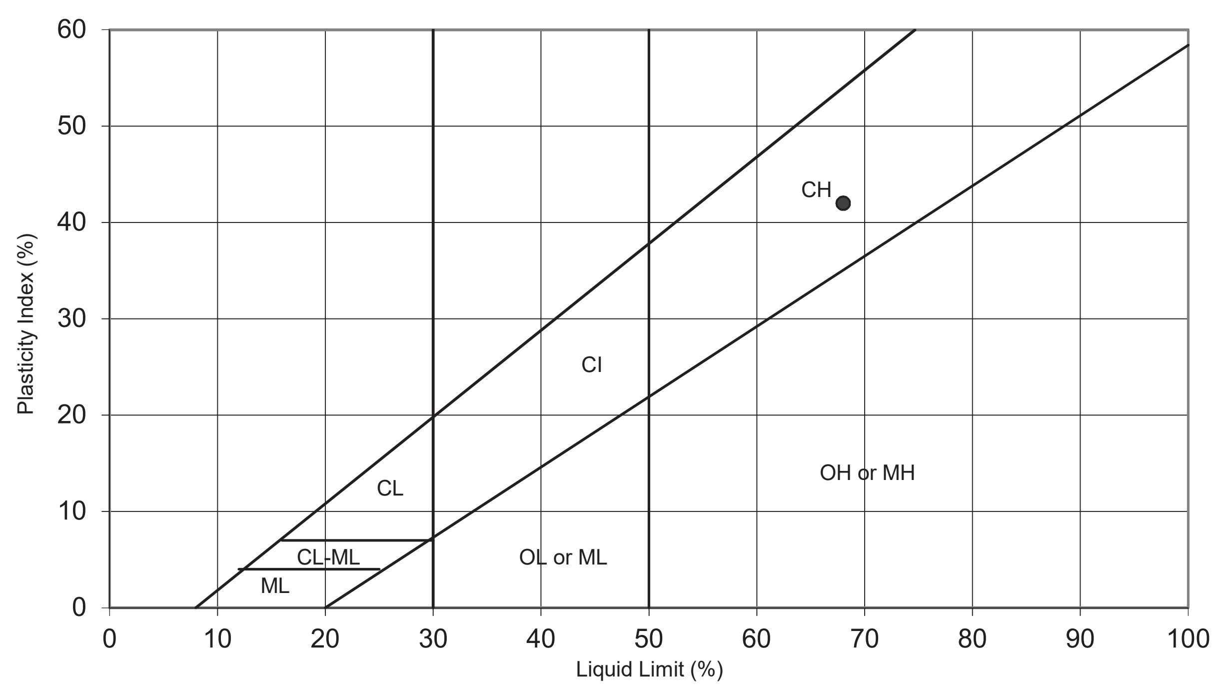
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	29	22	17	12
Container No.	1	2	3	4
Wet Soil + Container	13.05	13.01	13.58	14.49
Dry Soil + Container	7.79	7.71	8.01	8.47
Wt. Of Container	0	0	0	0
Moisture Content	67.5	68.7	69.5	71.1



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	27.94	28.37		
Dry Soil + Container	26.07	26.39		
Wt. Of Container	18.84	18.78		
Moisture Content	25.9	26.0		**25.9**



REMARKS

Liquid Limit:	**68**
Plastic Limit:	**26**
Plasticity Index:	**42**
USC Classification:	**CH**

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
P: 780.438.1460 F: 780.437.7125

Client: Dialog

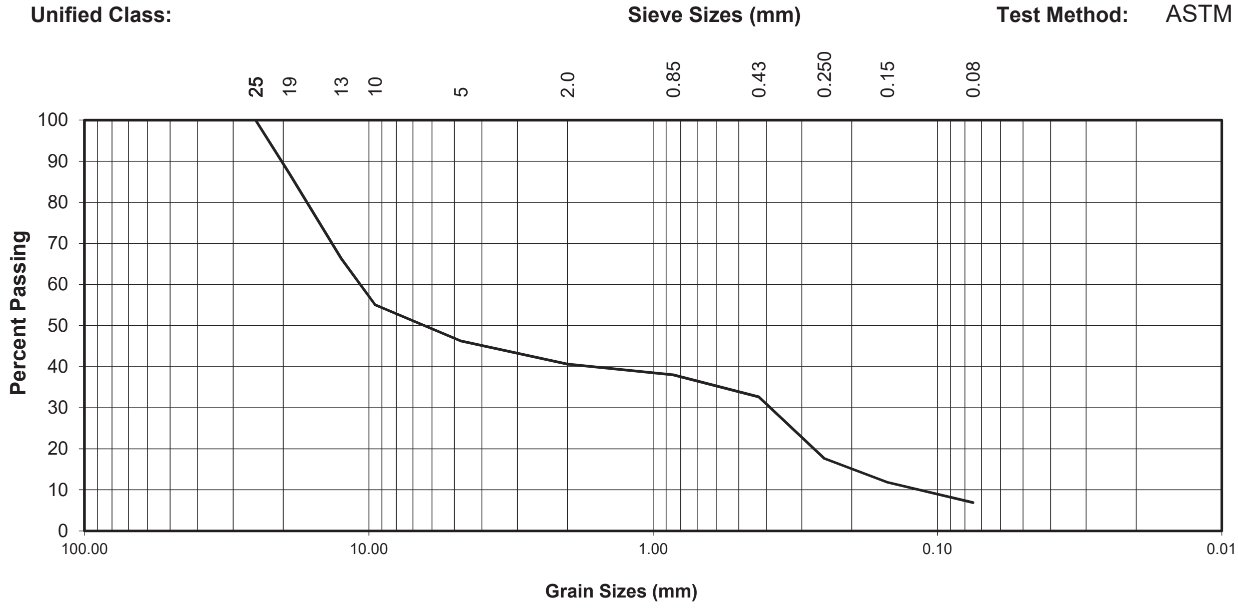
Project No.: 10298

Project: Groat Road River Bridge

Date: 5-May-16

Sample Source: TH16-1 P7 @ 6.40 -6.85 m
Material Type:
Specification:
Unified Class:

Date Tested: 5-May-16
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1	25	100.0		
3/4	19	86.9		
1/2	12.5	66.3		
3/8	9.5	55.1		
#4	4.75	46.3		
#10	2	40.6		
#20	0.85	38.0		
#40	0.425	32.6		
#60	0.25	17.6		
#100	0.15	11.8		
#200	0.075	6.9		

Total Sample Proportions	
Gravel:	53.7 %
Sand:	39.4 %
Fines:	6.9 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 13.1%

Percent Crush: -
Faces Counted:

Computer File : 10298
Series No.: n/a

Comments:

Checked By:

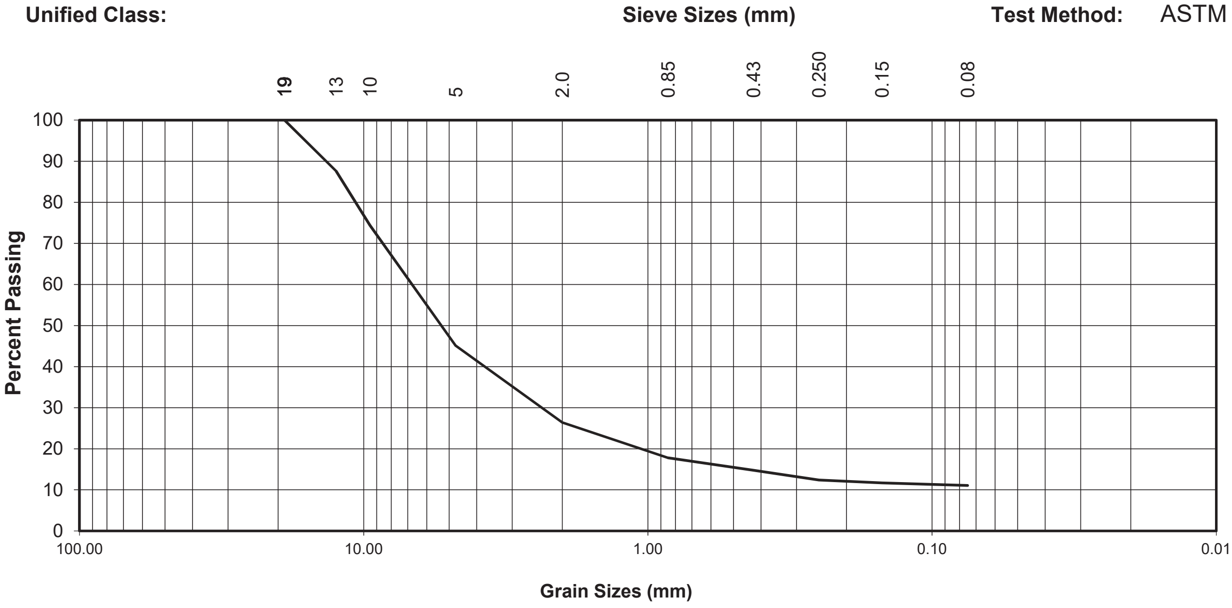
THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
P: 780.438.1460 F: 780.437.7125

Client: Dialog
Project No.: 10298
Project: Groat Road River Bridge
Date: 5-May-16

Sample Source: TH16-2 G11 @ 9.14 m
Material Type:
Specification:
Unified Class:

Date Tested: 5-May-16
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4	19	100.0		
1/2	12.5	87.6		
3/8	9.5	74.4		
#4	4.75	45.1		
#10	2	26.4		
#20	0.85	17.8		
#40	0.425	14.8		
#60	0.25	12.4		
#100	0.15	11.7		
#200	0.075	11.1		

Total Sample Proportions

Gravel:	54.9 %
Sand:	34.0 %
Fines:	11.1 %

Silt and Clay

Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 16.4%

Percent Crush: -
Faces Counted:

Computer File : TH16-2 G11
Series No.: n/a

Comments:

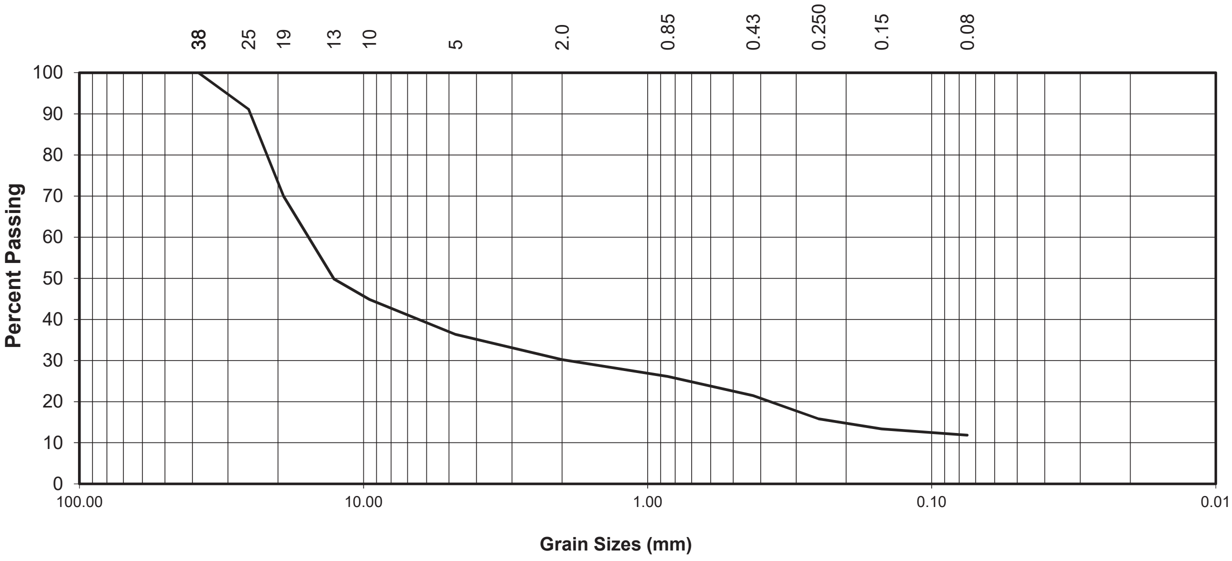
Checked By:

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
P: 780.438.1460 F: 780.437.7125

Client: Dialog
Project No.: 10298
Project: Groat Road River Bridge
Date: 09-May-16

Sample Source: TH16-3 G17 @ 12.19 m
Material Type:
Specification:
Unified Class:
Date Tested: 09-May-16
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
1.5	38.1	100.0		
1	25.4	91.1		
3/4	19.1	69.9		
1/2	12.7	49.8		
3/8	9.53	44.9		
#4	4.75	36.4		
#10	2	30.2		
#20	0.85	26.1		
#40	0.425	21.5		
#60	0.25	15.8		
#100	0.15	13.4		
#200	0.075	11.9		

Total Sample Proportions	
Gravel:	63.6 %
Sand:	24.5 %
Fines:	11.9 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 8.7%

Percent Crush: -
Faces Counted:

Computer File : TH16-3 G17
Series No.: N/A

Comments:

Checked By:

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

DIALOG
FILE NUMBER : 10298

REPORT DATE: May 26/16
REPORT NUMBER: UC16-8

Groat River Bridge

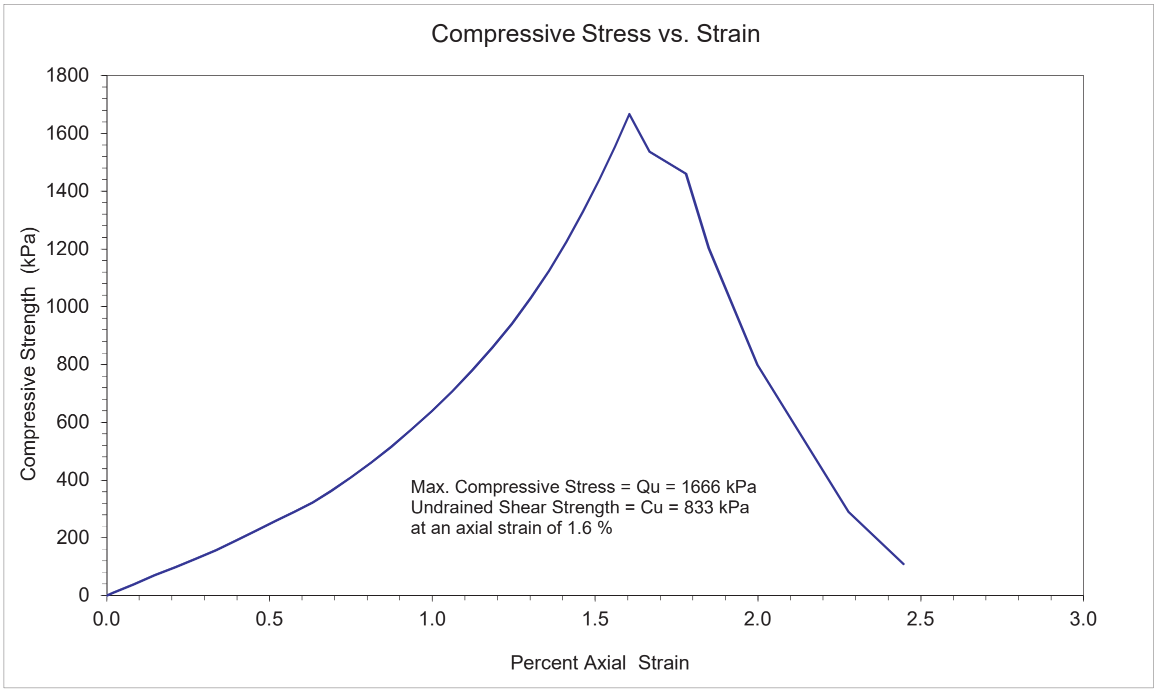
TEST DATE: May 26/16
SAMPLE: TH16-1 @ 11.10 - 11.25 m
DESCRIPTION: Sandstone (SC), mediun to fine grain, silty, slightly bentonitic, trace coal, thin clay shale lenses, light grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3): 2151
Dry Density (kg/m^3): 1911
Moisture Content (%): 12.6

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

Gravel (%):
Sand (%):
Silt (%):
Clay (%):



Max. Compressive Stress = Qu = 1666 kPa
Undrained Shear Strength = Cu = 833 kPa
at an axial strain of 1.6 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

DIALOG
FILE NUMBER : 10298

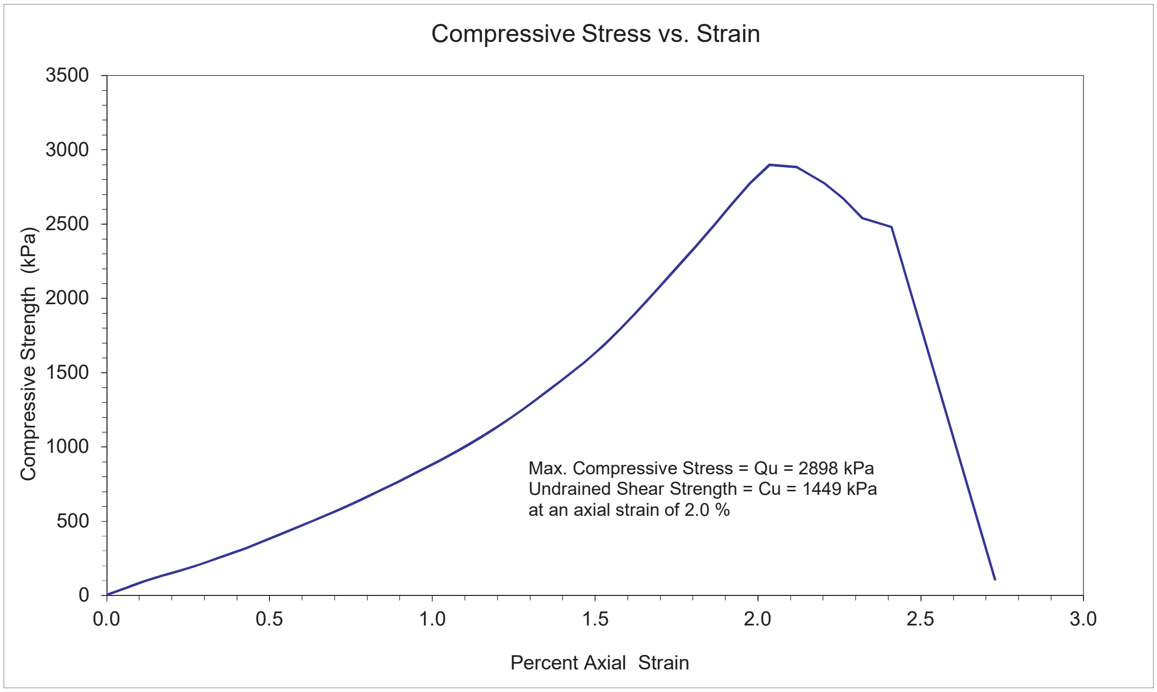
REPORT DATE: April 29/16
REPORT NUMBER: UC16-1

Groat River Bridge

TEST DATE: April 29/16
SAMPLE: TH16-1 @ 12.50 - 12.70 m
DESCRIPTION: Sandstone (SC), bentonitic, medium (to fine) grain, silty, trace coal lenses, cemented pockets, lt. grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3):	2169
Dry Density (kg/m^3):	1908
Moisture Content (%):	13.7
Liquid Limit (%):	
Plastic Limit (%):	
Plasticity Index (%):	
Gravel (%):	
Sand (%):	
Silt (%):	
Clay (%):	



Max. Compressive Stress = Qu = 2898 kPa
Undrained Shear Strength = Cu = 1449 kPa
at an axial strain of 2.0 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

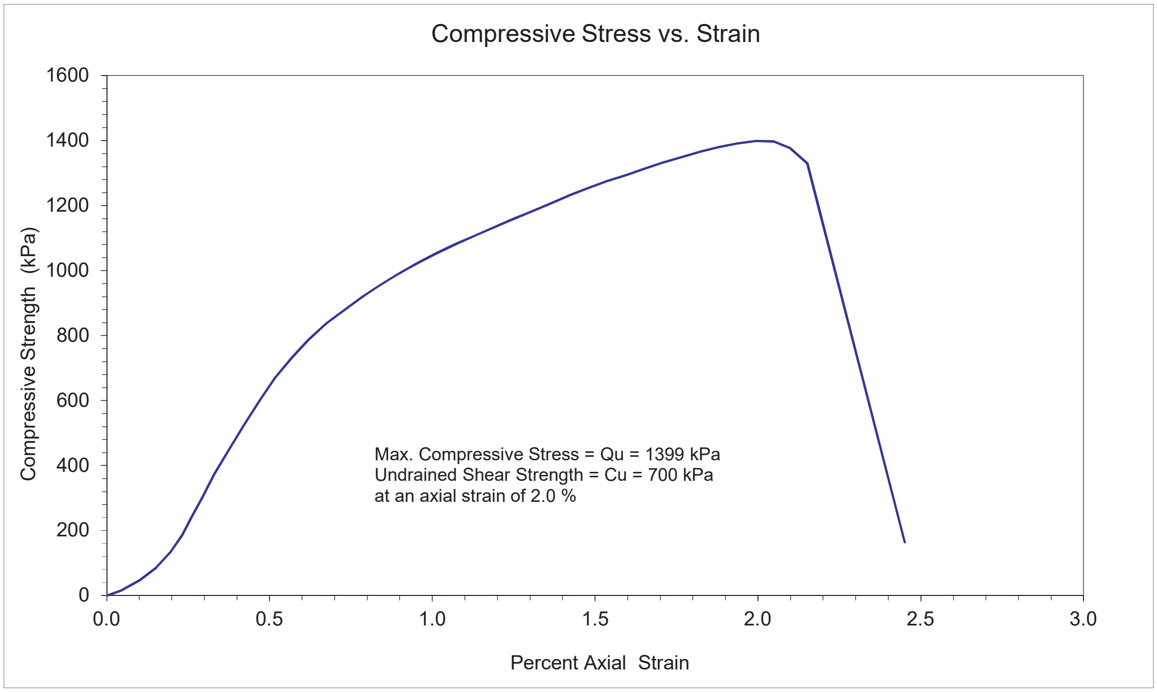
DIALOG		REPORT DATE:	April 29/16
FILE NUMBER :	10298	REPORT NUMBER:	UC16-2

Groat River Bridge

TEST DATE:	April 29/16
SAMPLE:	TH16-1 @ 16.00 - 16.15 m
DESCRIPTION:	Clay Shale (CH), slightly carbonacous, silty, trace coal lenses, dk. grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3):	1936
Dry Density (kg/m^3):	1566
Moisture Content (%):	23.6
Liquid Limit (%):	
Plastic Limit (%):	
Plasticity Index (%):	
Gravel (%):	
Sand (%):	
Silt (%):	
Clay (%):	



Max. Compressive Stress = Qu = 1399 kPa
Undrained Shear Strength = Cu = 700 kPa
at an axial strain of 2.0 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

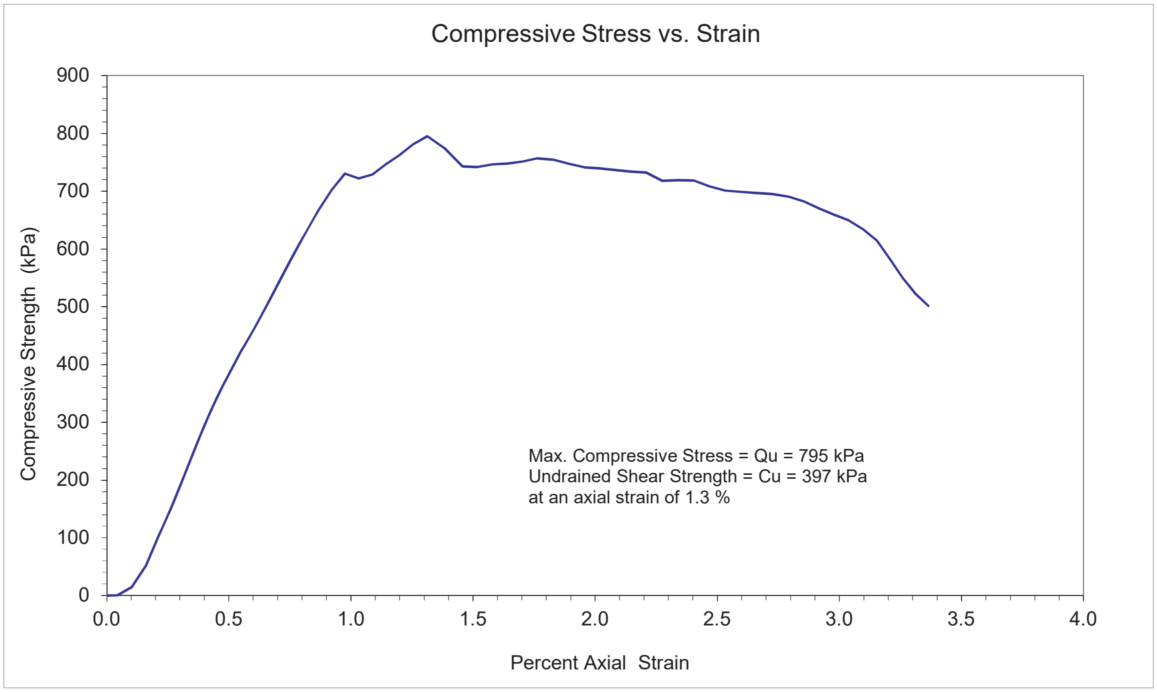
DIALOG		REPORT DATE:	April 29/16
FILE NUMBER :	10298	REPORT NUMBER:	UC16-3

Groat River Bridge

TEST DATE:	April 29/16
SAMPLE:	TH16-1 @ 19.25 - 19.40 m
DESCRIPTION:	Clay Shale (CH), silty, trace silt lenses, coal lenses, dk. grey

SPECIMEN DETAILS:

Wet Density (kg/m^3):	2150
Dry Density (kg/m^3):	1867
Moisture Content (%):	15.2
Liquid Limit (%):	
Plastic Limit (%):	
Plasticity Index (%):	
Gravel (%):	
Sand (%):	
Silt (%):	
Clay (%):	


Compressive Stress vs. Strain

Max. Compressive Stress = Qu = 795 kPa
Undrained Shear Strength = Cu = 397 kPa
at an axial strain of 1.3 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

DIALOG
FILE NUMBER : 10298

REPORT DATE: April 29/16
REPORT NUMBER: UC16-4

Groat River Bridge

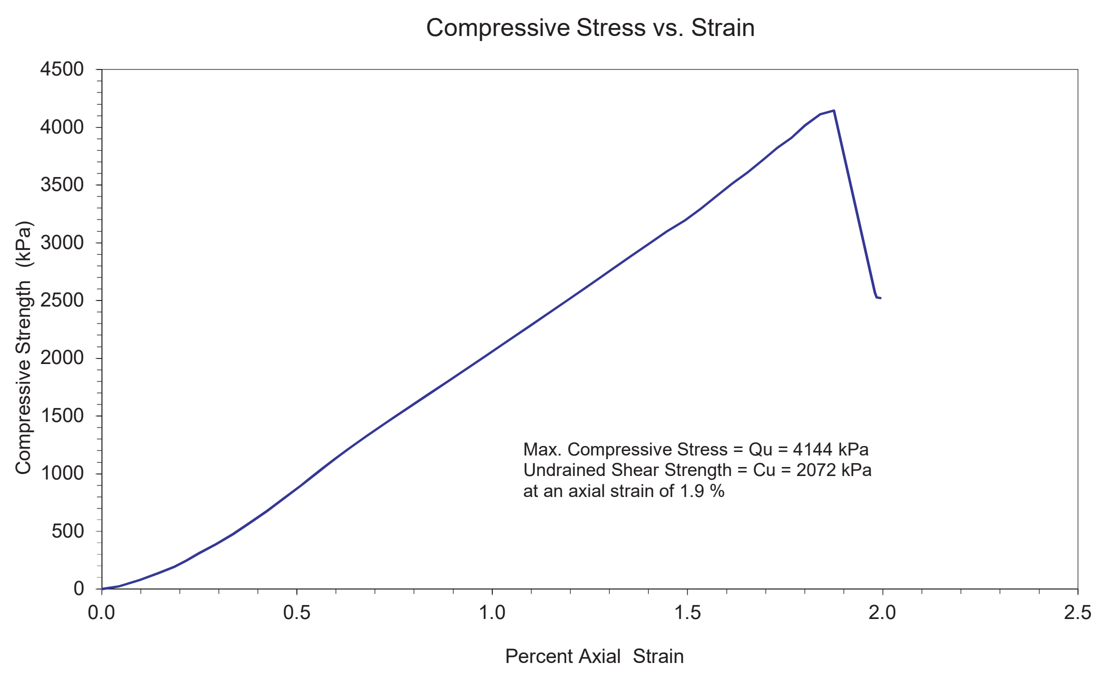
TEST DATE: April 29/16
SAMPLE: TH16-1 @ 21.10 - 21.25 m
DESCRIPTION: Siltstone (ML-CL), some clay shale laminations, trace sandstone lamination, lt. grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3): 2255
Dry Density (kg/m^3): 1949
Moisture Content (%): 15.7

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

Gravel (%):
Sand (%):
Silt (%):
Clay (%):



Max. Compressive Stress = Qu = 4144 kPa
Undrained Shear Strength = Cu = 2072 kPa
at an axial strain of 1.9 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

DIALOG
FILE NUMBER : 10298

REPORT DATE: April 29/16
REPORT NUMBER: UC16-5

Groat River Bridge

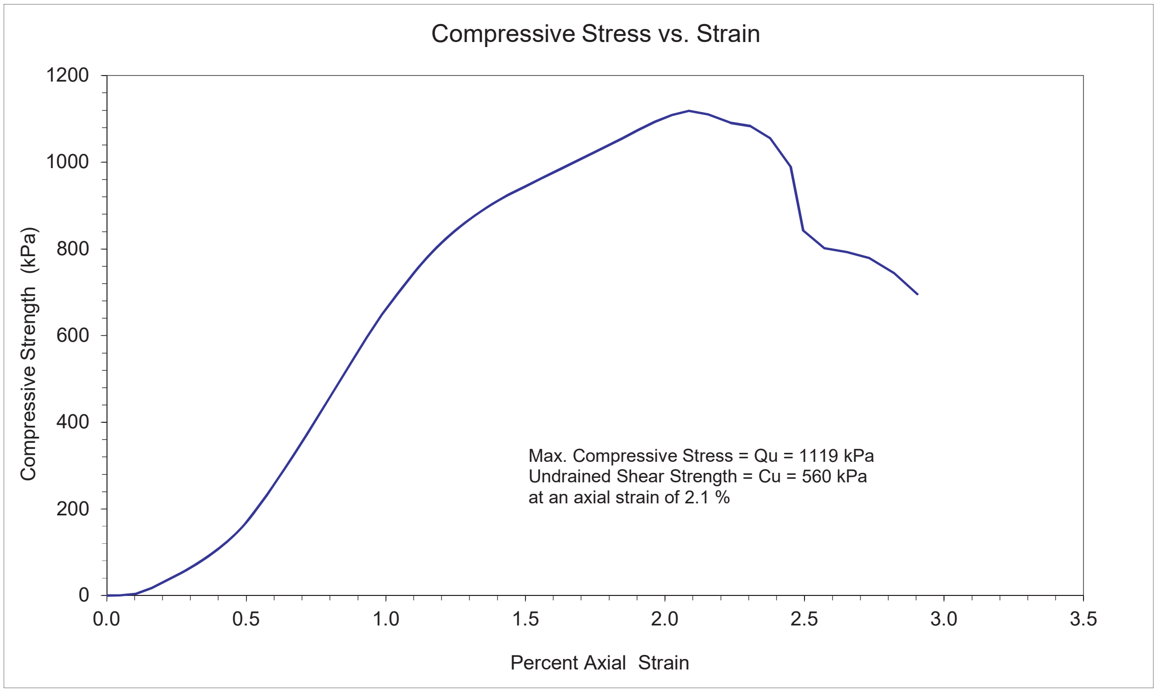
TEST DATE: April 29/16
SAMPLE: TH16-2 @ 12.85 - 13.00 m
DESCRIPTION: Clay Shale (CH), slightly bentonitic, silty, grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3): 2162
Dry Density (kg/m^3): 1826
Moisture Content (%): 18.4

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

Gravel (%):
Sand (%):
Silt (%):
Clay (%):



Max. Compressive Stress = Qu = 1119 kPa
Undrained Shear Strength = Cu = 560 kPa
at an axial strain of 2.1 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

DIALOG		REPORT DATE:	April 29/16
FILE NUMBER :	10298	REPORT NUMBER:	UC16-6

Groat River Bridge

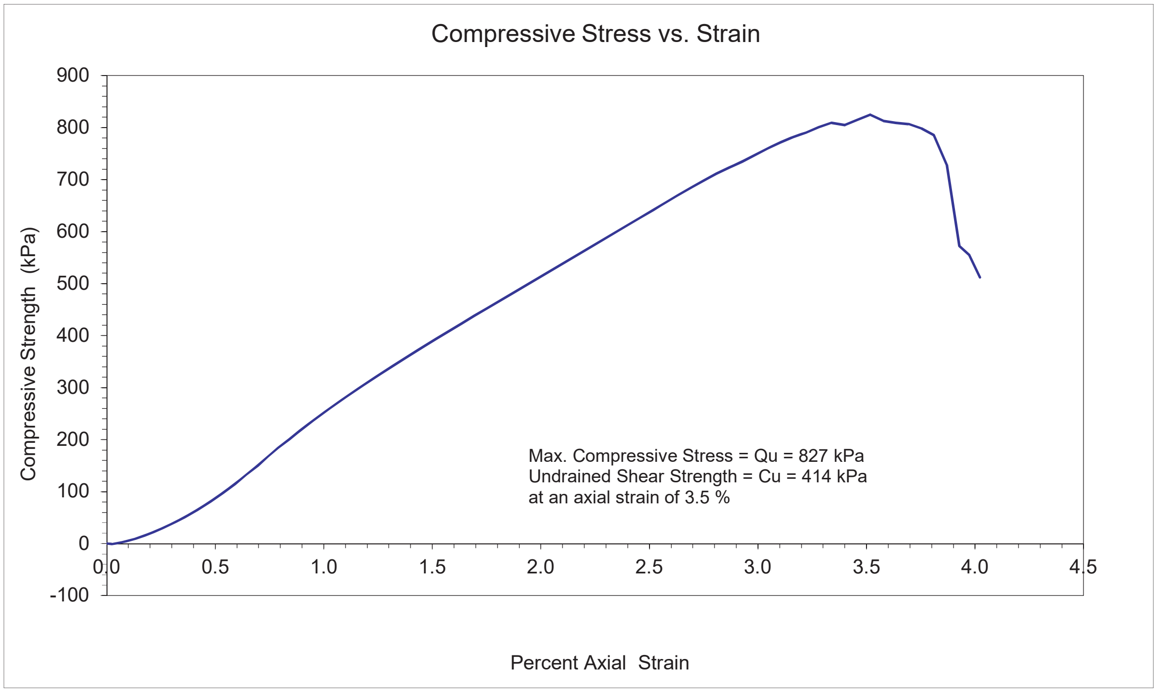
TEST DATE: April 29/16
SAMPLE: TH16-2 @ 15.70 - 15.90 m
DESCRIPTION: Sandstoone (SC), bentonitic, fine grain, trace coal and clay shale lenses, lt. grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3): 2179
Dry Density (kg/m^3): 1866
Moisture Content (%): 16.8

Liquid Limit (%):
Plastic Limit (%):
Plasticity Index (%):

Gravel (%):
Sand (%):
Silt (%):
Clay (%):



Max. Compressive Stress = Qu = 827 kPa
Undrained Shear Strength = Cu = 414 kPa
at an axial strain of 3.5 %

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

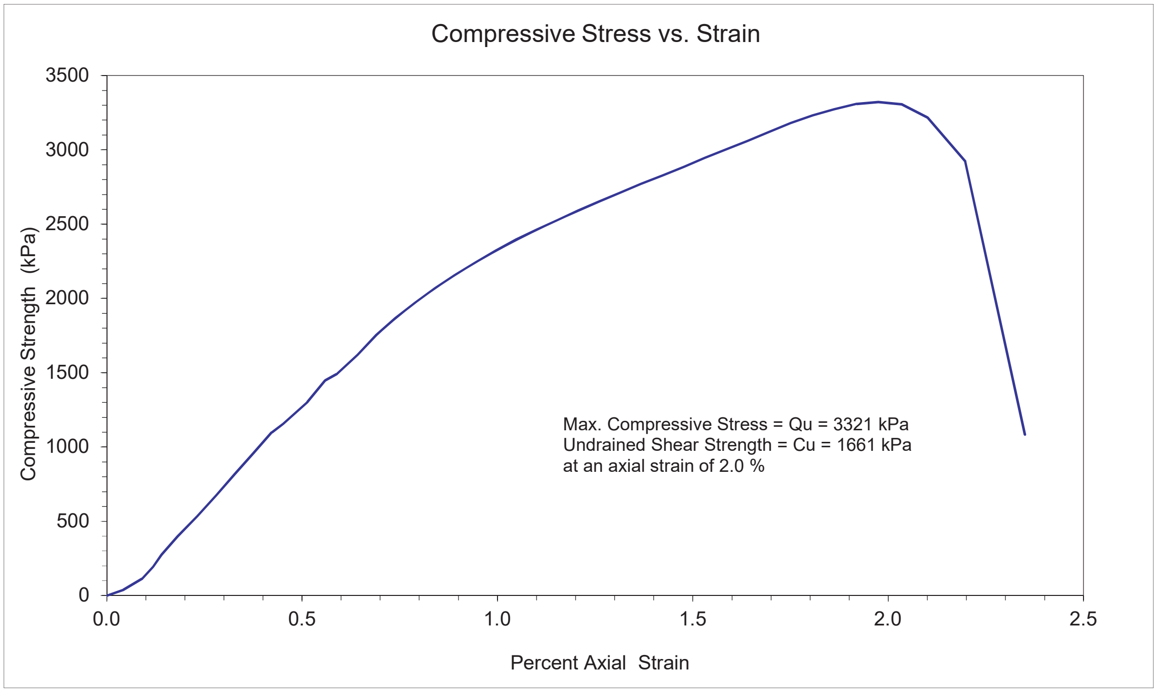
DIALOG		REPORT DATE:	April 29/16
FILE NUMBER :	10298	REPORT NUMBER:	UC16-7

Groat River Bridge

TEST DATE:	April 29/16
SAMPLE:	TH16-2 @ 18.50 - 18.70 m
DESCRIPTION:	Clay Shale (CH), silty, trace coal lenses, dk. grey.

SPECIMEN DETAILS:

Wet Density (kg/m^3):	2191
Dry Density (kg/m^3):	1907
Moisture Content (%):	14.9
Liquid Limit (%):	
Plastic Limit (%):	
Plasticity Index (%):	
Gravel (%):	
Sand (%):	
Silt (%):	
Clay (%):	



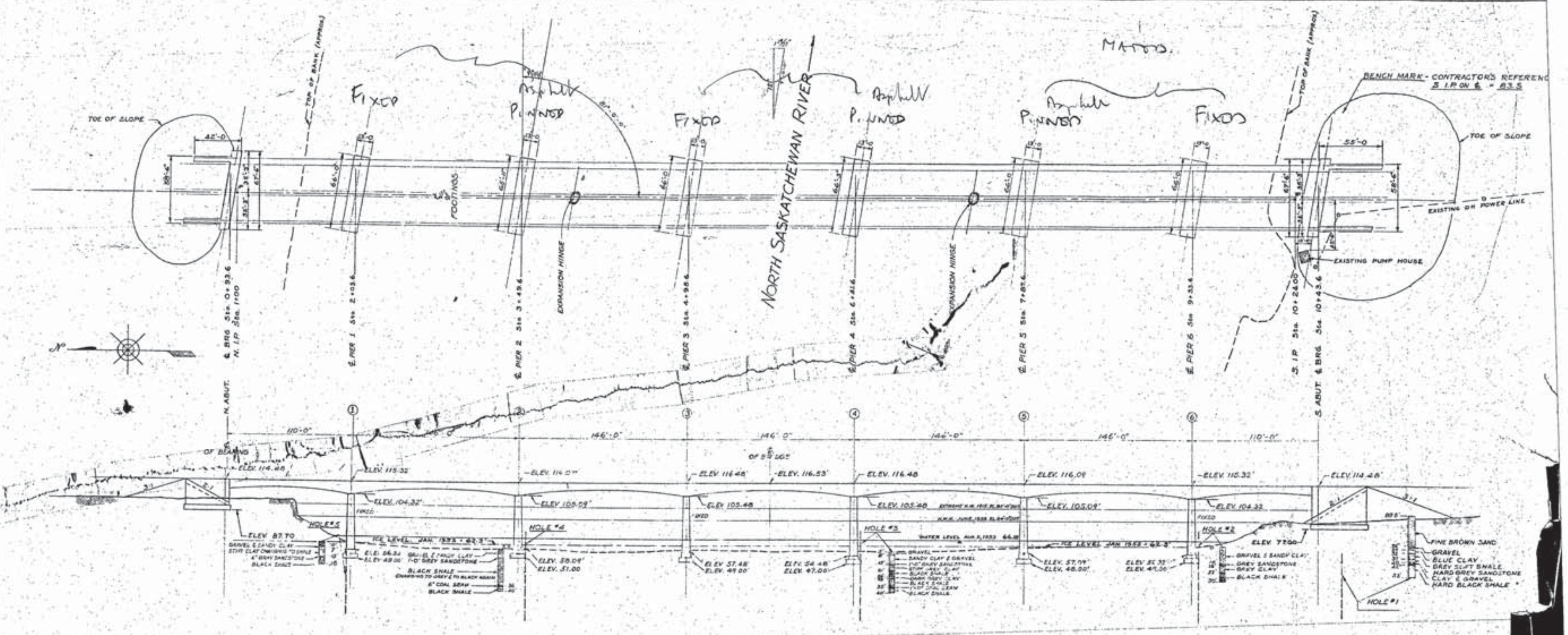
Max. Compressive Stress = Qu = 3321 kPa
Undrained Shear Strength = Cu = 1661 kPa
at an axial strain of 2.0 %

THURBER

APPENDIX D

Bridge Design Drawings

GROA 551 S9



SPECIFICATIONS

CONSTRUCTION: ALBERTA DEPT. OF HIGHWAYS SPECIFICATIONS

DESIGN:

LIVE LOAD H20 S-16 - 44 (AASHO)

DEAD LOAD INCLUDES 15#/SQ.FT FOR ASPHALT WEARING SURFACE

STRESSES $f_c = 0.40 f'_c$

$f_c = 0.45 f'_c$ AT SUPPORTS WITH 3000# CONCRETE

$f_s = 20\,000$ p.s.i.

MAXIMUM PILE LOAD 24 TONS

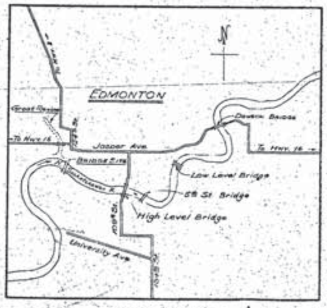
MAXIMUM SOIL PRESSURE 5 TONS/SQ.FT.

AIR ENTRAINMENT: ALL CONCRETE MIXES TO CONTAIN AN APPROVED AIR ENTRAINING AGENT TO BE SUPPLIED BY THE CONTRACTOR.

FOOTING ELEVATIONS ARE APPROXIMATE AND MAY BE ALTERED BY THE RESIDENT ENGINEER.

CONCRETE

CLASS	STRENGTH	MAX. SIZE AGG.	LOCATION
S	2500 psi	1½"	FOOTINGS
A	3000 psi	1½"	PIERS
B	3000 psi	¾"	DECK
D	3000 psi	¾"	PRECAST



SITE PLAN

APPROVED
CHIEF BRIDGE ENGINEER

INDEX		
SHT	TITLE	DRWG. No
1	GENERAL LAYOUT REINF. CONCRETE GIRDER BRIDGE	1057 P
2	NORTH ABUTMENT FOUNDATIONS AND DETAILS	1058 P
3	SOUTH ABUTMENT DECK & DETAILS, STEEL ALTERNATIVE	1059 P
4	SOUTH ABUTMENT AND DETAILS	1060 P
5	PIER 1 & 6	1061 P
6	PIER 2	1062 P
7	PIER 3	1063 P
8	PIER 4	1064 P
9	PIER 5	1065 P
10	PIER NOSE PLATES & HINGE DETAILS	1066 P
11	STEEL SCHEDULE	1067 P
12	GIRDER PROFILE, MAIN DECK SECTION & POUR SCHEDULE	1068 P
13	SIDEWALK GIRDER END SPAN	1069 P
14	INTERIOR GIRDER END SPAN	1070 P
15	INTERIOR CURB GIRDER END SPAN	1071 P
16	EXTERIOR CURB GIRDER END SPAN	1072 P
17	SIDEWALK GIRDER SPANS 1-2 5-6	1073 P
18	INTERIOR GIRDER SPANS 1-2 5-6	1074 P
19	INTERIOR CURB GIRDER SPANS 1-2 5-6	1075 P
20	EXTERIOR CURB GIRDER SPANS 1-2 5-6	1076 P
21	SIDEWALK GIRDER SPANS 2-3 4-5	1077 P
22	INTERIOR GIRDER SPANS 2-3 4-5	1078 P
23	INTERIOR CURB GIRDER SPANS 2-3 4-5	1079 P
24	EXTERIOR CURB GIRDER SPANS 2-3 4-5	1080 P
25	SIDEWALK GIRDER SPAN 3-4	1081 P
26	INTERIOR GIRDER SPAN 3-4	1082 P
27	INTERIOR CURB GIRDER SPAN 3-4	1083 P
28	EXTERIOR CURB GIRDER SPAN 3-4	1084 P
29	DECK REINFORCING DETAILS	1085 P
30	STEEL SCHEDULE	1086 P
31	STEEL SCHEDULE	1087 P
32	HINGE DETAILS TOP OF PIERS & ABUTMENT	1088 P
33	EXPANSION HINGE, EXPANSION DAM, WIND KEYS	1089 P
34	HANDRAIL & POSTS	1090 P
35	UTILITY & DRAINAGE DETAILS, PRECAST DUCT SLAB	1091 P
36	DETAIL OF EXPANSION PLATES	1092 P
37	UTILITY DUCT & CATWALK	1093 P
38	BRIDGE LIGHTING	1094 P
39	GENERAL LAYOUT STEEL GIRDER BRIDGE	1095 P
40	DECK CROSS SECTION STEEL ALTERNATIVE	1096 P
41	PIER 3 FOR STEEL ALTERNATIVE	1097 P

QUANTITIES — REINFORCED CONCRETE GIRDER BRIDGE				
	ITEM	ESTIMATED	AS CONSTRUCTED	UNIT
1	EXCAVATION - COMMON	400		CU.YD.
2	- WET COMMON	2,910		CU.YD
3	- SOLID	100		CU.YD
4	BACKFILL - COMPACTED	17,000		CU.YD
5	CONCRETE - CLASS 'S'	1,608		CU.YD
6	- CLASS 'A'	4046		CU.YD
7	- CLASS 'B'	6544		CU.YD
8	* REINFORCING STEEL (PLACING ONLY)	1510,300		lbs
9	MISCELLANEOUS IRON (PLACING ONLY)	120,000		lbs
10	PRECAST CONCRETE PILING	4214		lin.ft
11	PRECAST CONCRETE DUCT SLABS	172		EACH
12	PRECAST CONCRETE RAIL POSTS	194		EACH
13	STEEL HANDRAIL (PAINTING & PLACING ONLY)	160		PANELS
14	STONE FACING (PLACING ONLY)	3600		SQ.FT
15	LEAD PLATES & ELEC FITTINGS (PLACING ONLY)	—		—
16	FIBER EXPANSION BOARD + SEALING MATL.	—		—

* 1) INCLUDES REINFORCING STEEL FOR ALL PRECAST CONCRETE ITEMS
2) ALL REINFORCEMENT TO BE SUPPLIED BENT TO SHAPE AS DETAILED ON THE PLANS.

GROA 551 S01

NOTES

1. DOTTED LINE PROFILE AND TEST HOLE DA
REFER TO LOCATION 150 FT DOWNSTREAM FR

2. ℄ PROFILE AT BANKS REFERS TO SITE.

NO.	DATE	DESCRIPTION

REVISIONS

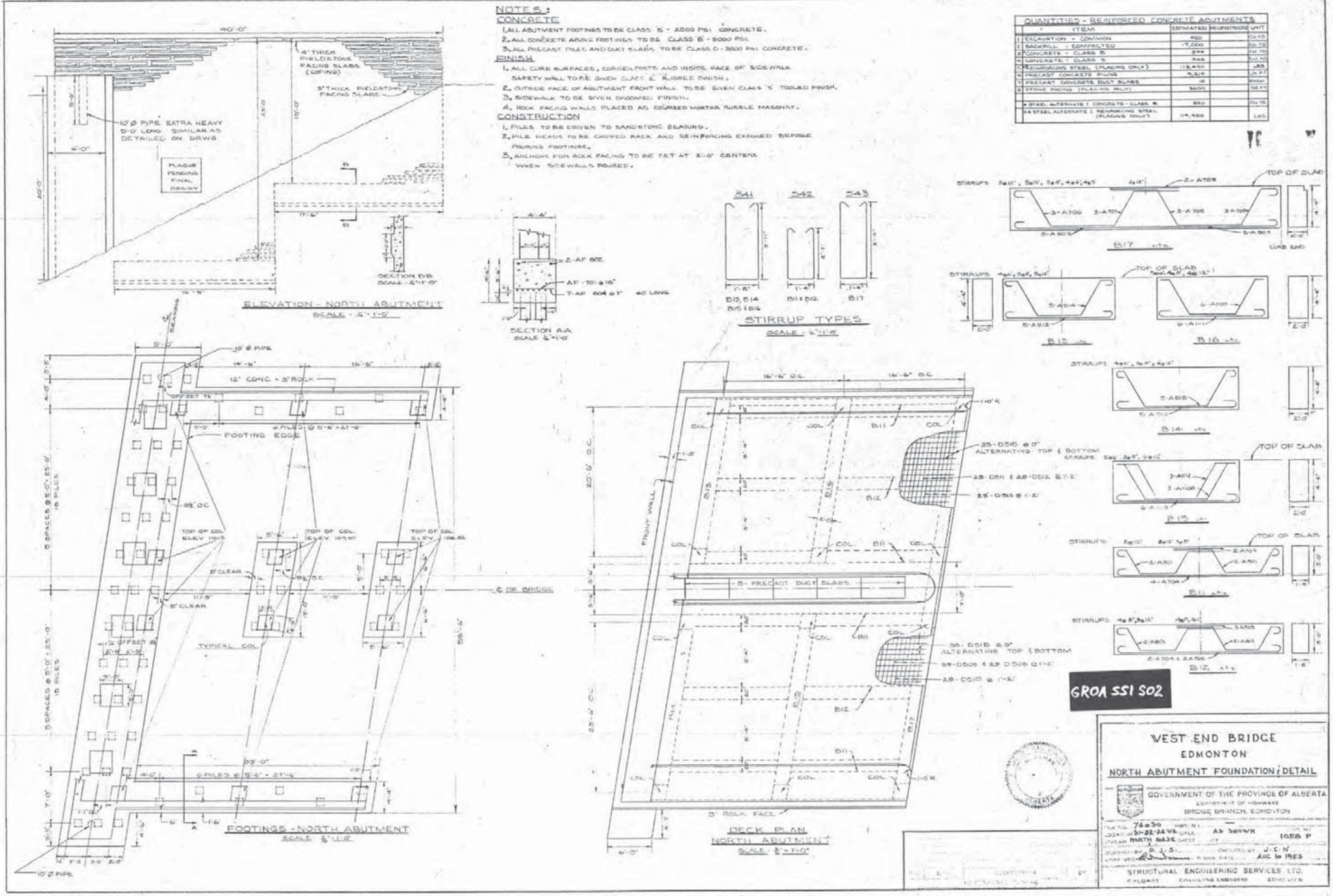
R. N. McMANUS
PROFESSIONAL ENGINEER
ALBERTA

WEST END BRIDGE
NORTH SASKATCHEWAN RIVER
EDMONTON
GENERAL LAYOUT
REINFORCED CONCRETE GIRDER BRIDGE

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 74030 HWY. No. —
LOCATION 31-52-24-W4 SCALE 1" = 40'-0"
STREAM NORTH SASK. SHEET 1
DWG. NO. 1057 P
DESIGNED BY D. FORD CHECKED BY D. de Wolff
APPROVED P. ENG. DATE AUG. 10, 1953

STRUCTURAL ENGINEERING SERVICES LTD.
CALGARY CONSULTING ENGINEERS EDMONTON



NOTES:

CONCRETE

1. ALL ABUTMENT FOOTINGS TO BE CLASS 'S' - 2500 PSI CONCRETE.
2. ALL CONCRETE ABOVE FOOTINGS TO BE CLASS 'B' - 3000 PSI.
3. ALL PRECAST PILES AND DUCT SLABS TO BE CLASS D - 3500 PSI CONCRETE.

FINISH

1. ALL CURB SURFACES, CORNER POSTS AND INSIDE FACE OF SIDEWALK SAFETY WALL TO BE GIVEN CLASS 2 RUBBED FINISH.
2. OUTSIDE FACE OF ABUTMENT FRONT WALL TO BE GIVEN CLASS 'S' TOOLED FINISH.
3. SIDEWALK TO BE GIVEN BROOMED FINISH.
4. ROCK FACING WALLS PLACED AS COURSED MORTAR RUBBLE MASONRY.

CONSTRUCTION

1. PILES TO BE DRIVEN TO SANDSTONE BEARING.
2. PILE HEADS TO BE CHIPPED BACK AND REINFORCING EXPOSED BEFORE POURING FOOTINGS.
3. ANCHORS FOR ROCK FACING TO BE SET AT 2'-0" CENTERS WHEN SIDEWALLS POURED.

QUANTITIES - REINFORCED CONCRETE ABUTMENTS

	ITEM	ESTIMATED	RECONSTRUCTED	UNIT
1	EXCAVATION - COMMON	400		CU.YD.
2	BACKFILL - COMPACTED	17,000		CU.YD.
3	*CONCRETE - CLASS B	844		CU.YD.
4	CONCRETE - CLASS S	566		CU.YD.
5	*REINFORCING STEEL (PLACING ONLY)	118,450		LBS.
6	PRECAST CONCRETE PILING	4,314		LIN.FT.
7	PRECAST CONCRETE DUCT SLABS	18		EACH
8	STONE FACING (PLACING ONLY)	3600		SQ.FT.
	* STEEL ALTERNATE I CONCRETE - CLASS B	880		CU.YD.
	** STEEL ALTERNATE I REINFORCING STEEL (PLACING ONLY)	114,480		LBS.

WEST END BRIDGE
EDMONTON
NORTH ABUTMENT FOUNDATION & DETAIL

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 74030 HWY. NO. —
LOCATION 31-52-24 W4 SCALE AS SHOWN 1058 P
STREAM NORTH SASK. SHEET
DESIGNED BY D. J. S. CHECKED BY J. C. N.
APPROVED [illegible] DATE AUG 10 1953

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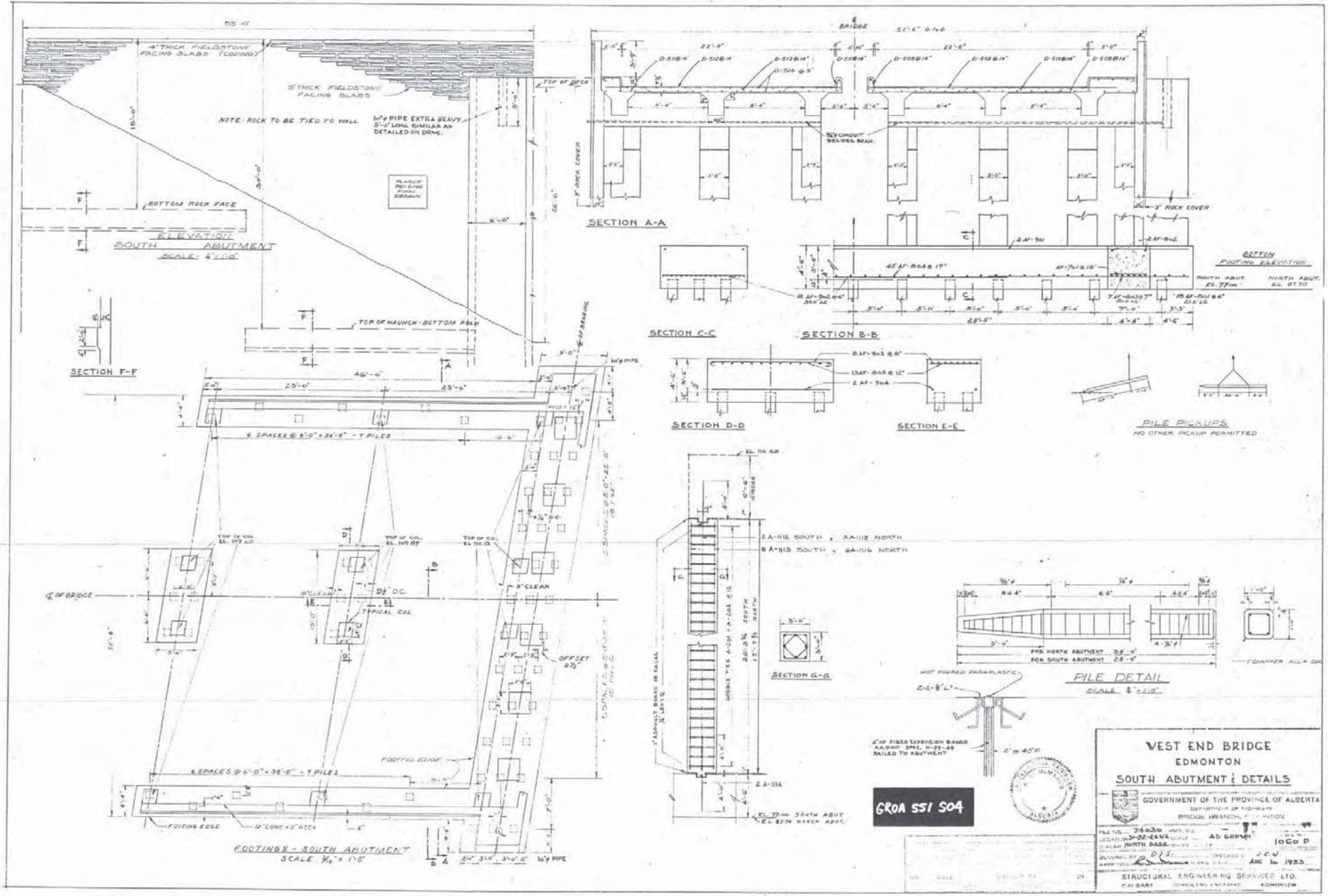
CALGARY CONSULTING ENGINEERS EDMONTON

ALBERTA

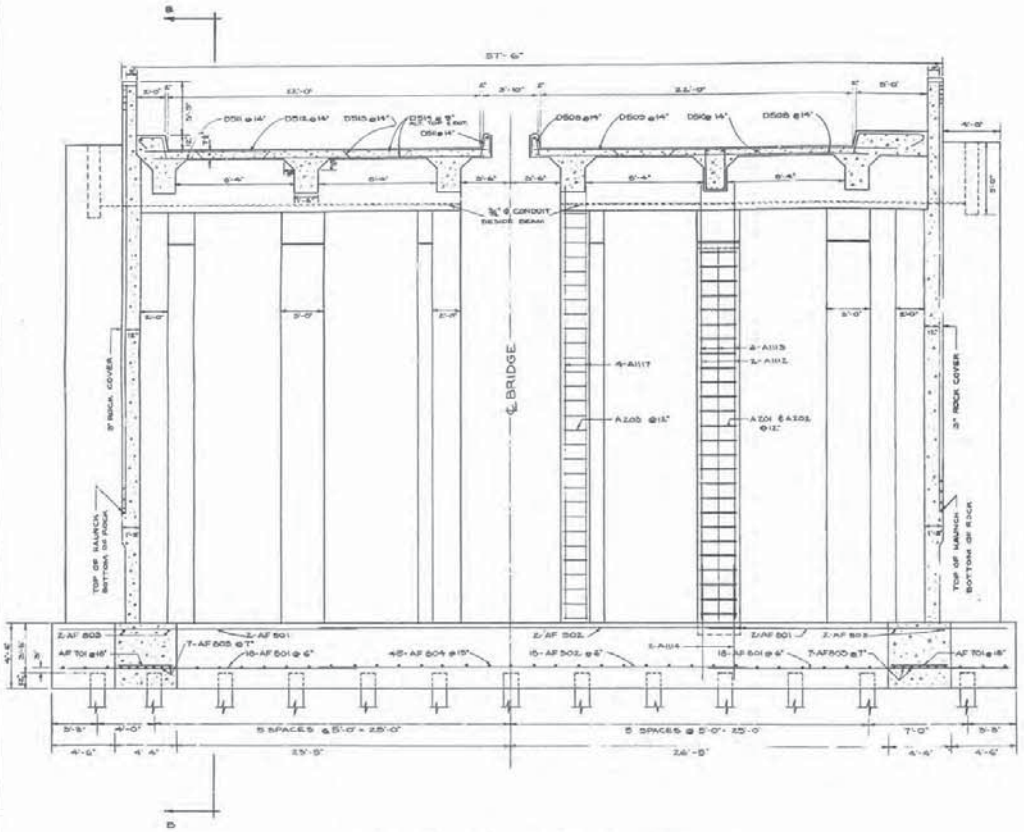


WEST END BRIDGE
EDMONTON
SOUTH ABUTMENT & DETAILS

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 74030
LOCATION 31-52-24 W4
STREAM NORTH SASK.
SCALE AS SHOWN
1060 P
DESIGNED BY D.J.S.
CHECKED J.C.N.
APPROVED
AUG 16 1953

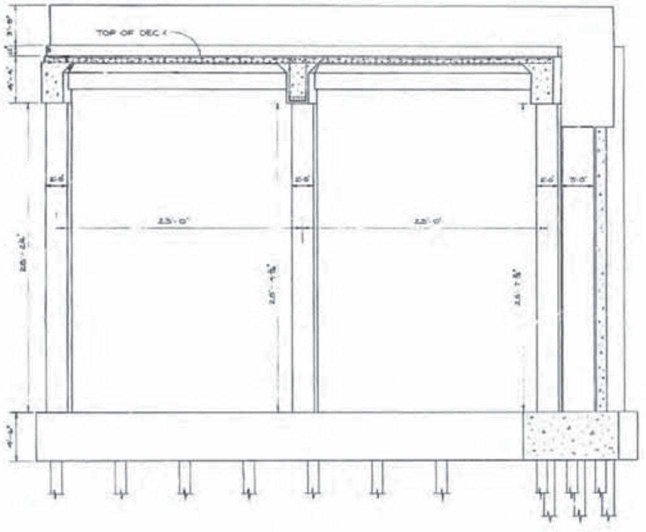
STRUCTURAL ENGINEERING SERVICES LTD.
CALGARY CONSULTING ENGINEERS EDMONTON



SECTION A-A   SEE DWG. 1060P

CROSS SECTION - SOUTH ABUTMENT LOOKING NORTH

SCALE - 1/4" = 1'-0"



SECTION B-B

SCALE - 3/8" = 1'-0"

R. N. McMANUS

NO.	DATE	DESCRIPTION	BY
1	SEPT. 17 '55	SHEET ADDED	MPP

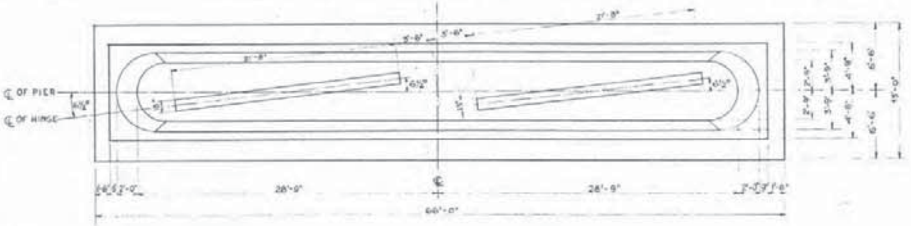
REVISIONS

WEST END BRIDGE
EDMONTON
SOUTH ABUTMENT

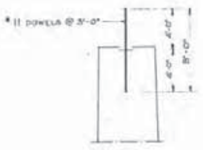
GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH EDMONTON

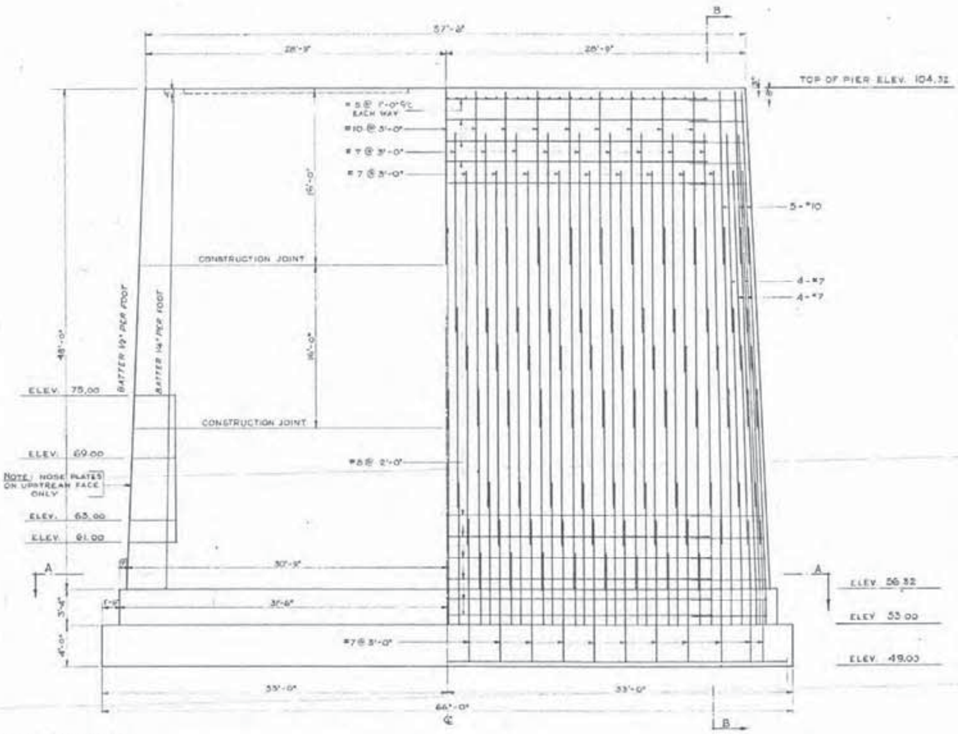
FILE NO. 74030   HWY. NO.
LOCATION 31-52-24-W4 SCALE AS SHOWN   DWG. NO. 1060 A-P
STREAM NORTH SASK.   SHEET
DESIGNED BY D.J.S.   CHECKED BY J.C.N.
APPROVED   P. ENG. DATE SEPT. 17, 1955

STRUCTURAL ENGINEERING SERVICES LTD.
CALGARY   CONSULTING ENGINEERS   EDMONTON

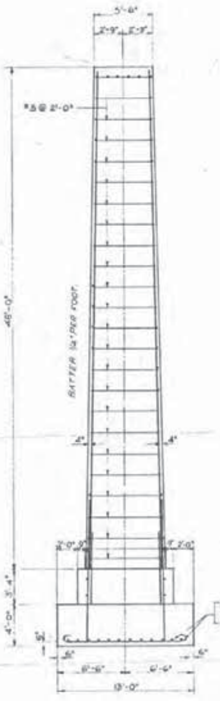


•TOP VIEW•





•ELEVATION•



•SECTION B-B•

•SECTION A-A•

FOR STEEL ALTERNATE

NOTE:

1) TOP OF PIER ELEV. TO BE 103.76
2) DELETE ROCKER WELL AND DOWELS AT TOP OF PIER AND FINISH BEARING SEATS IN ACCORDANCE WITH CONCRETE MASONRY SPECIFICATIONS.
3) TOP OF PEDESTAL ELEV. TO BE 55.76 HEIGHT OF PEDESTAL 2'-9⅛".
4) ELEV. TOP AND BOTTOM OF FOOTING TO REMAIN SAME AS SHOWN.

GENERAL

NOTE

1) FOR PIERS 1 TO 6 FOOTINGS & PEDESTAL CONCRETE 2500 PSI CLASS ,B' SHAFT CONCRETE 3000 PSI CLASS ,A'
2) CONCRETE SURFACE FINISH TO BE CLASS I
3) ALL FOUNDATION ROCK TO BE CHIPPED LEVEL AND CLEANED BEFORE POURING PIER FOOTING

•ESTIMATED QUANTITIES•

PIER 1 & 6 FOR STEEL STRUCTURE			
CONCRETE 2500# CLASS B	185	188	CU.YD
CONCRETE 3000# CLASS A	670	670	CU.YD
REINFORCING STEEL	27555	27555	LBS
MISCELLANEOUS IRON	2658	2555	LBS
WET COMMON EXCAVATION	544	561	CU.YD
BACKFILL	251	272	CU.YD
	1	6	

PIER 1 & 6 FOR CONCRETE STRUCTURE			
CONCRETE 2500# CLASS B	197	197	CU.YD
CONCRETE 3000# CLASS A	670	670	CU.YD
REINFORCING STEEL	28330	28330	LBS
MISCELLANEOUS IRON	2658	2555	LBS
WET COMMON EXCAVATION	544	561	CU.YD
BACKFILL	249	271	CU.YD

WEST END BRIDGE
EDMONTON
PIER 1 & 6

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 74630 HWY. NO. —
LOCATION 01-52-24-W4 SCALE 3/16" = 1'-0" DWG. NO. 1061 P
STREAM NORTH SASK. SHEET
DESIGNED BY CHECKED BY
APPROVED ENG. DATE AUG 10 1955.

STRUCTURAL ENGINEERING SERVICES LTD.
CALGARY CONSULTING ENGINEERS EDMONTON

DATE DESCRIPTION BY