Ottawa Public Library – Library and Archives Canada Joint Facility

Constructability Report

555 Albert St

Ottawa, Ontario

Presented to:

Diamond Schmitt Architects and KWC Architects in Joint Venture for the OPL-LAC Joint Facility

Project: 190167700 November 24, 2020
Revision No.: 1

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1 Introduction

Morrison Hershfield has been retained by Diamond Schmitt Architects and KWC Architects to complete a Constructability Report for the new 5 storey Ottawa Public Library – Library Archives Canada (OPL-LAC) Joint Facility located at 555 Albert St, Ottawa Ontario.

The objective of this report is to demonstrate how the new OPL-LAC Joint Facility will be constructed without impacting existing underground infrastructure owned by the City of Ottawa (City). This report was completed in collaboration with relevant disciplines (structural, geotechnical, architectural).

This report should be read in conjunction with the Site Plan Control Application and the latest versions of the site servicing and grading design documentation prepared by Morrison Hershfield.

1.1 Existing Infrastructure

The existing site consists of a mix of gravel and other hard surfaces. It served as a construction site office and lay-down area for the Stage 1 Light Rail Transit (LRT) project and served a similar purpose for the Combined Sewage Storage Tunnel (CSST) project.

The proposed OPL-LAC Joint facility will be built over, or in proximity to, four critical pieces of City infrastructure:

- Commissioner St 1520mm internal diameter concrete high-pressure transmission watermain (HPWM)
- Albert St 1220mm internal diameter steel HPWM
- 3000mm internal diameter concrete Combined Sewer Storage Tunnel (CSST), which runs in the bedrock below the proposed site
- 1800mm internal diameter concrete Interceptor Outfall Sewer (IOS) trunk sanitary sewer, which runs in the bedrock below the proposed site

In addition to the infrastructure listed above, the LRT tunnel is located along the north-west edge of the site. A Hydro Ottawa duct bank is located along the south-east (Albert Street) edge of the site. An LRT Proximity Study completed by Morrison Hershfield, dated October 2020, provides details regarding protection of the LRT tunnel.

In preparation of the OPL-LAC Joint Facility design and specifications, and development of this report, the OPL-LAC Joint Facility project team has coordinated with the City's Asset Management Branch (AMB) to determine protection requirements for the HPWM's and IOS, and with the CSST project team to determine protection requirements for the CSST. It is understood that the CSST project team will likely disband prior to completion of the OPL-LAC Joint Facility construction. At this stage responsibility for approval of CSST protection requirements will pass to AMB.

The existing backbone watermains and trunk sewer tunnels are displayed in **Figure 1** below. For clarity, only the existing utilities discussed in this report are shown.

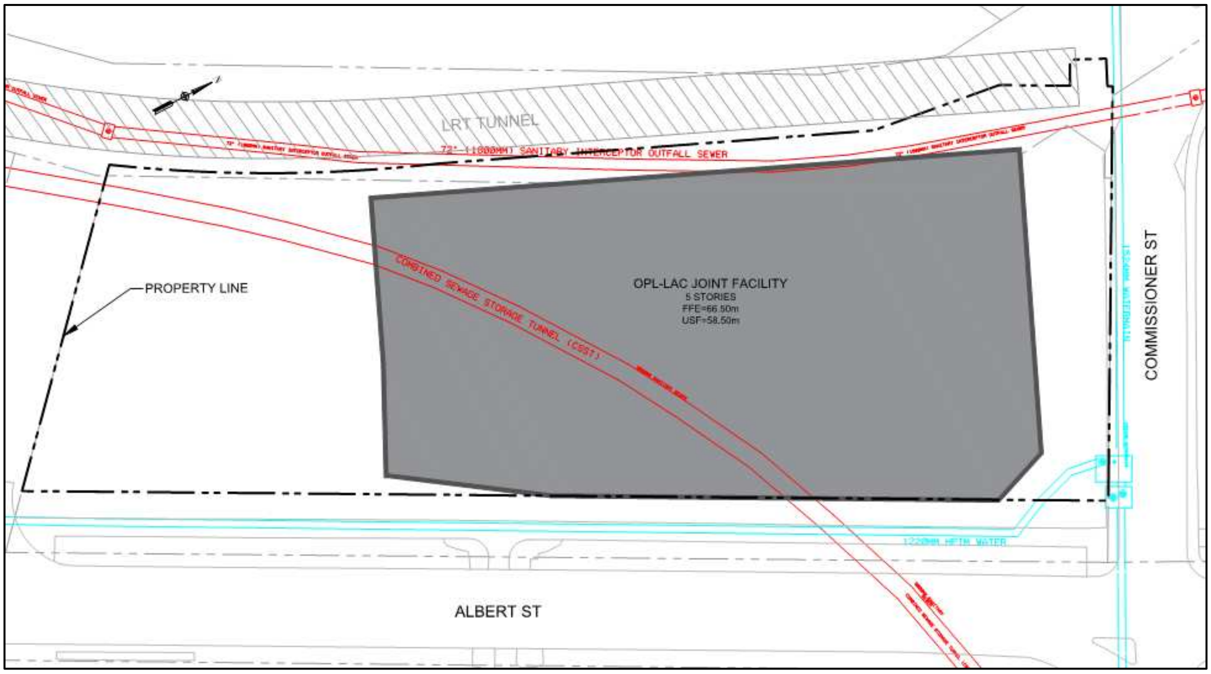


Figure 1 - Existing Backbone Watermains and Trunk Sewer Tunnels

Complete existing utility plans can be found in **Appendix A.** These drawings were prepared using the information listed in **Table 1**.

Table 1 - Locate Information for Backbone Watermains and Trunk Sewer Tunnels

Existing Utility	Locate Information
Commissioner St 1520mm HPWM	Subsurface Utility Engineering (SUE) Quality Level B Investigation in accordance with ASCE 38-02
Albert St 1220mm HPWM	Subsurface Utility Engineering (SUE) Quality Level B Investigation in accordance with ASCE 38-02
3000mm diameter Combined Sewer Storage Tunnel (CSST)	Ottawa Combined Sewage Storage Tunnel, Drawing #PP1 and #1B-C104, Stantec/CH2M Hill, June 2016
1800mm diameter concrete Interceptor Outfall Sewer (IOS)	Interceptor and Outfall Sewer Project, As-built #C35a-2, City of Ottawa, April 1961

1.2 Existing Geotechnical Conditions

A Geotechnical Investigation was undertaken by Golder Associates and is documented in Report No. 19131600 dated June 2020.

The Geotechnical Investigation Report describes the findings of eighteen new boreholes and 19 historical boreholes, drilled to depths up to 33m below the existing ground surface. The subsurface profile at the borehole locations within the area of the investigation consists of surficial fill materials overlying glacial till. The fill is heterogeneous in nature and consists of gravelly sand, to gravelly silty sand, to silty sand, to sand and gravel, to sand, and contains brick fragments, concrete fragments, pockets of silty clay, ash, and cobbles and boulders. The fill is underlain by glacial till at depths of 1.4 to 3.7m below grade. Bedrock depth varies between 4.2m – 13.4m below existing grade, generally increasing in depth from the north-east to south-west ends of the site.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and shale of the Verulam formation.

Groundwater was encountered at depths of 2.0 – 5.7 m below the existing ground surface.

2 Proposed Site Development

The proposed OPL-LAC Joint Facility is a 5-storey mixed-use commercial building. The OPL-LAC Joint Facility will house the new central Ottawa Public Library and the Library and Archives Canada's public services. The building will include two underground parking levels with access lanes and a loading dock area. The underside of the slab of the lowest parking level (P2) is at an elevation of approximately 58.5m above datum. The loading bay area will be located on the north side of the building along Commissioner Street, it will include two indoor loading docks and will be on the P1 parking level (61.5m above datum). The site will include an outdoor amphitheater and community spaces incorporating a mix of landscape elements. The project will require the addition of underground utilities, including new domestic water, sanitary, and storm services, an underground storm water storage tank, and a storm water pumping station.

Reconstruction of Albert Street is under design by the City as part of the Albert-Slater Reconstruction Project. This project will include raising existing grades along Albert Street by approximately 2.0m, the replacement of the existing combined sewers within Albert Street with separated storm and sanitary sewers as well as installation of a new 200mm diameter watermain. Construction of Albert Street is currently planned to be carried out in parallel with construction of the OPL-LAC Joint Facility, and to be completed prior to the OPL-LAC Joint Facility.

3 Infrastructure Protection Requirements

An initial meeting was held with representatives of the City of Ottawa (Asset Management Branch, AMB) and the OPL-LAC Joint Facility consultant design team on July 19th, 2019 to discuss potential impacts on existing underground infrastructure and AMB's requirements for protection of this infrastructure. The outcomes from this meeting are detailed in the following sections. The meeting minutes are provided in **Appendix B**.

3.1 Albert St HPWM

- Clearance from outside of HPWM to face of permanent building foundation was requested to be a minimum of 5m conceptually, subject to confirmation through the detailed design and Site Plan Application (SPA) processes.

- A vibration monitoring plan developed by a specialist geotechnical consultant was requested, and is to be implemented during construction. The team was requested to ensure that the geotechnical consultant has expertise in construction adjacent to critical infrastructure

- AMB indicated that a formal construction schedule would be required in order for both AMB and Drinking Water Services (operations) to assess whether or not it will be possible for the pressure in the Albert St HPWM to be reduced during the OPL-LAC excavation, based on predicted water demands

3.2 Commissioner St HPWM

- As above, clearance from outside of HPWM to face of permanent building foundation was requested to be a minimum of 5m conceptually, subject to confirmation through the detailed design and SPA processes

- A vibration monitoring plan was requested, similar to the Albert St HPWM.

3.3 Combined Sewage Storage Tunnel (CSST)

- The OPL-LAC Facility design team was requested to consult with the CSST project team regarding the required setback of OPL-LAC building foundations from CSST:
    - Initial correspondence with the CSST project team during June 2019 resulted in a total clear distance (setback) requirement of 4m between the outside of the CSST and the OPL-LAC building foundations.

    - During subsequent meetings with the CSST project team on October 13 and November 11, 2020 it was determined that a reduced clearance may be acceptable. It was also determined, that subject to completion of appropriate analysis, negligible increases in vertical or horizontal loading on the CSST may be acceptable.

- AMB indicated that pre and post-construction CCTV inspection of the CSST will be required.

3.4 Interceptor Outfall Sewer (IOS)

- It was agreed that the OPL-LAC facility should be designed such that there is no net increase in loading on the IOS.

- AMB indicated that pre and post-construction CCTV inspection of the IOS will be required.

4 Proposed Protection Measures

Proposed protection measures have been prepared to address the requirements for the critical pieces of infrastructure as outlined above. The following documents were referenced when preparing this section of the report:

- Geotechnical Investigation, Proposed Central Library, 555 Albert Street, Report #19131600, Golder Associates, June 2020.
- Settlement and Vibration Monitoring for Sensitive Infrastructure, Specification, Golder Associates, August 13, 2020.
- Foundation Interaction with Existing Tunnels, Structural Report, Fast + Epp, November 16, 2020.
- Utility Protection, Specification, Morrison Hershfield, August 2020.

4.1 Setbacks to HPWM and Temporary Shoring Design

4.1.1 Setbacks to HPWM's

The proposed foundation has been designed to generally meet the setback requirements for the HPWM along Albert St and Commissioner St as outlined above. Two locations have slightly reduced setbacks and are described below. The setbacks are intended to be sufficient to allow construction of the OPL-LAC Joint Facility without impact to the HPWM, and to allow future excavation for access to the HPWM to be carried out without impact to the OPL-LAC Joint Facility.

The proposed setback from the foundation wall to the Albert St HPWM ranges from 5.2 to 5.3m along the face of the building. Immediately south-west of Commissioner St, the Albert St HPWM turns 45 degrees and crosses the corner of the OPL-LAC Joint Facility site. For a length of approximately 9.5m along this section of the HPWM, the setback reaches a minimum of 4.5m.

The proposed setback from the OPL-LAC Joint Facility to the Commissioner St HPWM varies from 12 to 15m. For a length of 24m along close to Albert St, a part of the structure including a Hydro Vault, Storage Room and retaining wall will protrude closer to the HPWM, with a minimum clearance of 4.5m. This protruding part of the structure will be shallower than the main OPL-LAC Joint Facility, with its floor slab at a similar elevation to the invert of the HPWM.

Refer to **Appendix A** for a drawing which details these setbacks to the HPWM.

4.1.2 Future excavation to HPWM's

Since the OPL-LAC Joint Facility will extend two floors below grade, future excavation to the depth of the HPWM could safely extend to the face of the building (subject to appropriate support of the existing Hydro Ottawa ductbank). The HPWM adjacent to the Hydro Vault structure is at a similar elevation to the floor slab, and could also be excavated without undermining the floor slab. The proposed setbacks, including the two areas with reduced setbacks of 4.5m, allow sufficient space for use of a trench box or shoring system to allow excavation of a vertical-sided trench.

4.1.3 Temporary Shoring Design

As recommended by the Geotechnical Report, all excavation for construction of the OPL-LAC Joint Facility adjacent to sensitive infrastructure will be shored. The following are the recommendations provided in the Geotechnical Report prepared by Golder Associates for the temporary shoring system design:

- A soldier pile and timber lagging system is considered a suitable shoring method that may be considered for the proposed 5 to 7 m deep excavation at the site.

- Where foundations or settlement sensitive infrastructure, such as buried utilities, are present within the zone of influence of the shoring system the deflections may need to be greatly limited and a secant pile wall with pre-stressed tie backs may be required.

- Steel sheet pile systems would not be suitable where very dense till is present at shallow depth.

It is anticipated that the shoring system will require tiebacks, which would pass below the HPWM's to reach bedrock. No impact on the HPWM's is expected, provided that the contractor demonstrates that:

i. The tiebacks will be installed far enough below the HPWM's that there is no risk of damage to the watermain during installation (i.e. minimum of 2m clearance)

ii. The vertical and horizontal position of the HPWM's will be verified by daylighting (with survey of coordinates and elevation) prior to installation of tiebacks

iii. The tiebacks will be anchored in bedrock

iv. The tiebacks will be destressed (cut) prior to completion of the project.

The contractor is fully responsible for the detailed design and performance of the temporary shoring system. The temporary shoring drawings will be provided to AMB and to the CSST design team for review once received from the contractor.

4.1.4 Construction Schedule

It is understood that Drinking Water Services may consider reducing the operating pressure of the HPWM's either during shoring installation, or during the period that shoring is in place. The current proposed construction schedule is as follows:

Early Works Contract (Excavation, Shoring and Caissons):

Commencement of Excavation	October 2020
Commencement of Shoring	December 2020
Completion of Shoring	January 2021
Completion of Bulk Excavation	January 2021

Commencement of Caissons	February 2021
Completion of Caissons	May 2021

Main Contract:

Commencement of Foundations	August 2021
Structure complete to grade	December 2021
Completion of Superstructure and Roof	July 2022
Building Weathertight	October 2022
Complete Mechanical & Electrical	April 2023
Complete Landscaping	January 2024
Construction Completion	November 2024

4.2 Settlement and Vibration Monitoring

A Settlement and Vibration Monitoring specification has been prepared by Golder Associates dated July 2020. The specification identifies the requirements for settlement and vibration monitoring for each piece of existing infrastructure, including settlement and vibration limits. The contractor will be responsible for development and implementation of the final settlement and vibration monitoring plan. The complete specification is presented in **Appendix C**.

Vibration Monitoring is proposed for both HPWM's, as requested in the meeting held on July 19th, 2019 (refer to **Section 3** above), and also for the IOS and CSST.

Due to limited access to the CSST, vibration monitors for the CSST will be installed in boreholes adjacent to the CSST tunnel.

Due to limited access to the IOS, vibration monitoring will be by installation of a vibration monitor on the Ottawa Light Rail Transit (OLRT) tunnel, which is considered to be more likely to experience vibration since it is adjacent and above the IOS.

4.3 Loading on CSST and IOS

The project structural engineer, Fast + Epp, provided a report titled *Foundation Interaction with the Existing Tunnels*. The report describes the interaction of the foundation of the proposed building with the existing underground infrastructure. A summary of the proposed protection measure are summarized in this section of the report; the complete report and pile layout is provided in **Appendix D**.

4.3.1 <u>Combined Sewer Storage Tunnel (CSST)</u>

The proposed foundation design developed by Fast + Epp supports columns above the CSST on transfer beams founded on caissons located a clear distance of at least 1.5m either side of the CSST.

The caissons closest to the CSST will be sleeved to minimize the transfer of load into the rock in the zone of influence of the CSST. The bottom of the sleeves will be at or below the invert elevation of the CSST.

Golder Associates has completed analysis of the effect of the caissons on the CSST (refer to correspondence in **Appendix F**). The analysis indicates that under static conditions, the vertical and horizontal loading at the invert level of the CSST will be less than 2 kPa.

Under seismic loading conditions, Golder's analysis indicates that the caisson loading on the CSST within the vicinity of caissons 11, 15, 19, and 23 (see pile layout in **Appendix D**) is between -10 and 10 kPa. Golder's opinion is that this additional loading can be considered as negligible in comparison to the direct seismic loads on the CSST tunnel.

4.3.2 Interceptor Outfall Sewer (IOS)

As detailed in the structural report, the west side of the building basement will be supported on ground beams which cantilever from the first interior line of caissons. This ensures that no foundation load is applied directly over the IOS tunnel.

The proposed caisson locations are a minimum of 3.4m from the location of the IOS indicated by the As-Built drawing. The location of the IOS will be verified prior to caisson installation. If necessary, caisson locations will be adjusted to maintain a minimum setback of 1.5m from the outside of the tunnel wall (i.e. the same clearance proposed for the CSST).

Similar to the CSST, the caissons closest to the IOS will be sleeved to minimize the transfer of load into the rock in the zone of influence of the tunnel. The bottom of the sleeves will be at or below the invert elevation of the IOS.

4.4 Pre and Post-Construction CCTV

A Utility Protection specification has been developed (**Appendix E**), outlining utility protection and pre- and post-construction condition assessment requirements. The contractor will be responsible for completion of pre- and post-construction CCTV inspections of the CSST and IOS sewer tunnels.

5 Conclusions

In conclusion, the proposed protection measures presented in this report address the City of Ottawa requirements identified in the pre-consultation phase and subsequent discussions. We consider these protection measures to be sufficient to ensure the constructability of the OPL-LAC Joint Facility without impacting the existing underground infrastructure. It is recommended that this report be submitted to the City of Ottawa in support of the application for Site Plan Approval.

Sincerely,

Morrison Hershfield Limited

LICENSED PROFESSIONAL ENGINEER
J.G. FOOKES
Nov 24, 2020
PROVINCE OF ONTARIO

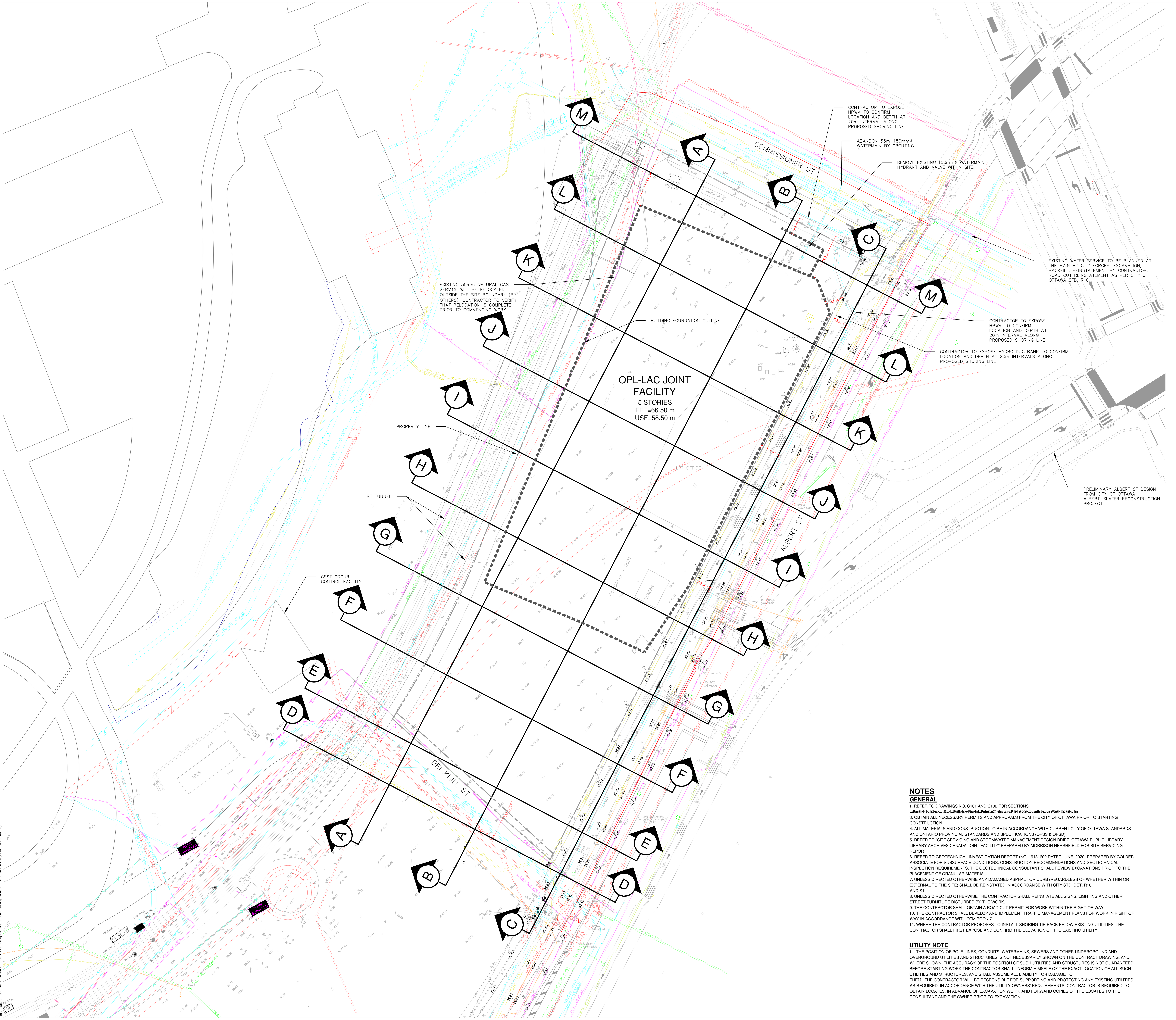
James Fookes, P.Eng., C.Eng.

Senior Municipal Engineer

Noah Chauvin, BASc

Municipal Designer

APPENDIX A: Existing Utility Plans



NOTES

GENERAL

1. REFER TO DRAWINGS NO. C101 AND C102 FOR SECTIONS
[illegible]
3. OBTAIN ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF OTTAWA PRIOR TO STARTING CONSTRUCTION
4. ALL MATERIALS AND CONSTRUCTION TO BE IN ACCORDANCE WITH CURRENT CITY OF OTTAWA STANDARDS AND ONTARIO PROVINCIAL STANDARDS AND SPECIFICATIONS (OPSS & OPSD).
5. REFER TO "SITE SERVICING AND STORMWATER MANAGEMENT DESIGN BRIEF, OTTAWA PUBLIC LIBRARY - LIBRARY ARCHIVES CANADA JOINT FACILITY" PREPARED BY MORRISON HERSHFIELD FOR SITE SERVICING REPORT
6. REFER TO GEOTECHNICAL INVESTIGATION REPORT (NO. 19131600 DATED JUNE, 2020) PREPARED BY GOLDER ASSOCIATE FOR SUBSURFACE CONDITIONS, CONSTRUCTION RECOMMENDATIONS AND GEOTECHNICAL INSPECTION REQUIREMENTS. THE GEOTECHNICAL CONSULTANT SHALL REVIEW EXCAVATIONS PRIOR TO THE PLACEMENT OF GRANULAR MATERIAL.
7. UNLESS DIRECTED OTHERWISE ANY DAMAGED ASPHALT OR CURB (REGARDLESS OF WHETHER WITHIN OR EXTERNAL TO THE SITE) SHALL BE REINSTATED IN ACCORDANCE WITH CITY STD. DET. R10 AND S1.
8. UNLESS DIRECTED OTHERWISE THE CONTRACTOR SHALL REINSTATE ALL SIGNS, LIGHTING AND OTHER STREET FURNITURE DISTURBED BY THE WORK.
9. THE CONTRACTOR SHALL OBTAIN A ROAD CUT PERMIT FOR WORK WITHIN THE RIGHT-OF-WAY.
10. THE CONTRACTOR SHALL DEVELOP AND IMPLEMENT TRAFFIC MANAGEMENT PLANS FOR WORK IN RIGHT OF WAY IN ACCORDANCE WITH OTM BOOK 7.
11. WHERE THE CONTRACTOR PROPOSES TO INSTALL SHORING TIE-BACK BELOW EXISTING UTILITIES, THE CONTRACTOR SHALL FIRST EXPOSE AND CONFIRM THE ELEVATION OF THE EXISTING UTILITY.

UTILITY NOTE

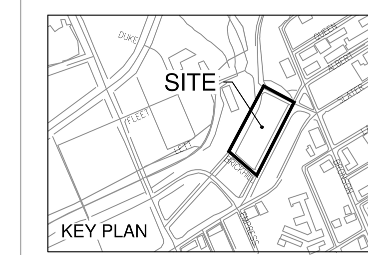
11. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWING, AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM. THE CONTRACTOR WILL BE RESPONSIBLE FOR SUPPORTING AND PROTECTING ANY EXISTING UTILITIES, AS REQUIRED, IN ACCORDANCE WITH THE UTILITY OWNERS' REQUIREMENTS. CONTRACTOR IS REQUIRED TO OBTAIN LOCATES, IN ADVANCE OF EXCAVATION WORK, AND FORWARD COPIES OF THE LOCATES TO THE CONSULTANT AND THE OWNER PRIOR TO EXCAVATION.

CONTRACTOR MUST CHECK & VERIFY ALL DIMENSIONS ON THE JOB.

DO NOT SCALE DRAWINGS.

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNTIL SIGNED BY THE ARCHITECT.

MORRISON HERSHFIELD
200-2932 BASELINE ROAD, OTTAWA, ON K2H 1B1



ISSUED

No.	Date	Description
0	06/29/20	EARLY WORKS PH.1 REVIEW SUBMISSION
1	08/12/20	EARLY WORKS PH.1 ISSUED FOR TENDER
2	10/02/20	ISSUED FOR CONSTRUCTION - EARLY WORKS

LICENSED PROFESSIONAL ENGINEER
J.G. FOOKES
Oct 2, 2020
PROVINCE OF ONTARIO

Diamond Schmitt Architects
KWC Architects Inc.
Architects in Joint Venture for the OPL/LAC Joint Facility
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OPL - LAC JOINT FACILITY

555 ALBERT ST.

OTTAWA ON
K1R 7X3

EARLY WORKS PHASE 1
UTILITIES PROTECTION PLAN

Scale:	1:300
Project No:	OCL1
Date:	27/08/20

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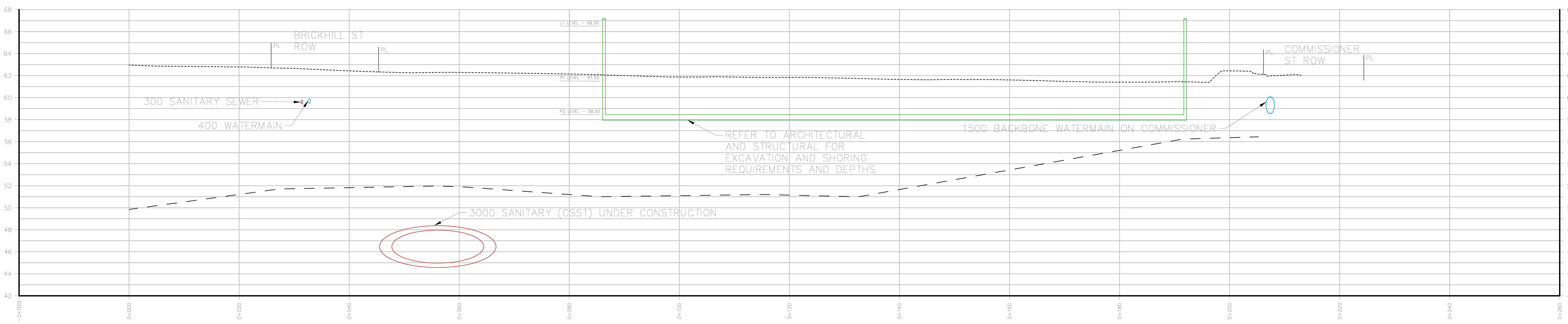

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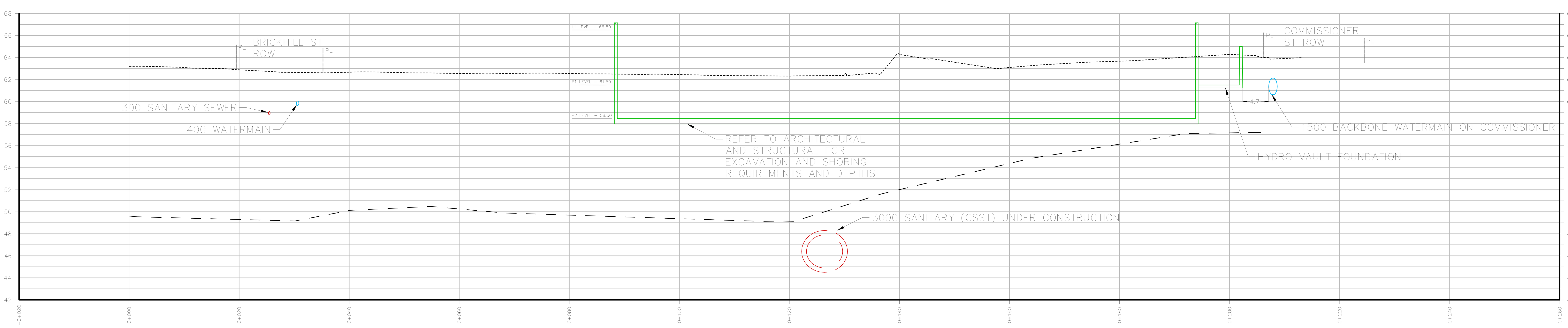
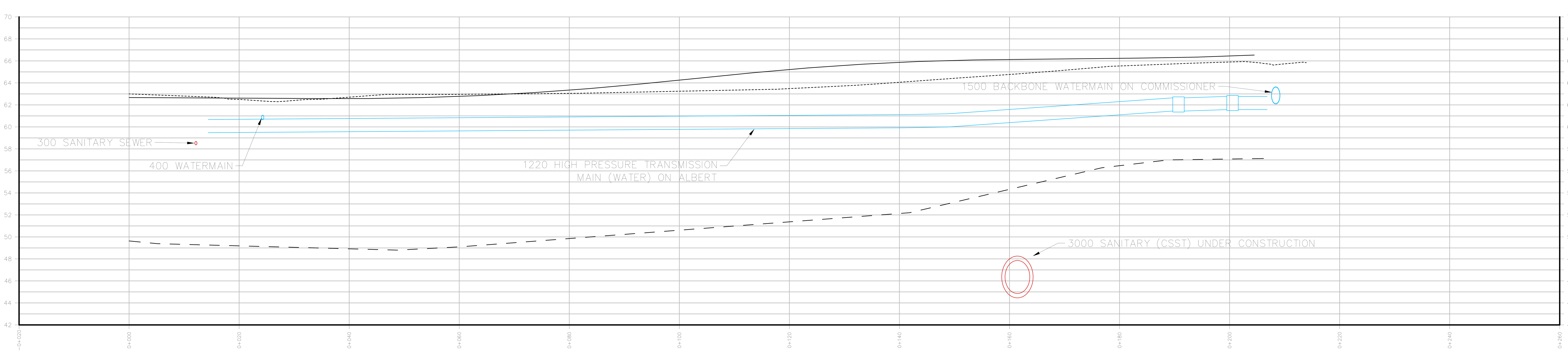


Section B–B



Section C–C

NOTES

GENERAL

1. ONLY SELECTED UTILITIES ARE SHOWN ON THESE SECTIONS. REFER TO DRAWING C100 FOR LOCATION OF SECTIONS, AND FOR LOCATIONS OF ALL KNOWN UTILTIES.
2. BEDROCK SURFACE IS APPROXIMATE AND SHALL NOT BE RELIED UPON FOR BIDDING, SHORING DESIGN, EXCAVATION, OR ANY OTHER PURPOSE. REFER TO GEOTECHNICAL INVESTIGATION REPORTS (GEOTECHNICAL INVESTIGATION NO.19131600, PROPOSED CENTRAL LIBRARY, GOLDER ASSOCIATES LTD., JUNE 2020) FOR MOST COMPLETE AVAILABLE INFORMATION.

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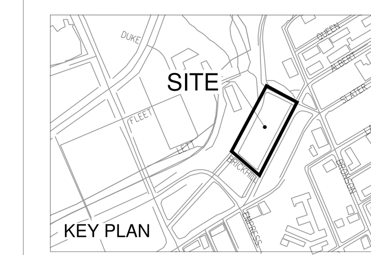
ALBERT ST. DESIGN GRADE
TOPO SURFACE
BEDROCK SURFACE
BUILDING FOUNDATION

MORRISON HERSHFIELD
200-2932 BASELINE ROAD, OTTAWA, ON K2H 1B1



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LICENSED PROFESSIONAL ENGINEER
J.G. FOOKES
Oct 2, 2020
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OPL - LAC JOINT FACILITY

555 ALBERT ST.

OTTAWA ON
K1R 7X3

EARLY WORKS PHASE 1
UTILITIES PROTECTION SECTIONS

Scale: 1:300
Project No: OCL1
Date: 27/08/20

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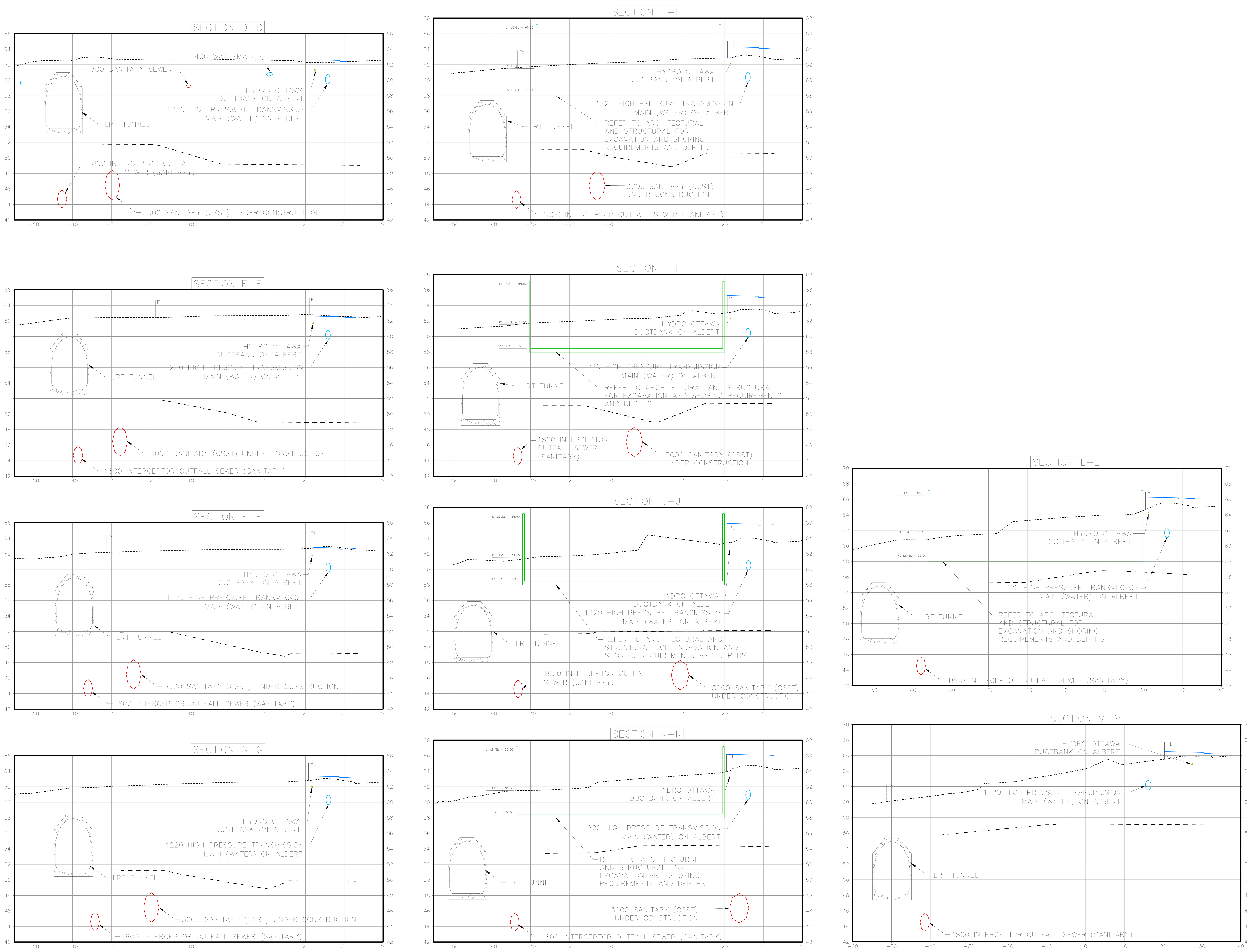

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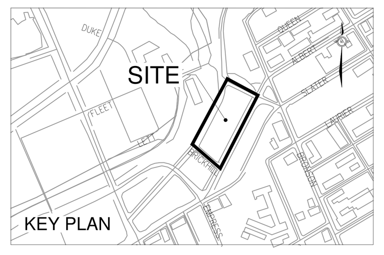

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OPL - LAC JOINT FACILITY

555 ALBERT ST.

OTTAWA ON
K1R 7X3

EARLY WORKS PHASE 1
UTILITIES PROTECTION SECTIONS

Scale: 1:350
Project No: OCL1
Date: 27/08/20

C102

APPENDIX B: Pre-construction Meeting Minutes

MINUTES

Civil Engineering – Meeting to discuss Backbone Watermain & Trunk Sewer Impacts

Project:	OPL-LAC Joint Facility	**Project No.:**	190167700
Attendees:	Paul Hussar (PH), City of Ottawa Richard Fouchard, City of Ottawa Peter McKay (PM), City of Ottawa James Fookes, Morrison Hershfield (MH) Bryan Kipp, Morrison Hershfield (MH)	**Absent:**	N/A
Date / Time:	July 19, 2019, 3-4pm	**Place:**	191 Laurier

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ITEM	MINUTES	ACTION BY / DATE

1. Clearance to High Pressure Watermains (HPWM's)

1.1 Albert St HPWM (1220mm diameter steel watermain)

- Discussed clearance shown on Schematic Design drawings from outside of Albert St HPWM to face of permanent building foundation.
  - MH advised that based on as-built drawings and results of subsurface utility engineering (SUE) investigation, current clearance provided on design drawings is approximately 6.25m, constant along the east edge of the building adjacent to Albert St.
  - PM stated that typical watermain easement width is 3m from pipe centerline to edge of easement, or 6m total width. PM continued to describe that the purpose of typical easement width is such that watermain can be repaired or rehabilitated adjacent to infrastructure that may exist (e.g building foundation, retaining wall). Given that the subject HPWM is a critical piece of infrastructure, PM advised that the offset from the edge of the watermain to the face of the building foundation needs to be increased beyond the typical 3m.
  - **PM advised that clearance from outside of HPWM to face of permanent building foundation can be an absolute minimum of 5m conceptually, subject to confirmation through the detailed design and Site Plan Application (SPA) processes.**

PM

- **Discussed that a Geotechnical consultant will need to be develop vibration monitoring plan to be implemented during construction. PH confirmed that**

Geotechnical consultant will be engaged to provide vibration monitoring of all critical infrastructure located on the OPL-LAC site.

PH

- Discussed OPL-LAC construction timing in relation to CSST project, and in relation to seasonal water demands and associated function of Fleet Street Pumping Station. PM raised concern about excavation adjacent to HPWM while watermain is required to operate at high pressure (i.e. during peak demand periods).
  - PH advised that CSST will be completed prior to construction beginning for OPL-LAC Joint Facility.
  - PM advised that peak water demand occurs during the summer months, beginning in mid to late May.
  - PH advised that OPL-LAC construction is to begin in 2020. PH proposed that excavation of OPL-LAC could begin in early 2021, prior to the beginning of peak summer water demand conditions. PH stated that excavation could begin on Albert St side, to ensure that bottom of excavation is reached prior to start of peak summer water demand conditions.
  - **PM advised that formal construction schedule is required in order for City Asset Management and Operations to assess whether or not it will be possible for the pressure in the Albert St HPWM to be reduced during the OPL-LAC excavation, based on predicted water demands.**

2. PH

  - **PM stated that input from Geotechnical consultant specialized in construction adjacent to critical infrastructure will be required in order to provide recommendations to the City in terms of risk associated with excavating adjacent to the Albert St HPWM in a fully pressurized state vs. non-pressurized state, and protective measures or specific type of support of excavation system that would need to be implemented.**

PH

<u>1.2 Commissioner St HPWM (1524mm diameter concrete pressure pipe watermain)</u>

- Discussed clearance shown on Schematic Design drawings from outside of Commissioner St HPWM to face of permanent building foundation.
  - MH advised that based on as-built drawings and results of subsurface utility engineering (SUE) investigation, current clearance provided on design drawings is approximately 6m at northeast corner of proposed OPL-LAC building, increasing to approximately 12m at northwest corner of proposed building adjacent to Fleet Street Pumping Station.
- **As above, PM advised that clearance from outside of HPWM to face of permanent building foundation can be an absolute minimum of 5m conceptually, subject to confirmation through the detailed design and SPA processes.**
- **PM confirmed that vibration monitoring requirements and input from Geotechnical consultant specialized in construction adjacent to critical infrastructure will be required, similar to Albert St HPWM.**

PH

3. CSST

- PH advised that consultation with CSST project team is in progress regarding required setback of OPL-LAC building foundations from CSST and that no net increase in loading on CSST shall occur.

4. Interceptor Outfall Sewer (IOS) - Sanitary

- Discussed age of 1800mm IOS and that depth of cover is greater than that of CSST.
- PH advised that proposed foundation construction over top of CSST uses a raft system, whereby piles will be excavated to bear directly on the bedrock, with a reinforced concrete slab spanning over the CSST such that no net increase in loading results.
- **PM advised that requirement of no net loading increase shall also apply to IOS. PH/MH to provide loading requirement to OPL-LAC Structural consultant. PM advised that a submission will be required from the structural engineer as part of the Site Plan Control submission.**

  PH/MH
- PH advised that in some areas loading imposed in area of IOS will be only be 2 parking garage levels and at-grade terracing, as upper levels of building are offset towards Albert St.
- CCTV
  - MH reported that pre-construction closed circuit television (CCTV) and sonar inspection from Stage 1 LRT project had been obtained from the City.
  - **PM advised pre and post-construction CCTV inspection of IOS will be required for OPL-LAC project.**
  - MH discussed possibility of using Stage 1 LRT post-construction CCTV inspection results as baseline (pre-existing conditions) for OPL-LAC project. Given that the Stage 1 post-construction inspection was completed in 2017, and that construction on the OPL-LAC facility will not begin until 2021, and considering that the CSST project has been using the OPL-LAC site for lay-down and staging, it was determined that a new pre-construction CCTV inspection will need to be completed as part of the OPL-LAC project.
  - PM estimated that the previous CCTV investigations completed as part of the Stage 1 LRT project cost approximately $10,000 each.
  - PM advised that Scott Laberge, Manager of Wastewater Collections with the City, should be contacted to schedule and coordinate the CCTV investigations.

5. OPL-LAC Joint Facility Design and SPA schedule

- PH advised that approximate timelines for design completion and SPA are as follows:
  - Formal SPA Pre-Consultation meeting - November 2019.
  - Detailed Design Completion - end of January 2020.
  - Formal SPA to be submitted - March 2020.
- PH advised that City Development Review representative is Richard Buchannan.

6. Adjacent Future Developments

- PH advised that all infrastructure within Brickhill St right-of-way (ROW) will be relocated at a future date to the Empress Ave ROW to accommodate affordable housing development plans for property located to south-west of future OPL-LAC Facility.
- PH requested confirmation that available capacity exists within the Albert St sanitary sewer for discharge from the OPL-LAC Facility. MH confirmed that the OPL-LAC site was within the limits of the Somerset-Wellington Servicing Plan (Stantec, 2008), and therefore sufficient capacity should have been allocated in the downstream sewers. However, 2x200mm diameter redundant sanitary forcemains are being installed from the Zibi development. The sanitary flow from the Zibi development is pumped until crossing the Stage 2 LRT tunnel, where it continues to flow by gravity and connects to the Albert St sanitary sewer. Confirmation is needed that the Albert St sewers have sufficient capacity for the Zibi flows (which were not considered in the Somerset-Wellington Servicing Plan). PM agreed to follow up and provide confirmation. MH will be required to document the receiving capacity within the servicing design brief, to be prepared and submitted for Site Plan Control.

PM/MH

7. Civil Servicing of OPL-LAC Facility

6.1 Storm:

- MH described conflict between proposed storm service and Albert St HPWM, and possible alternative drainage outlets upstream or downstream of Fleet Street Pumping Station to avoid permanent stormwater pumping station.
- PM advised that providing a new outlet or modifying an existing outlet to the Fleet Street Aqueduct would be unlikely to be accepted by the City, and advised that a permanent stormwater pumping station appears to be the best option.

6.2 Sanitary:

- MH described the proposed routing of the sanitary service to connect to the upstream end of the existing separated sanitary sewer maintenance hole at the intersection of Brickhill and Albert.

6.3 Water:

- MH described that proposed water service connection indicated on preliminary Schematic design was to connect to existing 403mm diameter watermain within Brickhill St, however given City's future development plans and associated relocation's of all infrastructure from within the Brickhill ROW to the Empress Ave ROW, the proposed connection is no longer feasible.
    - MH described that the extension of the 403mm diameter watermain recommended as part of the Stantec servicing report has not been included in project charter for the the Albert-Slater integrated roads project. MH stated that an existing local watermain may need to be extended to the OPL-LAC facility in order to provide water service.
    - **PM to confirm whether or not 403mm diameter watermain will be included in Albert-Slater integrated roads project.**

PM

- MH queried recent City response to DIR 015 which confirmed that from a building code perspective the OPL-LAC facility should meet requirements for “”buildings likely to be used as post-disaster shelters”. In this light, and generally considering the importance of the facility, MH suggested that the City may want to install redundant water services even though the water demand may not meet the $50m^3$/day limit above which the City normally required redundant water services. MH noted that if the watermain on Brickhill is to be removed, redundant water servicing could only provided from a new watermain on Albert Street.

Dist: Participants

Ralph Weisbrock (KWC)

Sydney Browne, Matthew Tsui, Jeff Geldart (DSAI)

Caroline Butchart (Fast+Epp)

APPENDIX C: Settlement and Vibration Monitoring Specifications

Part 1 GENERAL

In general, the Contractor shall be responsible for the protection and monitoring of all existing services and utilities across and adjacent to the proposed construction works.

However, the Contractor shall pay particular attention to protecting the existing high pressure watermain (HPWM), the existing hydro duct, the Combined Sewage Storage Tunnel (CSST), the interceptor outfall sewer (IOS) tunnel, and the Ottawa Light Rail Transit (OLRT) tunnel which will remain in service at all times during the work.

Part 2 SCOPE OF WORK

2.1 Monitoring of Watermain Movements

The Contractor must take all precautions necessary to minimize settlement or movement of the high pressure watermain during both working and non-working periods.

The top center of the watermain will be hydro-vacced at four locations; at the center of the alignment parallel to the proposed excavation on Albert Street, and 10m on either side of this central location on Albert Street, and at the closest location on Commissioner Street or as directed by the Consultant. The location of the monitoring locations may be moved prior to installation as directed by the Consultant based on ground conditions encountered. These daylight holes (monitoring locations) will be used to measure pipe elevations continuously throughout the construction work as described below. The hydro-vac holes will need to be cased (prepared and maintained) to prevent collapse of the hole and an insulated temporary cap shall be fitted on the top of the holes for safety and to prevent water and / or debris falling into the hole.

Baseline elevations of the HPWM survey monuments shall be established by taking three complete sets of readings, on three separate days, prior to construction. The average of the three readings will be used as the baseline measurement all for subsequent readings.

Throughout the duration of shoring, excavation, and foundation and basement wall (to finished grade) construction work within 20 m of the watermain, movement readings are to be taken twice per shift. Movement readings should be taken once per shift at all other times during construction work until completion of the mass excavation, shoring, foundation construction, and backfill of perimeter foundations. Measurement of movement readings shall be performed to an accuracy of 1 mm. Movement readings are to be reported to the Consultant daily. If, at any time, movement of the watermain is recorded, the Contractor is to inform the Consultant immediately.

The maximum allowable settlement/heave of the watermain is 5 mm. If settlement/heave of the watermain exceeds this allowable tolerance, the Contractor is required to stop all work immediately and inform the Consultant. The Contractor shall then be required to prepare a new work plan detailing how the revised work will prevent further any movement of the watermain.

If, in the opinion of the Consultant, the degree of movement presents a concern to the integrity of the watermain, the Consultant reserves the right to stop the progress of the work and request additional information from the Contractor in terms of how the site work will be changed to stop the unacceptable excessive movement.

The monitoring shall continue until the mass excavation, shoring, foundation construction, basement wall construction (to finished grade) and backfill (including compaction) is completed, and shall then also be carried out monthly for 2 months following the completion of the work above.

After that time, provided there is no on-going movement (in which case the monitoring could need to be extended), the holes/casings are to be filled/decommissioned and the pavement surface reinstated.

2.2 Vibration Monitoring of Watermains

Vibration monitoring shall be carried out with an approved seismograph capable of monitoring on a continuous basis and providing peak levels at regular intervals (no greater than 5 minutes) as well as full waveform data. The proposed equipment must meet the requirements outlined in Section 2.8.

Prior to the commencement of construction work within 20 metres of the watermain, the HPWM pipes are to be exposed with the use of hydro-vac equipment. Once the HPWM pipe is exposed, vibration monitoring equipment shall be installed immediately and remain in place for 48 hours to establish baseline readings.

The seismic equipment is to be encased to prevent collapse of the hole with an insulated cap fitted on top to prevent water or debris from falling into the casing.

The seismic equipment is to remain in place until the mass excavation, foundation, and perimeter basement wall (to finished grade) construction and backfill and compaction is completed.

The maximum allowable Peak Particle Velocity (PPV) on the HPWM is as follows:

Frequency Range	**Peak Particle Velocity (PPV) Vibration Limits (millimetres/second)**
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

The Contractor shall retain a licensed and experienced professional engineer licensed to practice engineering in the Province of Ontario to undertake the vibration monitoring of ground (pipe) vibrations during mass excavation, shoring, foundation and foundation wall construction, and backfilling.

Vibration Monitoring Reports shall be prepared on a daily basis during mass excavation, shoring, foundation and basement wall (to finished grade) construction, and backfilling (including compaction) construction activities and must be submitted to the Consultant. Vibration Monitoring Reports shall be prepared twice weekly during other construction activities until the basement wall (to finished grade) construction and backfill is completed.

Upon construction completion, a Final Vibrations Report must be submitted to the Consultant. The final monitoring report shall be signed and sealed by a qualified Professional Engineer licensed to practice in the Province of Ontario. The report shall clearly summarize the monitoring method implemented, the duration and vibration results, with a recommendation as to the meaning of these results in relation to the monitored infrastructure.

2.3 Monitoring of Hydro Duct Movements

The Contractor must take all precautions necessary to minimize settlement of the hydro duct during both working and non-working periods.

The hydro duct along the length of the Albert Street site will be exposed as part of the proposed shoring works along the exposed section or as directed by the Consultant. . Survey monitors should be affixed to the length of the hydro duct at 10 metre intervals.

Baseline elevations of the survey monuments shall be established by taking three complete sets of readings in advance of any construction, completed on three separate days. The average of the three readings will be used as the baseline for subsequent readings.

Throughout the duration of shoring, excavation, and foundation and basement wall (to finished grade) construction work within 20 m of the hydro duct, movement readings are to be taken twice per shift. Movement readings should be taken once per shift at all other times during construction work until completion of the basement wall (to finished grade) and backfill (including compaction). Monitoring shall be performed to an accuracy of 1 mm. Movement readings are to be reported to the Consultant daily. If, at any time, any movement of the hydro duct is recorded, the Contractor is to inform the Consultant immediately.

The maximum allowable settlement/heave of the hydro duct is 15 mm. If settlement/heave of the hydro duct exceeds this allowable tolerance, the Contractor is required to stop all work immediately and inform the Consultant. The Contractor shall then prepare a new work plan detailing how the revised work will prevent any further movement of the hydro duct.

If, in the opinion of the Consultant or the utility owner, the degree of movement presents a concern to the integrity of the hydro duct, the Consultant reserves the right to stop the progress of the work and request additional information from the Contractor in terms of how the operation will be changed to reduce the unacceptable movements.

The monitoring shall continue until the mass excavation, foundation, and basement wall (to finished grade) construction and backfill is completed, and shall then also be carried out 1 and 2 months later to document any subsequent movement.

After that time, provided there is no on-going movement (in which case the monitoring could need to be extended), the exposed hydro duct is to be reinstated.

2.4 Vibration Monitoring of Hydro Duct

Vibration monitoring shall be carried out with an approved seismograph capable of monitoring on a continuous basis and providing peak levels at regular intervals (no greater than 5 minutes) as well as full waveform data. The proposed equipment must meet the requirements outlined in Section 2.8.

The hydro duct along the length of the Albert Street site will be exposed as part of the proposed shoring works. Once the hydro duct is exposed, vibration monitoring equipment shall be installed immediately at two locations spaced 40 m apart and remain in place for 48 hours to establish baseline readings.

The seismic equipment is to be encased to prevent water or debris from falling into the casing.

The seismic equipment is to remain in place until the mass excavation, foundation, and basement wall (to finished grade) construction and backfill is completed.

The maximum allowable Peak Particle Velocity (PPV) on the hydro duct is as follows:

Frequency Range	**Peak Particle Velocity (PPV) Vibration Limits (millimetres/second)**
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

The Contractor shall retain a licensed and experienced professional engineer licensed to practice engineering in the Province of Ontario to undertake the vibration monitoring of ground (pipe) vibrations during mass excavation and construction of the foundations and basement walls (to finished grade).

Vibration Monitoring Reports shall be prepared on a daily basis during mass excavation and foundation construction activities and must be submitted to the Contract Administrator. Vibration Monitoring Reports shall be prepared twice weekly during other construction activities until the basement wall (to finished grade) construction and backfill is completed.

Upon construction completion, a Final Vibrations Report must be submitted to the Contract Administrator. The final monitoring report shall be signed and sealed by a qualified Professional Engineer licensed to practice in the Province of Ontario. The report shall clearly summarize the monitoring method implemented, the duration and vibration results, with a recommendation as to the meaning of these results in relation to the monitored infrastructure.

2.5 Monitoring of OLRT Tunnel Movements

The Contractor must take all precautions necessary to minimize settlement or movement of the OLRT tunnel walls and this will include both working and non-working periods.

Within the OLRT tunnel, one set of three monitors should be installed at the closest point to the proposed works, and two sets of three monitors should be installed at 10 metres offset from this location. The monitors should be placed at the top, center, and base of the tunnel wall on the side closest to the proposed excavation to monitor for potential differential movement. All elevations shall be monitored relative to a non-settling benchmark within the tunnel (e.g., a station located outside the influence of the project built on piles or bedrock, or an existing maintenance structure not impacted by construction). These benchmark monument(s) shall clearly be identified in the Contractor's Settlement Monitoring Plan, which shall also reference which buildings are monitored relative to which benchmark. Alternatively, a tunnel profile monitoring system may be considered and installed at the closest point to the excavation. The proposed tunnel monitoring system must be reviewed and approved by the Consultant prior to implementation.

The tunnel wall shall also be monitored for total, lateral or shear movements of existing cracks, features, etc. that are identified during the pre construction survey using pins, glass plate telltales, and/or movement telltales (to be identified in the Settlement Monitoring Plan). Access must be confirmed and coordinated with the OLRT access management team for the OLRT tunnel. It is anticipated that access will be restricted to overnight during periods where trains are not running, however access should be confirmed with the OLRT access management team prior to installation of the movement monitoring system.

Baseline elevations of the survey monuments shall be established by taking three complete sets of readings in advance of any construction, completed on three separate days. The average of the three readings will be used as the baseline for subsequent readings.

Throughout the duration of shoring, excavation, and foundation and basement wall (to finished grade) construction work within 30 metres of the OLRT tunnel, movement readings are to be taken once per shift. Movement readings shall be taken twice weekly at all other times during construction work until completion of the mass excavation, shoring, foundation and basement wall (to finished grade) construction, and backfill (including compaction). Monitoring shall be performed to an accuracy of 1 mm. Movement readings are to be reported to the Consultant daily. If, at any time, movement of the OLRT tunnel is recorded, the Contractor is to inform the Consultant immediately.

The maximum allowable movement of the OLRT tunnel wall is 5 mm. If movement of the tunnel wall exceeds this allowable tolerance, the Contractor is required to stop all work immediately and inform the Consultant. The Contractor shall then prepare a new work plan detailing how the revised work will prevent further movement of the tunnel wall.

If, in the opinion of the Consultant or the OLRT project team, the degree of movement presents a concern to the integrity of the OLRT tunnel, the Consultant reserves the right to stop the progress of the work and request additional information from the Contractor in terms of how the operation will be changed to reduce the unacceptable movements.

The monitoring shall continue until the mass excavation, shoring, foundation and basement wall (to finished grade) construction and backfill (including compaction) is completed, and shall then also be carried out 1 and 2 months later to document any subsequent movement.

2.6 Vibration Monitoring of OLRT, CSST and IOS

Vibration monitoring shall be carried out with an approved seismograph capable of monitoring on a continuous basis and providing peak levels at regular intervals (no greater than 5 minutes) as well as full waveform data. The proposed equipment must meet the requirements outlined in Section 2.8.

Prior to the commencement of construction work, vibration monitoring equipment shall be installed at the closest accessible points to the OLRT, and IOS tunnels. Access points must be confirmed and coordinated with the OLRT access management team for the OLRT tunnel, and City AMB for the IOS tunnel. It is understood that access to theseinfrastructure may be limited and access coordination with the above noted teams should be anticipated.

For vibration monitoring of the CSST, vibration monitors will be installed in boreholes adjacent to the CSST tunnel. The boreholes should be advanced into the bedrock to the depth of the CSST at 4 locations along the length of the CSST. The locations are to be reviewed and accepted by the CSST project team prior to installation of the instrumentation. The vibration monitors should be secured in the base of the borehole and the borehole should be cased to prevent surface water or debris from entering the hole.

The vibration monitoring equipment shall remain in place for 48 hours to establish baseline readings.

The seismic equipment is to be encased to prevent water or debris from falling into the casing.

The seismic equipment is to remain in place until the mass excavation, foundation, and basement wall (to finished grade) construction and backfill is completed.

The maximum allowable Peak Particle Velocity (PPV) on the OLRT, CSST and IOS is as follows:

Frequency Range	**Peak Particle Velocity (PPV) Vibration Limits (millimetres/second)**
< 40	20 (sliding scale)
> 40	50

The Contractor shall retain a licensed and experienced professional engineer licensed to practice engineering in the Province of Ontario to undertake the vibration monitoring of ground (pipe) vibrations during mass excavation and construction of the foundations and basement walls (to finished grade).

Vibration Monitoring Reports shall be prepared on a daily basis during mass excavation,shoring and foundation construction activities and must be submitted to the Consultant. Vibration Monitoring Reports shall be prepared twice weekly during other construction activities until the basement wall (to finished grade) construction and backfill is completed.

Upon construction completion, a Final Vibrations Report must be submitted to the Consultant. The final monitoring report shall be signed and sealed by a qualified Professional Engineer licensed to practice in the Province of Ontario. The report shall clearly summarize the monitoring method implemented, the duration and vibration results, with a recommendation as to the meaning of these results in relation to the monitored infrastructure.

2.7 Settlement Monitoring Plan

In advance of construction, the Contractor shall submit to the Consultant a detailed Settlement Monitoring Plan. This Plan shall include:

- A detailed pre-construction survey of structures and utilities in areas where settlement monitoring is required. Any existing interior/exterior structural deficiencies (such as cracks) in the structures shall be identified during this pre-construction survey as well as the methodology for how these will be monitored during construction.
- A description of the scope of the monitoring program and the methodology required to meet the plans objectives.
- Locations of settlement monitoring (with the types of survey monuments used for the settlement monitoring specified).
- Settlement monitoring benchmarks.
- Survey staff and equipment for settlement monitoring (with achievable tolerances).

Included in the Settlement Monitoring Plan shall be the Contractor's Contingency Plan which provides the mitigation and response plan for potential exceedances of the Review Limits assigned for total and differential settlement. The Contingency plan shall include how the Contractor will first address the exceedance (such as immediately stopping all settlement inductive work and increasing monitoring intervals) and then how they will alter their construction methodology to ensure that no further settlement beyond the limit occurs.

Once the plan has been implemented, the Contractor shall provide weekly monitoring Reports to the Consultant detailing settlement readings. The Consultant and Owner shall be notified immediately if limits are exceeded, and a report shall be provided immediately if limits are exceeded. Information required to be required in the Monitoring Reports shall include:

- A written description of the monitoring activities completed that week.
- The date(s) and time(s) of all monitoring activities carried out.
- Survey grade control elevations taken that week on the settlement monitoring points including an historical tabulation of all shots taken since the establishment of the points.

A statement indicating that the results of the monitoring show that the risks of settlement of adjacent structures are within acceptable tolerances and construction practices as established on site can continue.

2.8 Vibration Monitoring Plan

In advance of construction, the Contractor shall submit to the Contract Administrator a detailed Vibration Monitoring Plan. This shall include:

The vibration monitoring plan shall, at a minimum, include the following information:

- Proposed excavation methodology and equipment
- Proposed vibration monitoring equipment/instrumentation
- Proposed locations for vibration monitoring equipment/instrumentation
- Proposed vibration monitoring recording, reporting and warning systems.
- Proposed monitoring triggers, precautionary actions and measures required to adjust construction methods if readings show vibrations approaching the maximum allowable levels.
- Proposed adjustments to construction methods if readings show vibrations exceeding maximum levels.

Vibration equipment/instrumentation:

- Vibration monitoring shall be carried out with an Instantel Minimate Plus seismograph or an approved equivalent capable of monitoring on a continuous basis and providing peak levels at regular intervals (no greater than 5 minutes), as well as, full waveform data.
- The vibration monitoring equipment shall be capable of measuring vibration intensities up to 254 mm/s at a frequency response of 2 to 250 Hz.
- The vibration monitor shall be equipped with a real time warning system consisting of either a red flashing light and an air horn alert, with a remote warning also sent to the Owner, Consultant and Contractor by text message or e-mail when the threshold value is reached.

Weekly vibration monitoring summary reports:

- A written description of the monitoring activities completed that week and a summary of the measured vibrations.
- The date(s) and time(s) of all monitoring activities carried out.
- Changes to vibration monitoring locations to reflect construction progress.
- A statement by the Vibration Monitoring Specialist Engineer that the results of the monitoring show that measured vibrations are below the specified vibration limits and construction practices as established on site can continue.

As construction progresses and a suitable quantity of vibration monitoring data has been measured and analyzed, the Vibration Monitoring Specialist Engineer may formally recommend increasing the spacing between vibration monitoring points provided that the data shows measured vibrations to be well below the vibration limits specified and that ongoing construction activities will use the same equipment and methodology, will be further away from the existing infrastructure, and will be within similar subsurface material to that under which previous vibrations were measured.

Approval to increase the spacing between monitoring points will be at the sole discretion of the City and the Consultant.

PART 3 PENALTY FOR DAMAGE TO INFRASTRUCTURE

It is agreed by the parties to the Contract that in the event of infrastructure damage (i.e. leak and/or break) occurring during the duration of the Contract, damage and/or loss will be sustained by the Owner. The Consultant shall assess the Contractor a penalty of $50,000.00 for the first day or part thereof that the damage occurs, and a further penalty of $50,000.00 per day for each subsequent day or part thereof that any infrastructure is not operational and City of Ottawa or other utility owner crews are required onsite to carry out repairs. The Contractor will be responsible for the cost of the repairs to be completed by the City or utility owner, the cost of all traffic control operations performed by the Contractor and the City or utility owner, and the cost of the reinstatement of the damaged areas. The Consultant shall deduct penalty amounts from monies owing to the Contractor.

PART 4 MEASUREMENT FOR PAYMENT

Payment shall be as a lump sum, all inclusive, in accordance with the following payment schedule:

- 20% upon submission and acceptance of all specified pre-construction submissions and system installation testing and verification
- 70% pro-rated over the duration of the approved construction schedule
- 10% upon completion of the settlement and vibration monitoring programs, final reporting, and reinstatement at the settlement and vibration monitoring points to the satisfaction of the Contract Administrator.

Note that the monthly pro-rated payments will be withheld until such time as all weekly Summary Reports have been provided up to the cut-off date for the progress payment.

APPENDIX D: Structural Report & Pile Layout

City of Ottawa

Ottawa Public Library – Library and Archives Canada Joint Facility

Foundation interaction with existing tunnels

Structural report

Fast + Epp
201 - 1672 West 1st Avenue
Vancouver BC V6J 1G1

Revision 2
16 November 2020

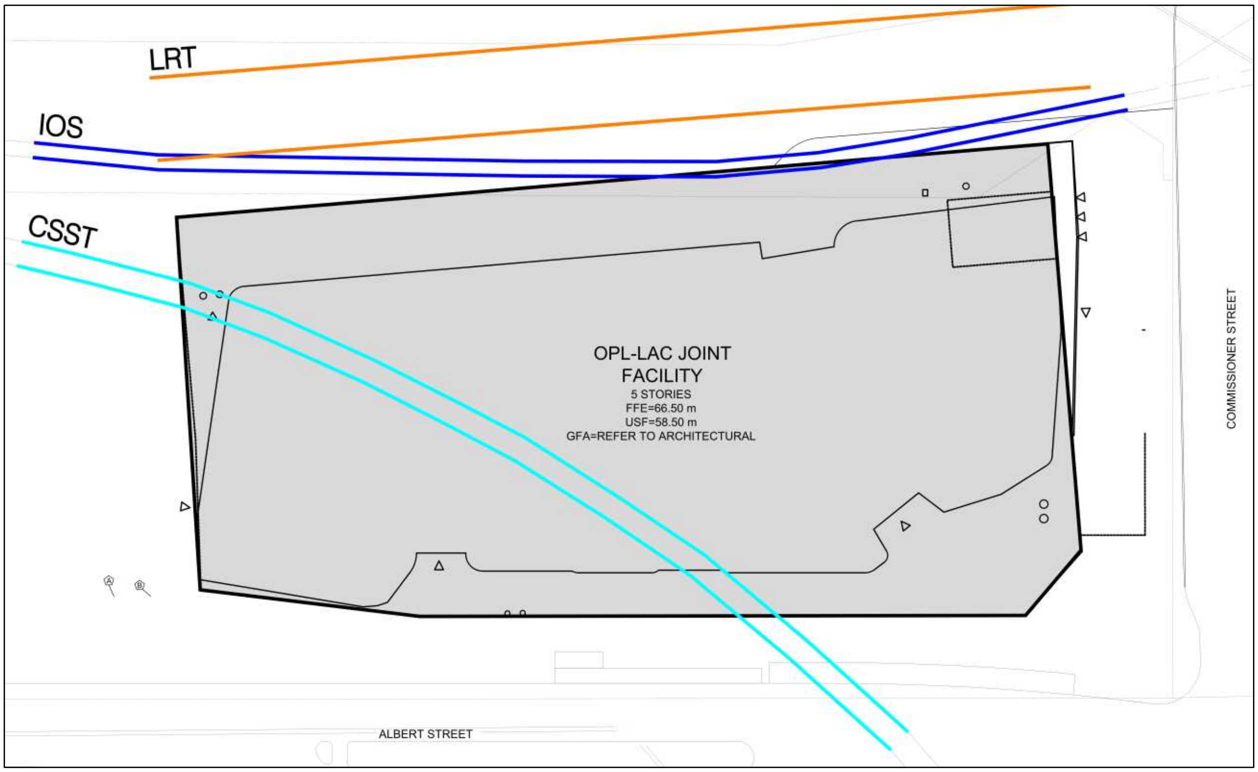
Table of contents

1 Introduction

The proposed Ottawa Public Library – Library and Archives Canada Joint Facility passes over or near to three tunnels:

- the combined sewer storage tunnel (CSST), recently constructed (in cyan below)
- the interceptor outfall sewer (IOS) tunnel, constructed in the 1960s (in dark blue below)
- a light rail transit (LRT) tunnel, recently constructed (in orange below)

This report describes the interaction of the foundations of the proposed building with these existing tunnels.



Plan showing building basement (grey) and tunnels (colour) [Background: Morrison Hershfield; Mark-up: Fast + Epp]

2 Site conditions

Reference should be made to the geotechnical report by Golder Associates Ltd. (report number 19131600, dated June 2020).

The slab level for the lowest parking level (P2) is at +58.5m above datum.

2.1 Soil and rock profile

The existing ground level falls from the north-east corner (at around +64m) of the proposed building to the south (at around +62.5m).

The ground is understood to be made up of a fill stratum between 1.4m and 3.7m thick, overlying a glacial till stratum between 2m and 8.2m thick. The glacial till stratum lies on limestone bedrock with shale interbeds.

The limestone bedrock is closest to the ground at the north of the building, where its surface is expected to be close to the lowest parking slab level (P2 at +58.5m). Away from the north end of the building, the surface of the limestone bedrock falls away to between approximately +49m and +53m.

2.2 Ground water

Ground water levels have been recorded between 2m and 6m below ground and between +56m and +62m above datum. The ground water level is expected to be above the lowest basement level across parts of the east side of the building.

3 Foundation system

The building is supported on concrete caisson foundations, except at the north of the site, where the limestone bedrock is near to the basement and footings may bear directly on the bedrock. A foundation plan is included in Appendix A.

The following construction sequence is anticipated:

- Piled shoring wall installed where required.
- Basement excavated inside shoring wall, with tie-backs installed as excavation progresses, or as an open-cut excavation, where possible.
- Caissons installed.
- Pile caps, tie beams and footings installed.
- Basement constructed.
- Open cut back-filled.

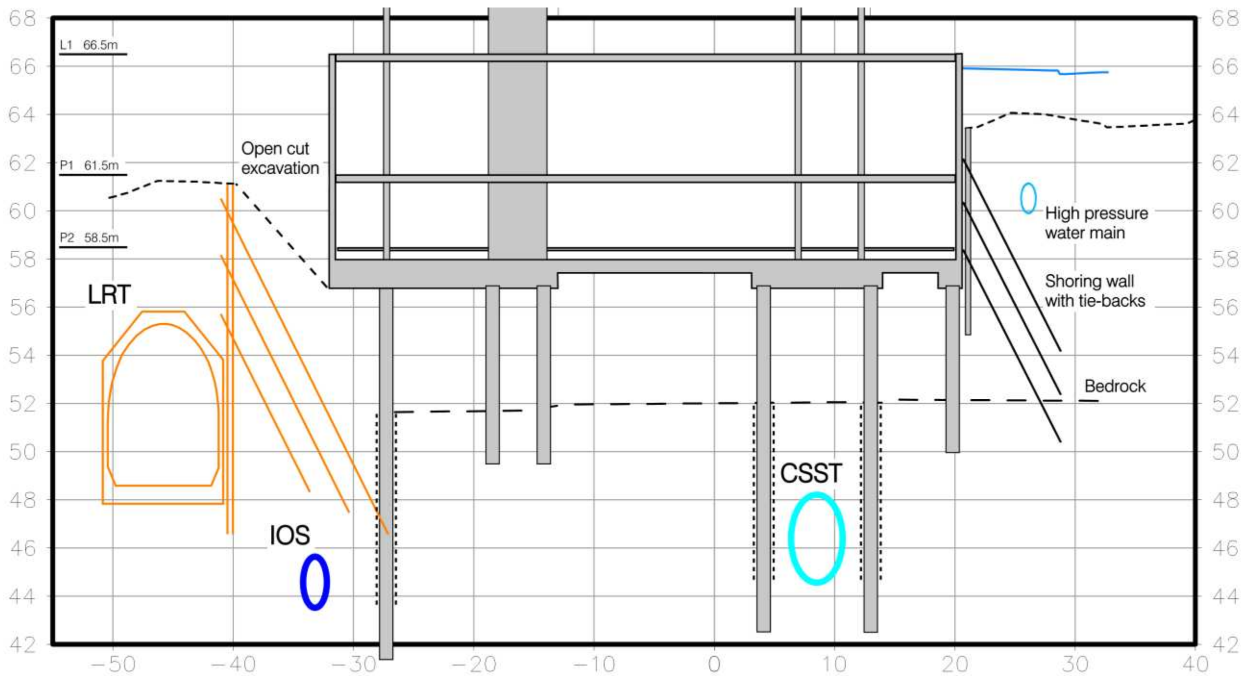
The concrete caissons are 1200mm in diameter, passing through the soil and socketed into the bedrock. Temporary steel casings are expected to be used within the soil during construction of the caissons. A drill head will be used to advance the drilling to the required depth within the bedrock. The caissons will be socketed a minimum distance of 2.4m into sound bedrock, except where the interaction with the existing tunnels requires deeper sockets, as described in the following sections.

The geotechnical capacity of the caissons is calculated as the side-wall resistance between the concrete caissons and the rock. The end of the caissons also bear directly on the base of the rock sockets, but this component of the resistance is not relied on in calculating the geotechnical capacity of the caissons.

Where required to prevent induced stresses on existing tunnels, the caissons are partially sleeved, to ensure that vertical load transfer into the rock occurs outside the zones of influence of the tunnels.

4 Foundation interaction with existing tunnels

The typical section below shows the relationship between the building foundation and the three tunnels passing under or near to the site. Note that the vertical and horizontal scales are different.



Typical transverse section across site [Background: Morrison Hershfield; Mark-up: Fast + Epp]

4.1 Combined sewer storage tunnel (CSST)

The CSST runs across the site from the south-west to the east. The tunnel, including its lining, is understood to be 3.71m in diameter.

Columns located above the CSST are supported on transfer beams which span onto caissons located a clear distance of at least 1.5m from the outside of the CSST.

The caissons are sleeved so as to minimize the transfer of load into the rock within the zone of influence of the CSST. For the caissons closest to the tunnel, the bottom of the sleeves is at or below the bottom of the tunnel, including its lining. Reference should be made to the geotechnical analysis by Golder on the effect of the caissons on the CSST.

4.2 Interceptor outfall sewer (IOS) tunnel

The IOS tunnel runs approximately parallel to the west property line and outside of it, except at the north end of the building where it passes inside the property line.

The west side of the building basement is supported on ground beams which cantilever from the first interior line of caissons. This ensures that no foundation load is applied directly above the IOS tunnel. Where caissons are close to the IOS tunnel on plan, they are sleeved from the rock surface down to the bottom level of the tunnel, including its lining, following the same approach as for the caissons adjacent to the CSST. Reference should be made to the geotechnical analysis by Golder on the effect of the caissons on the IOS tunnel.

4.3 Light rail transit (LRT) tunnel

The light rail transit (LRT) tunnel runs by the west side of the site, outside the property line. It runs deeper as it proceeds north, away from Pimisi station, and near the north end of the site it begins to turn further west, away from the site.

The tunnel was built using a cut-and-cover approach, with a shored excavation. The tie-backs from the shoring pass under the proposed building within the bedrock. It is possible that one or more of these tie-backs are cut during the piling operation for the proposed building. It is understood that these tie-backs are not required for the stability of the LRT tunnel and that there is no impact on the LRT tunnel of cutting them.

The line of caissons supporting the proposed building is approximately 12m from the face of the LRT tunnel. There is not expected to be any significant effect on the LRT tunnel from the permanent building loads, but the geotechnical engineer should be referred to if any further detail or quantification is required.

5 Conclusion

The foundation design approach for the proposed building has been developed in consultation with the geotechnical engineer to ensure that the existing tunnels below and around the site are not adversely affected by the proposed building.

Please contact us if you have any questions about the contents of this report.

2020-11-23

William Loasby
P.Eng. Struct.Eng. CEng MIStructE MICE MHKIE MIEAust
ASSOCIATE

Appendix A – Foundation plan

Fast + Epp

Suite 201
1672 West 1st Ave T 604 731 7412
Vancouver BC F 604 731 7620
Canada V6J 1G1 mail@fastepp.com

PILE ID	UNFACTORED LOAD			
	DEAD (kN)	LIVE (kN)	SNOW (kN)	SEISMIC LOAD TENSION/COMPRESSION (kN)
P1	2000	750	250	-
P2	3750	1500	225	-
P3	2250	750	225	-
P4	5250	2000	225	-
P5	5750	1750	250	-
P6	5750	1500	250	-
P7	3750	1000	100	-
P8	5750	1750	150	-
P9	3000	750	100	6500
P10	3250	750	100	3000
P11	3500	750	100	8500
P12	3500	500	100	7750
P13	3500	500	100	4000
P14	2750	250	100	5500
P15	3000	750	100	6000
P16	3250	500	125	4500
P17	3250	250	125	3750
P18	2750	250	100	6500
P19	2250	500	100	3750
P20	2500	500	100	2500
P21	2500	250	100	5750
P22	2000	250	100	8750
P23	1500	500	100	3000
P24	1750	250	100	2750
P25	1750	250	100	5250
P26	1250	250	100	7500
P27	1000	500	-	-
P28	3250	1000	100	-
P29	3250	1000	100	-
P30	1500	1000	100	
P31	3000	500	100	6250
P32	4500	750	100	5650
P33	5000	1000	100	7000

PILE ID	UNFACTORED LOAD			
	DEAD (kN)	LIVE (kN)	SNOW (kN)	SEISMIC LOAD TENSION/COMPRESSION (kN)
P34	4750	1000	100	6250
P35	3500	500	100	6750
P36	4750	750	100	1000
P37	5250	750	100	5750
P38	4250	750	100	6250
P39	2500	250	100	5750
P40	3750	500	100	6000
P41	4000	500	100	6500
P42	3000	500	100	6250
P43	1500	750	125	-
P44	1500	750	125	-
P45	1500	750	125	-
P46	2750	1000	225	-
P47	1750	1000	125	-
P48	3250	1250	-	-
P49	3250	1250	-	-
P50	1000	500	-	-
P51	3750	1250	-	-
P52	3750	1250	275	-
P53	5250	2000	475	-
P54	2250	750	375	-
P55	4250	1250	300	-
P56	5000	1500	325	-
P57	1750	250	100	5500
P58	1750	250	100	4500
P59	2750	250	100	8000
P60	2500	250	100	9000
P61	2250	250	100	9250
P62	2000	250	100	9750
P63	2500	1250	-	-
P64	2500	1250	-	-
P65	1250	750	200	-

FOUNDATION PLAN

1 : 125

Notes
1) For piles along CSST clearance line, piles are sleeved down to top of socket at the bottom level of the CSST, including its lining.
2) For other piles, the socket begins at 1m below rock depth.
3) Snow and seismic loads include importance factor for high importance building.

Fast+Epp structural engineers Suite 201 1672 West 1st Ave T 604 731 7412 Vancouver BC F 604 731 7620 Canada V6J 1G1 mail@fastepp.com	Project: OPL-LAC Joint Facility	Project No. 2541 Scale: n/a	Date: 16 Nov 2020 Ref. Doc.:
	Title: CSST PILE PLAN AND LOADING	Drawn: RBT Checked: WL	Dwg. No. 1 of 1
This drawing to be read in conjunction with all Structural drawings and Contract documents.	Ref. Dwg.:		

BIM 360://1855-OPL-LAC-R20/1855-STRU-FEP-Building-R20.rvt
2020-11-01 6:04:22 PM

APPENDIX E: Utility Protection Specifications

Part 1 GENERAL

1.1 SCOPE

.1 Utility protection and pre-and post- construction assessments of existing infrastructure located on or in the vicinity of the OPL-LAC Joint Facility site.

.2 In general, the Contractor shall be responsible for the protection of all existing services and utilities across and adjacent to the proposed construction works.

.3 However, the Contractor shall pay particular attention to protecting the existing high pressure watermain (HPWM), the existing hydro duct, the Combined Sewage Storage Tunnel (CSST), the interceptor outfall sewer (IOS) tunnel, and the Ottawa Light Rail Transit (OLRT) tunnel which will remain in service at all times during the work.

.4 The work under this item shall include all labour, materials and equipment necessary for coordination with the City of Ottawa and utility companies regarding protection, support and/or relocation of their plant. This item shall also include payment by the Contractor of all fees charged by the City of Ottawa and utility companies regarding protection, support and/or relocation of their plant.

1.2 REFERENCES

[Rev 1] .1 01 72 00 Settlement and Vibration Monitoring of Sensitive Infrastructure

.2 City of Ottawa Special Provision F-1011, Pre-Construction Inspection

.3 City of Ottawa Special Provision F-4090, Cleaning and Televising of Sewers

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit all pre-construction inspections required by this specification a minimum of 10 working days prior to commencing excavation or shoring work.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Submit post-construction inspections required by this specification.

Part 2 EXECUTION

2.1 GENERAL

.1 Utilities including but not limited to Hydro Ottawa, Bell, Rogers, Enbridge and the City of Ottawa have existing utility plant within and/or adjacent to the Site. City of Ottawa utilities and infrastructure include HPWM's, the CSST, IOS and OLRT tunnel, as well as watermains, storm sewers, sanitary sewers and forcemains, street-lighting and traffic plant. The Contract Drawings indicate the approximate extent and locations of utilities within and adjacent to the Site. The Contractor is responsible for verification of this information.

.2 The Contractor shall schedule sufficient time for utility coordination, in accordance with the advance notice requirements of each utility. No claims for delays or related costs will be considered where the Contractor failed to provide a utility owner with all necessary information in a timely manner and in accordance with the utility's specified requirements. The Contractor is responsible for confirming the advance notice requirements of each utility.

.3 Wherever work is required above, below or in the vicinity of existing utility plant (including hydro poles) the Contractor shall support and protect, or arrange for the utility owner to support and protect, such plant to the satisfaction of the utility owner. The Contractor shall be responsible for all costs associated with support and protection of existing utility plant.

.4 Whenever required by the utility owner, by the Contract Documents, or to ascertain the location of a utility prior to work, the Contractor shall excavate test pits to confirm the location, type and depth of the utility. Such test pits shall be by hydro-vac excavation or hand-digging, shall be in accordance with the utility-owner's requirements, and shall be coordinated with the utility owner. No separate payment will be made for test pits.

2.2 EMERGENCY CONTACTS

.1 Prior to construction above or in the vicinity of each utility, the Contractor shall obtain emergency contact details from the utility owner, and shall provide the Contractor's emergency contact details to each utility owner. Such emergency contacts shall be available 24 hours per day, 7 days per week.

.2 A copy of the comprehensive emergency contact list shall be submitted to the Owner prior to commencing construction work.

.3 The Contractor shall be responsible for reconfirming monthly that the list is current, and shall submit any updates to the Owner.

2.3 SPECIFIC REQUIREMENTS INCLUDING PRE- AND POST-CONSTRUCTION INSPECTIONS

.1 The Contractor shall note and protect the following utilities, and carry out pre and post construction assessments as per the following:

- .1 Commissioner Street 1520mm diameter concrete high pressure transmission watermain (HPWM)
  - .1 Test pit at 50m intervals. Survey location and depth in each test pit.
  - .2 No excavation or piling is permitted within 5m of outer edge of HPWM unless pre-approved in writing by City (Drinking Water Services).
  - .3 Comply with Settlement and Vibration Monitoring requirements.
- .2 Albert Street 1220mm diameter steel HPWM
  - .1 Test pit at 50m intervals. Survey location and depth in each test pit.

.2 No excavation or piling is permitted within 5m of outer edge of HPWM unless pre-approved in writing by City (Drinking Water Services).

.3 Comply with Settlement and Vibration Monitoring requirements.

.3 Combined Sewage Storage Tunnel (CSST)

.1 Carry out pre- and post-construction CCTV inspection.

.2 Comply with Settlement and Vibration Monitoring requirements.

.4 Interceptor Outfall Sewer (IOS) – sanitary

.1 Carry out pre- and post-construction CCTV and sonar inspection.

.2 Comply with Settlement and Vibration Monitoring requirements.

.5 Hydro Ottawa Concrete Ductbank (parallels Albert St)

.1 Expose and protect as specified on Contract Drawings and elsewhere in Contract Documents.

.2 Comply with Settlement and Vibration Monitoring requirements.

.6 Stage 1 LRT cut and cover tunnel

.1 Carry out Pre- and Post-construction inspections in accordance with Special Provision F-1011 (Pre-Construction Inspection), modified as follows:

.1 Coordinate with OC Transpo to arrange timing and access (assume that inspection will be scheduled at night).

.2 Building/Structure Pre-Construction Report <u>shall</u> be submitted to the Owner.

.2 Comply with Settlement and Vibration Monitoring requirements.

.7 Storm and sanitary sewers within Brickhill right-of-way

.1 Carry out pre- and post-construction CCTV inspection in accordance with Special Provision F-4090 (Cleaning and Televising of Sewers).

.2 Requirements for CSST and IOS inspections:

.1 City of Ottawa Special Provision F-4090 (Cleaning and Televising of Sewers), as modified herein.

.2 Submit site-specific health and safety plan for all inspections and investigations. Allow one week for review.

.3 Provide all traffic management measures necessary to access sewer shafts.

.4 A preliminary investigation of entry and exit chambers shall be completed to obtain all information required to plan inspection. Following the preliminary investigation, the Contractor shall develop and submit a detailed work plan for the sewer inspection. The work plan shall include a proposed schedule, providing in 30 minute intervals. Allow two weeks for review.

.5 The date and time of all inspections shall be coordinated with the City. The Contractor shall be aware that the City may require inspections to be carried out at specific times due to operational constraints, and will need to be carried out during dry weather conditions.

.6 For bidding purposes Contractors shall assume that access shafts, ladders, safety platforms and similar equipment are in useable condition.

.7 To carry out the IOS inspection it should be anticipated that sandbagging will be required in MHSA61750 to divert incoming flow from the Booth Regulator.

.8 IOS inspection shall be from MHSA61751 (Booth Street Regulator) to MHSA00756 (Garden of the Provinces Chamber). CCTV and sonar inspection shall be carried out throughout. The intermediate maintenance holes/connections have previously been found to be unsuitable for use as access points. Due to flow rates, floating inspection equipment shall be used.

.9 CSST inspection shall be from the Kent St Access Shaft to the East-West Tunnel Exit Shaft (Brickhill). CCTV inspection shall be carried out between Bronson Avenue and the Exit Shaft.

.10 Submit inspection reports in accordance with S.P. F-4090.

2.4 SETTLEMENT AND VIBRATION MONITORING

[Rev 1] .1 Refer to Section 01 72 00 (Settlement and Vibration Monitoring of Sensitive Infrastructure).

[Rev 1] **2.5 DELETED**

END OF SECTION

APPENDIX F: Correspondence with Golder regarding Caisson Loading on CSST

James Fookes

From: Ralph Wiesbrock <rwiesbrock@kwc-arch.ca>
Sent: November 20, 2020 4:34 PM
To: James Fookes
Cc: Noah Chauvin; William Loasby; Caroline Butchart; sbrowne@dsai.ca; Gary McCluskie; Matthew Tsui
Subject: 2020-11-20 OPLLAC FW: OCL-1 - CSST bridging geotechnical analysis
Attachments: 201028_CSST Pile Load Layout.pdf

James,

Below are the results of the geotechnical analysis prepared by Golder to assess the degree of loading on the bedrock that could be transferred to the CSST structure.

Ralph Wiesbrock Architect | OAA . FRAIC . LEED AP
Partner / Principal | KWC Architects Inc.
Office: 613.238.2117 x 225 | Mobile: 613.728.5800
201-383 Parkdale Avenue, Ottawa, Ontario K1Y 4R4
Email | Website | LinkedIn | Instagram

From: Ghadbane, Sarah <Sarah_Ghadbane@golder.com>
Sent: November 20, 2020 4:18 PM
To: Siwanowicz, Felix <Felix.Siwanowicz@colliersprojectleaders.com>; 'Fouchard, Richard' <Richard.Fouchard@ottawa.ca>
Cc: Ralph Wiesbrock <rwiesbrock@kwc-arch.ca>; Laszlo Mohacsi <lmohacsi@kwc-arch.ca>; Hussar, Paul <Paul.Hussar@ottawa.ca>
Subject: RE: OCL-1

NOTE: This email chain appears to contain email from outside Golder

Hello Felix and Richard,

We have completed the updated analysis for the caissons adjacent for the CSST considering the socket beginning at the invert level of the tunnel. The analysis indicates that under static conditions, the vertical and horizontal loading at the invert level of the pipe will be less than 2kPa.

Under seismic loading conditions, the caisson loading on the pipe profile within the vicinity of caissons 11, 15, 19, and 23 (see attached drawing) is between -10 and 10 kPa. It is our opinion that this additional loading can be considered as negligible in comparison to the direct seismic loads on the CSST tunnel, but the CSST team will need to confirm their acceptance.

Please let us know if there are any questions with the above.

With regards to the shoring analysis, I have followed up with our team in Mississauga and they do not have capacity to begin this analysis next week, but would possibly have availability the week after.

Thanks,

Sarah

Sarah Ghadbane (P.Eng.)
Geotechnical Engineer

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From: Siwanowicz, Felix <Felix.Siwanowicz@colliersprojectleaders.com>
Sent: November 19, 2020 8:25 AM
To: Ghadbane, Sarah <Sarah_Ghadbane@golder.com>
Cc: Ralph Wiesbrock <rwiesbrock@kwc-arch.ca>; Laszlo Mohacsi <lmohacsi@kwc-arch.ca>; Hussar, Paul <Paul.Hussar@ottawa.ca>; 'Fouchard, Richard' <Richard.Fouchard@ottawa.ca>
Subject: OCL-1

EXTERNAL EMAIL

Sarah,
Can you advise the timing for the delivery of the CSST geotechnical analysis that DSA/KWC requires to submit to the City?
Regards,

Felix Siwanowicz
Senior Project Manager
COLLIERS PROJECT LEADERS
Mobile 613 513 3756
Suite 700, 150 Isabella Street | Ottawa ON K1S 1V7 | Canada
Felix.siwanowicz@colliersprojectleaders.com