2021-01-19

Dawn Blackman
Carleton University
1125 Colonel By Drive
Ottawa, ON
K1S 5B6

**Subject: Carleton University - Vibration Impact Assessment for Construction New Residence Carleton University - Vibration Impact Assessment for New Residence Construction**

Dear Dawn:

Carleton University is proposing to build a residence east of 1125 Colonel By Drive (the Project). WSP Canada Inc., was retained by Carleton University to conduct a Vibration Impact Assessment for the planned construction activities associated with the project as required by the City of Ottawa (the City). This assessment focuses on the impact of vibration due to construction activities on nearby structures.

# BACKGROUND

The proposed residence is a 9-storey building with a basement level. As part of a Site Plan Control Application (SPCA), the City requested vibration study be undertaken to assess the potential construction-induced, ground-borne vibration impact on Underground Services within the Campus Avenue right-of-way (including a 400 mm diameter watermain and sewers) and the City's LRT corridor due the anticipated piling operations. The City further highlighted the potential for damage to the 400 mm water main to impact the LRT corridor. The City requested a vibration monitoring program be conducted during piling based on limits provided by the City.

At this stage, the actual planned construction activities are not available as they will be determined by the general construction contractor. This study is based on assumed construction activities to investigate the potential impact of construction. It provides recommendations and vibration monitoring plan requirements during construction.

The project location is shown in **Figure 1**.

## SPCA STRUCTURES OF CONCERN DURING PILING OPERATIONS

As noted above, the SPCA noted Underground Services and the LRT corridor as structures of concern. These are discussed further below.

### UNDERGROUND SERVICES

The Site Servicing Plan Drawing C001 prepared by Morrison Hershfield, dated August 11, 2020 ("Issued for Site Plan Approval") indicated that the Underground Services (e.g. existing watermain, storm and sanitary sewers) located underneath the proposed building will be removed and are assumed to have been removed prior to piling operations.

Unit 2
126 Don Hillock Drive
Aurora, ON, Canada L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
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Where they are not underneath, those services will be rerouted through new lines and portions of remaining lines shall be abandoned.

Drawing C001 further notes existing watermain, storm and sanitary sewers will be removed when located underneath the proposed residence's building footprint. Where these services are not located under the footprint, they will be abandoned.

### LRT CORRIDOR

The centreline of the LRT Corridor is located approximately 27 m to the east of the Project's Limit and 51 m to the east of the proposed building boundary. **Figure 1** shows the location of the LRT corridor in relation to the Site.

## OTHER STRUCTURES AND CONSTRUCTION ACTIVITIES

Upon review of the project, WSP noted other structures could also be impacted by construction, outside of the City's SPCA request. The structures are also included in the assessment and include the following:

- Carleton University P18 Parking Garage (the Parking Garage)
- Leeds House building and Dundas House building (the existing residences)
- Campus Avenue bridge over the LRT (the Bridge)
- Existing tunnel located to the west, southwest of the proposed building
- Concrete Pad and Monument (the monument)
- Cooling Tower and Brick Wall (the cooling tower)

Further review of the drawings indicated that other ground disturbing construction activities outside of piling are expected to occur during the Project. These activities may also impact structures around the Project and are included in the assessment.

It should be noted that as part of the construction, the general construction contractor is required to design shoring which will include caissons, solder piles and tiebacks. As the design of the shoring is not yet available, it is not assessed in this report. However, shoring shall be discussed in the recommendations section further in the report.

# VIBRATION ASSESSMENT

## ASSESSMENT APPROACH

The following methodology was used in assessing vibration effects from construction activities of the Project:

- Review of the following drawings to determine the expected construction area, assumed construction activities and locations where vibration is transmitted to ground;
  - Reissued for Site Plan Approval civil drawings prepared by Morrison Hershfield dated August 11, 2020
  - Issued for Site Plan Control R2 landscape drawings by Lashley Associates, dated August 11, 2020
  - Issued for Permit structural drawings by Read Jones Christoffersen Ltd. Engineers, dated April 7, 2020
- Review of the geotechnical report "Carleton University Proposed Residence Geotechnical Investigation" prepared by WSP, dated December 19, 2020 to understand the ground/soil conditions of the area; and
- Prediction of ground-borne vibration from anticipated activities and compare them to the applicable vibration limits. The extent around the construction zone which may be impacted by vibration emanating from construction activities was then determined. This is called Zone of Vibration Influence (ZOI).

The assessment only considered construction activities that had the potential to induce vibration at the ground. Other construction activities are not considered in this assessment (e.g. construction work above Level 1 of the building).

## VIBRATION DESCRIPTOR

Vibration is generally measured in peak particle velocity (PPV) or root mean square (RMS) oscillatory velocity, acceleration or displacement. PPV is generally used to quantify vibrations at the structures and RMS for human comfort.

The PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal measured in millimetres/second (mm/s). The US Federal Transit Administration (FTA) publication "Transit Noise and Vibration Impact Assessment", dated September 2018, suggests the use of PPV for assessment of construction as it relates to the stress that a structure receives due to vibration. The PPV was used in estimating ground-borne vibration levels in this study.

## VIBRATION CRITERIA

As part of its request, the City requested limits be set to 15 mm/s for Underground Services and the LRT corridor. As these are understood to be owned and operated by the City, the limit of 15 mm/s is reviewed in this assessment.

WSP also reviewed other guidelines for this assessment typically used for construction vibration and that consider different structure types. These guidelines were the City of Toronto Municipal Code Chapter 363 (TMC 363) and the DIN 4150-3 Structural Vibration Part 3: Effects of Vibration on Structures (DIN 4150). The limits discussed in these guidelines and the applicable structures are recommended to be applied to are provided below.

It should be noted these limits are based on the information WSP has at this time. Limits for some of these structures may differ than what the owners or operators of these structures would consider.

### EXISTING RESIDENCES, TUNNEL, MONUMENT AND COOLING TOWER VIBRATION LIMITS

The TMC 363 provides vibration limits for construction activities which are considered typical for most structures/buildings and are considered for the existing residences, existing tunnel, monument, and cooling tower for the purposes of this assessment. The limits from TMC 363 are provided below in **Table 1**.

*Table 1 TMC 363 Vibration Limits*

| FREQUENCY OF VIBRATION [Hz] | VIBRATION PEAK PARTICLE VELOCITY [mm/s] |
|---|---|
| Less than 4 | 8 |
| 4 to 10 | 15 |
| More than 10 | 25 |

Reference: City of Toronto Municipal Chapter 363

### PARKING GARAGE AND BRIDGE VIBRATION LIMITS

DIN 4150 provides limits for different structure types including those which are built for commercial, industrial or similar purposes. The Parking Garage and the Bridge are considered to fall within this category for the purposes of this assessment, and the limits are provided below in **Table 2**.

*Table 2 DIN 4150 Vibration Limits for Buildings Used for Commercial Purposes, Industrial Buildings and buildings of similar design*

| FREQUENCY OF VIBRATION [Hz] | VIBRATION PEAK PARTICLE VELOCITY [mm/s] |
|---|---|
| 1 to 10 | 20 |
| 10 to 50 | 20 to 40 |
| 50 to 100* | 40 to 50 |

*For frequencies above 100 Hz, 50 mm/s may be considered as the limit.

Reference: DIN 4150-3 Standard

### UNDERGROUND SERVICES

For Underground Services the City suggested vibration should not exceed 15 mm/s. However, vibration limits for Underground Services can be higher than this. DIN 4150 also provides limits for underground structures. For Underground Services, such as watermains and sewers around the Project, Line 3 from **Table 3** could be considered. For the purposes of this assessment both the City limit and **Table 3** are reviewed in the assessment. However, as these services are assumed to be operated by the City, the City limit (15 mm/s) is the enforced limit.

*Table 3 DIN 4150 Vibration Limits for Buried Pipework*

| LINE | PIPE MATERIAL | VIBRATION PEAK PARTICLE VELOCITY [MM/S] |
|---|---|---|
| 1 | Steel | 100 |
| 2 | Clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange) | 80 |
| 3 | Masonry, Plastic | 50 |

Reference: DIN 4150-3 Standard

### LRT RAIL LINE

For the LRT corridor the City provided a limit of 15 mm/s and was considered for the purposes of this assessment.

## PREDICTION METHOD

In order to estimate the vibration through predictions, the actual force generated at the interface of the ground using the chosen construction method and equipment type are required. Therefore, the vibration propagation model in the U.S. Department of Transportation, Federal Transit Administration (FTA) document, “Transit Noise and Vibration Impact Assessment Manual”, dated September 2018 (FTA Document) was used. This model provides a conservative estimate of the potential vibration using reference vibration levels at a known distance from vibration sources.

## ZONE OF INFLUENCE

Using the FTA model described in the Prediction Method, a vibration Zone of Influence (ZOI) was calculated. A ZOI is an area from the vibration source within which there is the potential for vibration to impact nearby structures. Structures predicted to be impacted by vibration are identified as those that are located within the ZOI.

The impact of the construction activity is estimated as a distance away from the source which forms the ZOI. For this Project several ZOIs were estimated and are described in the section below.

## VIBRATION ZOI

Based on a review of project drawings, it is understood that the onsite activities can be broadly divided into three categories for the project: demolition, piling and Level 1 general construction activities. These three categories were each assessed separately and ZOIs were produced for each category of construction and are discussed further below. The ZOIs are shown in **Figure 2** to **Figure 7**. Further specific ZOIs were estimated for each structure and are shown on each figure.

For the purposes of the figures, the ZOI for the existing residences, existing tunnel, monument and cooling tower are labelled as Existing Residences and Tunnel ZOI.

### DEMOLITION PHASE ZOI

The demolition phase considers work associated from removal of walkways and walls around the project location understood to occur prior to construction. These walkways and walls are noted in landscape drawing, issued for site plan control R2, L001, dated August 11, 2020.

The ZOI was estimated for demolition is shown in **Figure 2** and **Figure 3**. As shown in **Figure 2**, the existing residences, tunnel, monument and cooling tower fall within the ZOI for activities occurring adjacent to them. The Parking Garage, Bridge, and LRT Corridor are not within their respective ZOIs. As shown in in **Figure 3** Underground Services may be impacted during demolition for the City limit and for the **Table 3** limits.

### PILING ZOI

Piling was assessed separately from other ground construction activities as it is expected to be the highest impact activity for the Project and is the only activity assessed for the piling ZOIs. Piling locations are noted in structural drawings S200, issued for permit, dated April 7, 2020. From the geotechnical report bedrock occurs at approximately 10 m depth and from drawing S103, piles are expected to be in bedrock.

The estimated ZOIs from piling activities is shown in **Figure 4** and **Figure 5**. As shown in **Figure 4** the existing residences, and existing tunnel, fall within the ZOI. The Parking Garage slightly falls within the ZOI while the Bridge and the LRT Corridor do not fall within the ZOI.

As previously discussed, the existing Underground Services will have been removed where they are under the proposed building footprint prior to piling. The extent of the ZOIs for Underground Services is shown in **Figure** 5 and shows Underground Services are within the ZOI from piling operations.

### LEVEL 1 GENERAL CONSTRUCTION ACTIVITIES

Level 1 general construction activities were assessed, and these activities have the largest footprint around the proposed building. The footprint of these activities extends to the Bridge to the east, the parking lot to the north and the Existing Residential buildings to the south and west. The extent of the footprint was noted in Grading Plan on drawing C003.

These construction activities are limited to activities that have the potential to induce ground vibrations. Construction activities above Level 1 of the proposed building are not expected to induce ground vibration and not considered further in this assessment.

The footprint and expected ZOI for Level 1 general construction activities is shown in **Figure 6** and **Figure 7**. The existing residences and existing tunnel are shown to be within the ZOI for Level 1 General Construction Activities in **Figure 6**. The monument, the Parking Garage and the Bridge are just slightly within or at the edge of the ZOI. The

LRT Corridor, cooling tower do not fall within the ZOI are not expected to be impacted by construction. As shown in **Figure 7**, Underground Services are expected to be within the ZOI.

# RECOMMENDATIONS

Based on the ZOIs shown in **Figure 2** to **Figure 7** the different structures surrounding the Project are within the ZOIs and could be impacted by construction.

The following recommendations are provided:

1. A baseline vibration study should be conducted to determine the existing vibration levels the ground surrounding the Project is currently exposed to prior to commencement of construction.
2. The general construction contractor (GC) retain their own vibration engineer to oversee vibration monitoring for the Project.
3. The GC will implement a vibration monitoring program to monitor vibration throughout the Project. Vibration monitoring shall occur structures when they have the potential to be impacted by vibration due to construction. Refer to the Vibration Monitoring Plan Requirements section below for additional details.
4. The GC shall provide an updated ZOI study where differences between this study and planned construction activites, or site conditions are noted.
    a. Further if the GC's wishes to pursue higher vibraton limits or alter the monitoring requirements the GC must submit an updated ZOI study for approval by the City. It is recommended that the owners or operators of the structures be consulted on the appropriate vibration limits for their respective structures.
    b. As previously noted, shoring is to be designed by the GC, so those drawings are not available for this assessment. For shoring and any similar work the GC is responsible for designing shall be included in the GC's updated ZOI.
    c. The GC shall update the monitoring plan where appropriate based on the its updated ZOI study.
5. Contract documents should state the GC is responsible for vibration control measures to prevent any damage to structures due to vibration from construction. Similarly the contract documents should state the GC is responible for any damages to structures caused by vibration due to construction.

# VIBRATION MONITORING PLAN REQUIREMENTS

The following sections detail the vibration monitoring requirements for the Project to be conducted by the GC during construction.

## INSTRUMENTATION

A seismograph configured to produce a continuous record shall be used for vibration monitoring. The seismographs will record vibrations in three orthogonal directions in peak particle velocity with a geophone sensor. The equipment must be capable of monitoring from 1 to 100 Hz; recording at a minimum of 1024 samples per second.

The monitors shall record PPVs throughout each day for the duration of the construction. At least one PPV measurement shall be recorded every minute during the period construction is occurring. Where measured vibration exceeds the limits for a structure, the monitor shall record a waveform event for the measured vibration event. The waveform file should record at least 3 seconds in length.

## MONITORING LOCATIONS

The monitoring locations should be selected to capture expected worst-case vibration from construction activity at or near the following:

- Underground Services

- 400 mm diameter watermain
- Carleton University P18 Parking Garage
- Leeds House building Dundas House building
- Existing Tunnel
- Campus Avenue bridge over the LRT
- Concrete Pad and Monument
- Cooling Tower and Brick Wall

Structures are to be monitored when they are within the ZOI during planned construction activities and at the point where they will be impacted by construction. Where a monitoring location is no longer measuring the location where a structure being impacted by construction induced vibration, the monitor shall be moved to the location of the structure that is being impacted by vibration.

For above ground structures, geophones should be located as close as possible to the structures being monitored. Where this is not possible they shall be located at a similar set back to construction as the structure. Monitoring for these structures shall occur for the following situations:

- Vibration monitoring shall occur for the existing residences, existing tunnel, monument and cooling tower when:
  - within 36 m of piling activities; and
  - within 8 m for all other construction activities.
- Vibration monitoring shall occur for the Parking Garage and Existing Bridge when:
  - within 20 m of piling activities; and
  - within 5 m for all other activities.

For underground services, the geophones shall be placed either directly on the service, at the surface directly above the service or a similar setback to construction from the service. At a minimum monitoring shall occur for the underground services when construction is occurring:

- within 24 m of piling activities; and
- within 6 m for Level 1 General Construction and Demolition activities.

The 400 mm diameter watermain must be monitored for vibration during all deep foundation piling operations as noted in the SPCA such that vibrations do not exceed 15 mm/s PPV at any section of the service.

## APPLICABLE VIBRATION LIMITS

The applicable vibration limits for vibration monitoring shall be those noted below.

*Table 4: Leeds House and Dundas House Residences, Existing Tunnel, Monument and Cooling Tower Vibration Limits*

| FREQUENCY OF VIBRATION [Hz] | VIBRATION PEAK PARTICLE VELOCITY [mm/s] |
|---|---|
| Less than 4 | 8 |
| 4 to 10 | 15 |
| More than 10 | 25 |

*Table 5: P18 Parking Garage and Campus Avenue Bridge Vibration Limits*

| FREQUENCY OF VIBRATION [Hz] | VIBRATION PEAK PARTICLE VELOCITY [mm/s] |
|---|---|
| 1 to 10 | 20 |
| 10 to 50 | 20 to 40 |
| 50 to 100* | 40 to 50 |

Vibration limits for the 400 mm water main and other underground services is 15 mm/s.

## ON-SITE MONITORING PROCEDURE

The vibration meters should be actively monitored by either on-site personnel or via a remote monitoring system. Further, continuous monitoring shall be conducted with construction is occurring near structures at the distances noted in the Monitoring Locations section above and down times from monitors shall be limited. Where a monitor is not functioning, the cause shall be addressed immediately, or the monitor shall be replaced with a functioning unit.

When vibration levels reach the respective limits, the construction manager should be notified immediately, and steps outlined in Response Plans for Vibration Levels Exceeding the Limits below should be followed.

## REPORTING REQUIREMENTS

Baseline – A baseline monitoring report must be included with this package. The baseline monitoring report must include the measured vibration levels, monitoring locations, equipment used, and calibration certificates.

During Construction – Vibration monitoring must be carried out during construction when structures are expected to be impacted by construction activities. A weekly vibration monitoring summary report should be provided by the GC including details on monitoring locations, measured vibration levels compared against the vibration limits, and any exceedances or complaints registered during the monitoring period and actions taken.

## RESPONSE PLANS FOR VIBRATION LEVELS EXCEEDING THE LIMITS

Vibration limits are not to be exceeded. Activities may be suspended in affected area with the exception of those actions necessary to avoid the exceedance of the vibration limits or to make the work and affected properties safe and secure. If the vibration limit is reached:

1. Stop work and inform the Contract Administrator immediately;
2. Investigate and report the cause of exceedance to the Contract Administrator;
3. Provide the Response Plan of Action and mitigation strategy for review and approval by the Contract Administrator;
    a. The construction activity causing the exceedance should not commence until the Response Plan of Action andmitigation strategy has been implemented.
4. Implement the reviewed and approved Response Plan of Action prior to proceeding with the activity that caused the exceedance;
5. Install additional monitors as directed by the Contract Administrator.

## SAFETY AND PROTECTION

The above ground location of monitoring instrumentation shall be made clearly visible to avoid accidental damage at all times. Markings shall be of sufficient size to be visible to construction equipment operators.

Instruments must be clearly labelled in the field, each instrument having a unique identifier. The labelling must remain legible for the duration of the monitoring period.

All instruments must be adequately protected by the Contractor such that they are not damaged during construction or disturbed while monitoring.

## CONCLUSION AND CLOSURE

WSP prepared this letter report solely for the use of the intended recipients, Carleton University, in accordance with the agreed upon professional services agreement. This letter report detailed a vibration impact assessment for construction of a proposed residence east of 1125 Colonel By Drive. The study discussed applicable limits, identified structures potentially impacted by construction and identified construction activities that could impact those structures. WSP further recommended vibration monitoring be conducted for the nearby structures and provided details on vibration monitoring plan requirements to be implemented during construction, including when to monitor vibration at those structures.

The intended recipient is solely responsible for the disclosure of any information contained in this letter report. The content and opinions contained in the present letter report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this letter report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this letter report. This limitations statement is considered an integral part of this letter report.

Yours truly,


Prabu Surendran, B.Eng.
Acoustic, Noise and Vibration Specialist

Bill Hoogeveen, P.Eng.
Senior Project Manager

PS/BH

Encl. Figures
WSP ref.: 191-12948-00

# FIGURES



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM


## LEGEND

- PROJECT LIMIT
- PROPOSED BUILDING FOOTPRINT
- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT

N W E S

15 7.5 0 15 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

CLIENT:

CARLETON UNIVERSITY

PROJECT:

VIBRATION STUDY
CARLETON UNIVERSITY
NEW STUDENT RESIDENCE
OTTAWA, ONTARIO

| PROJECT NO: | DATE: |
|---|---|
| 191-12948-00 | DECEMBER 2020 |

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: -

| FIGURE NO: | SCALE: |
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TITLE:

STUDY AREA

DISCIPLINE:

ENVIRONMENT

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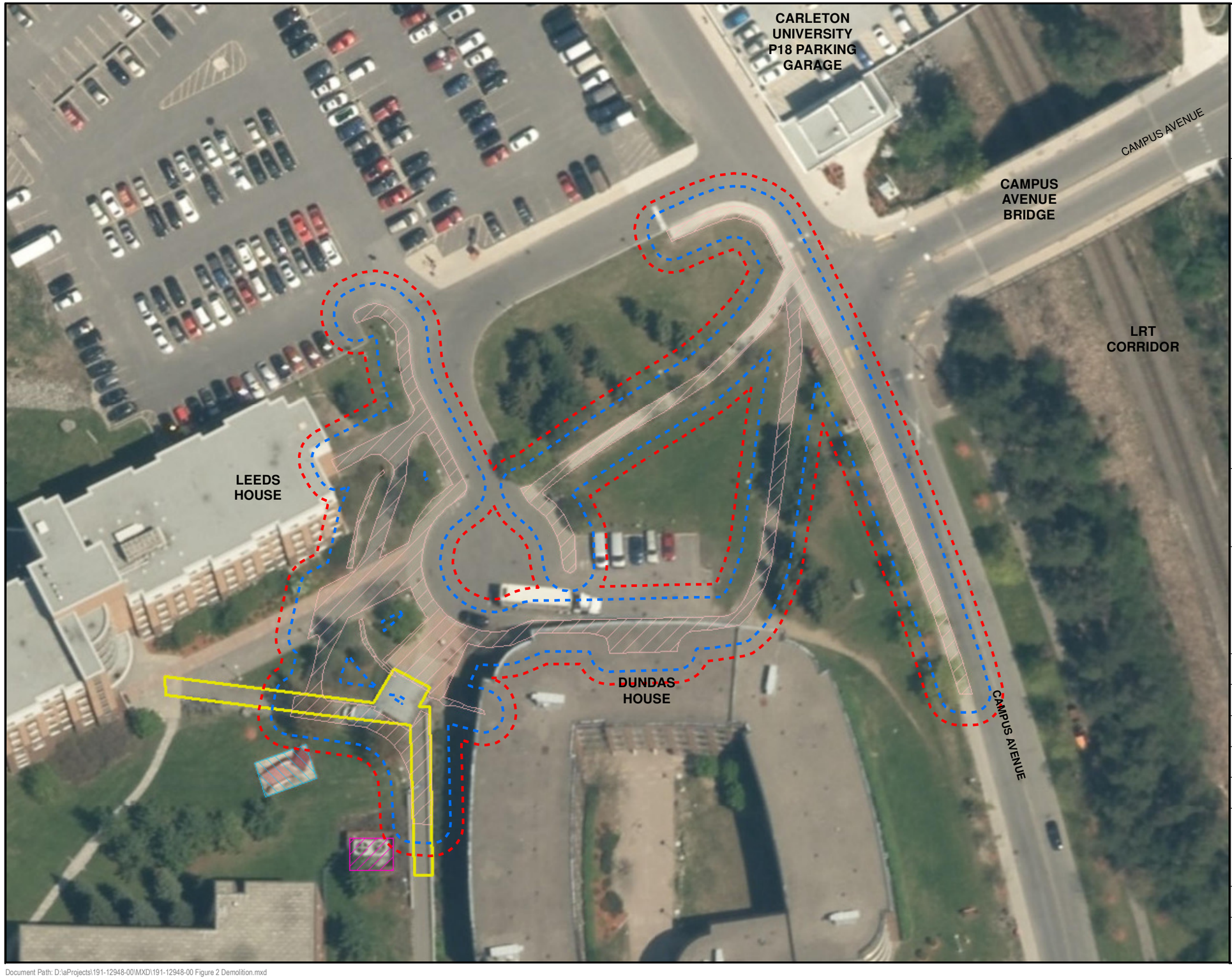


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AURORA, ONTARIO CANADA L4G 0G9
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## LEGEND

- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT
- DEMOLITION
- PARKING GARAGE AND BRIDGE ZOI / LRT CORRIDOR ZOI
- EXISTING RESIDENCES & TUNNEL ZOI

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6 3 0 6 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

CLIENT:
CARLETON UNIVERSITY

PROJECT:
VIBRATION STUDY
CARLETON UNIVERSITY
NEW STUDENT RESIDENCE
OTTAWA, ONTARIO

| PROJECT NO: | DATE: |
|---|---|
| 191-12948-00 | DECEMBER 2020 |

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: -

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TITLE:
DEMOLITION PLAN ZOI

DISCIPLINE:
ENVIRONMENT

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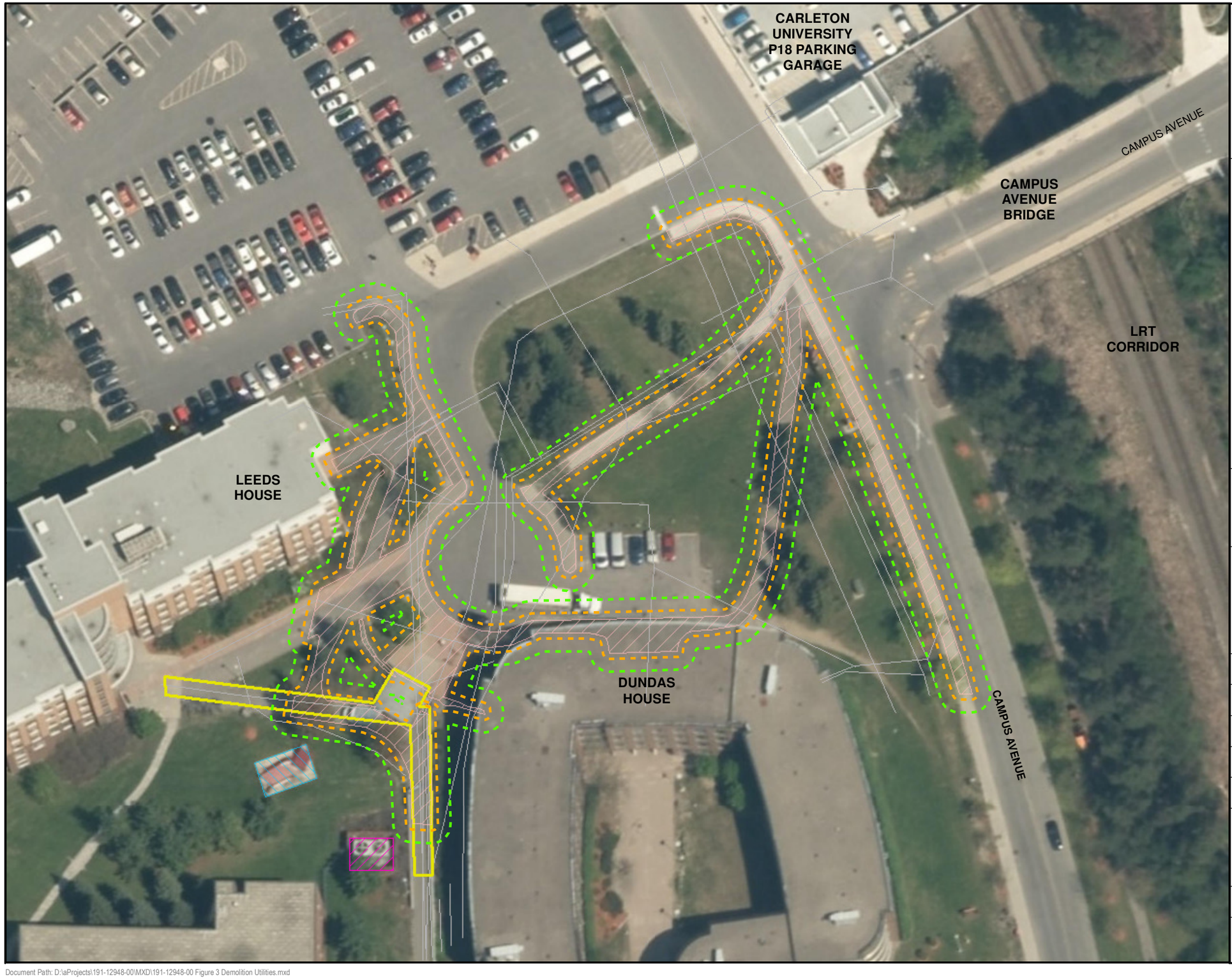


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**LEGEND**

- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT
- DEMOLITION
- EXISTING UNDERGROUND SERVICES
- TABLE 3 LIMITS ZOI
- CITY LIMITS ZOI

N W E S

6 3 0 6 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

CLIENT:
CARLETON UNIVERSITY

PROJECT:
VIBRATION STUDY
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TITLE:
UNDERGROUND SERVICES
DEMOLITION ZOI

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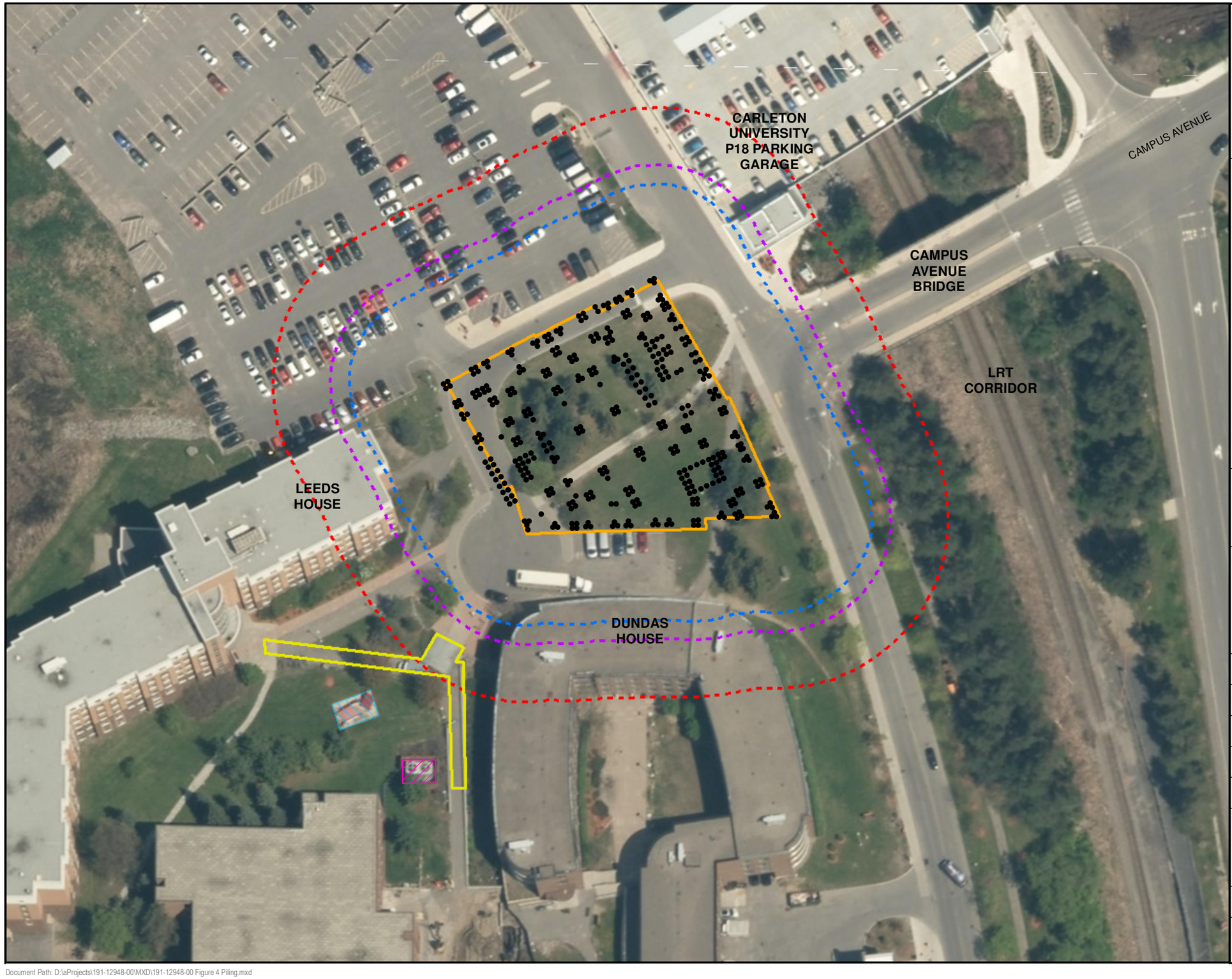


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**LEGEND**

- PILING LOCATION
- PROPOSED BUILDING FOOTPRINT
- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT

BEDROCK PILING ZOI:

- EXISTING RESIDENCES & TUNNEL ZOI
- PARKING GARAGE AND BRIDGE ZOI
- LRT CORRIDOR ZOI

N W E S

8 4 0 8 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

CLIENT:
CARLETON UNIVERSITY

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OTTAWA, ONTARIO

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DESIGNED BY: -

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TITLE:
PILING ZOI

DISCIPLINE:
ENVIRONMENT

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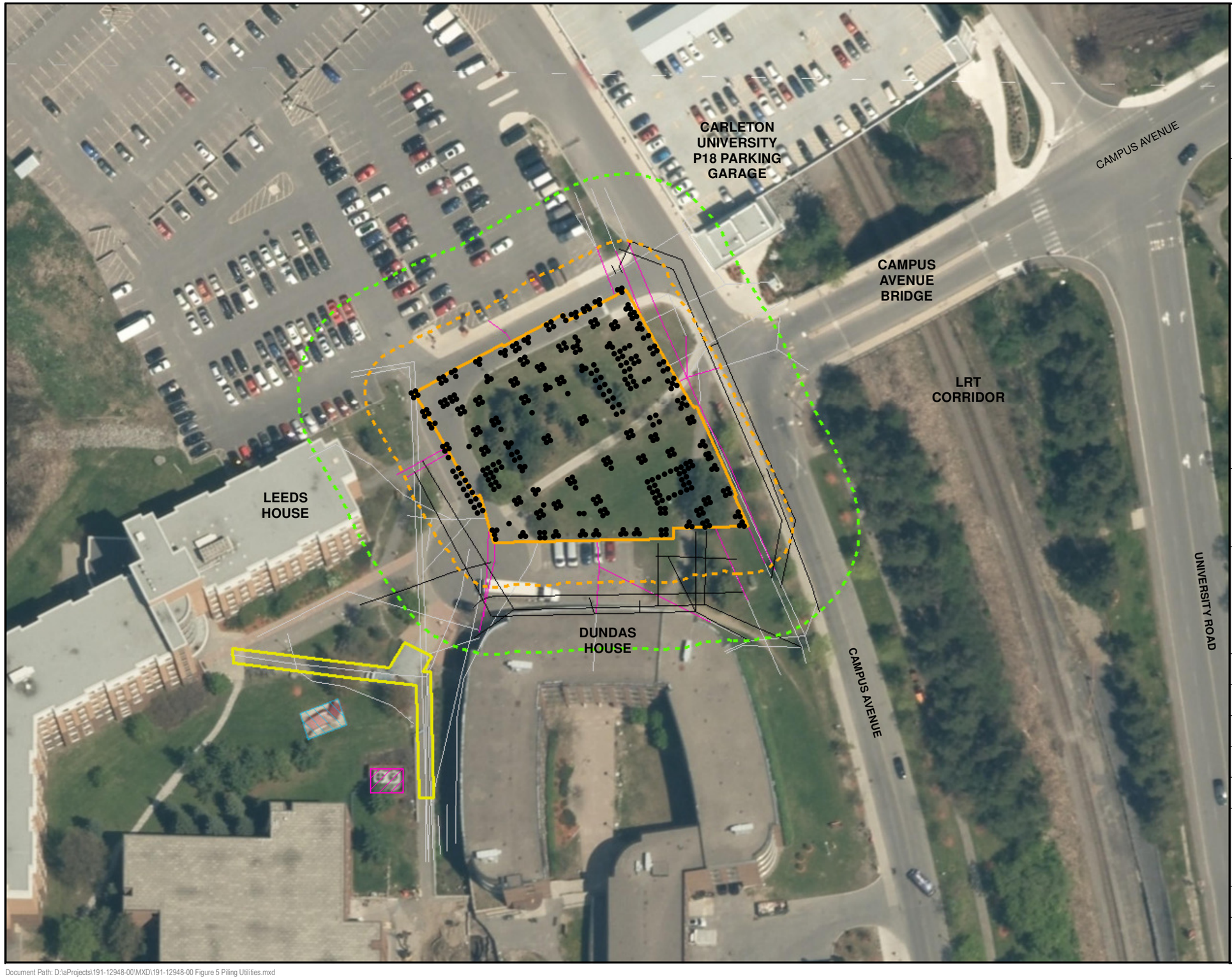


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## LEGEND

- PILING LOCATION
- PROPOSED BUILDING FOOTPRINT
- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT
- CITY LIMITS ZOI
- TABLE 3 LIMITS ZOI
- PROPOSED UNDERGROUND SERVICES
- ABANDONED UTILITIES
- EXISTING UNDERGROUND SERVICES

N W E S

8 4 0 8 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

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DESIGNED BY: -

DRAWN BY: T.P.

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TITLE:

UNDERGOUND SERVICES PILING ZOI

DISCIPLINE:

ENVIRONMENT

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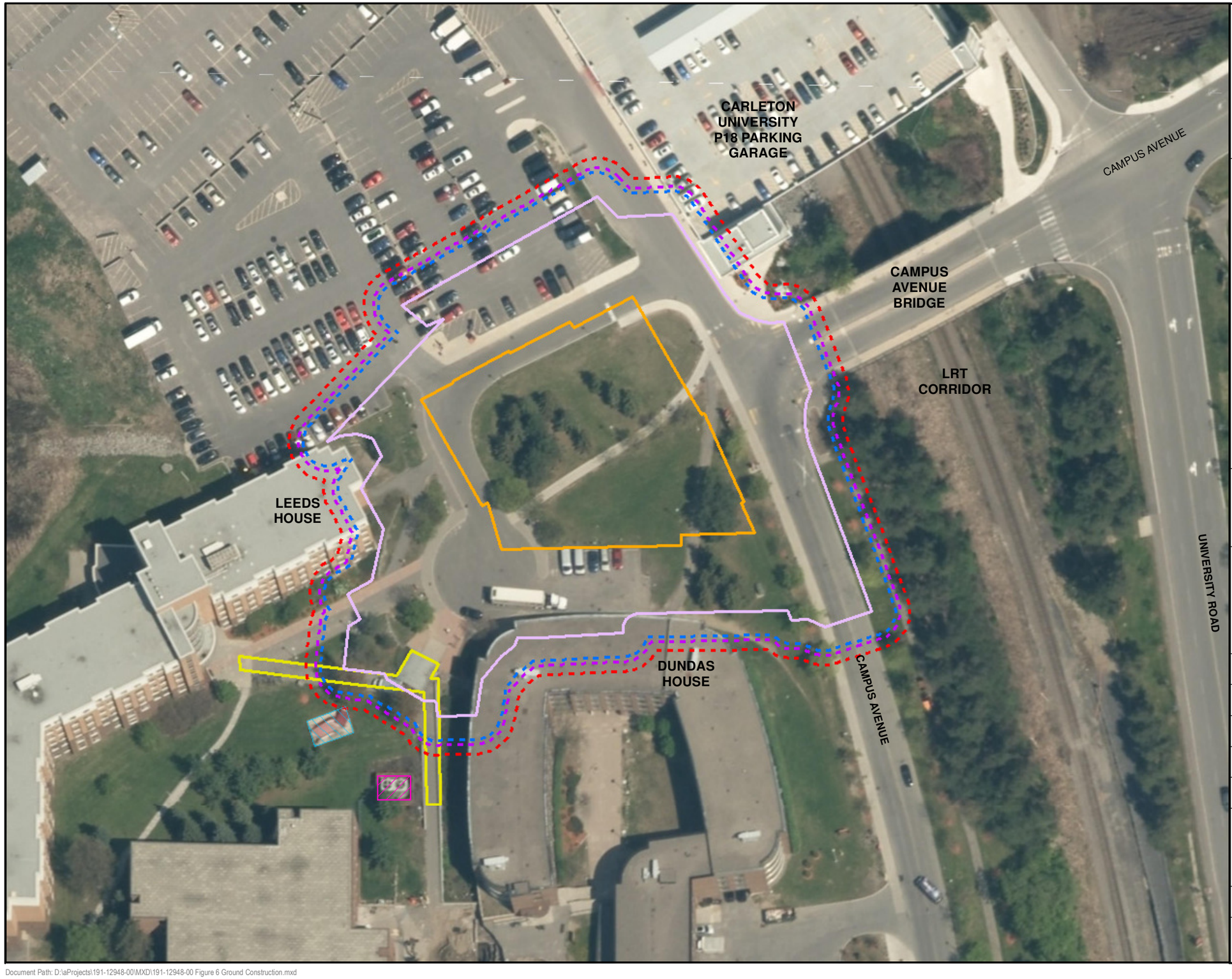


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AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

**LEGEND**

- CONSTRUCTION ACTIVITIES
- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT
- PROPOSED BUILDING FOOTPRINT
- LRT CORRIDOR ZOI
- PARKING GARAGE AND BRIDGE ZOI
- EXISTING RESIDENCES & TUNNEL ZOI

N W E S

8 4 0 8 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

CLIENT:
CARLETON UNIVERSITY

PROJECT:
VIBRATION STUDY
CARLETON UNIVERSITY
NEW STUDENT RESIDENCE
OTTAWA, ONTARIO

| PROJECT NO: | DATE: |
|---|---|
| 191-12948-00 | DECEMBER 2020 |

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: -

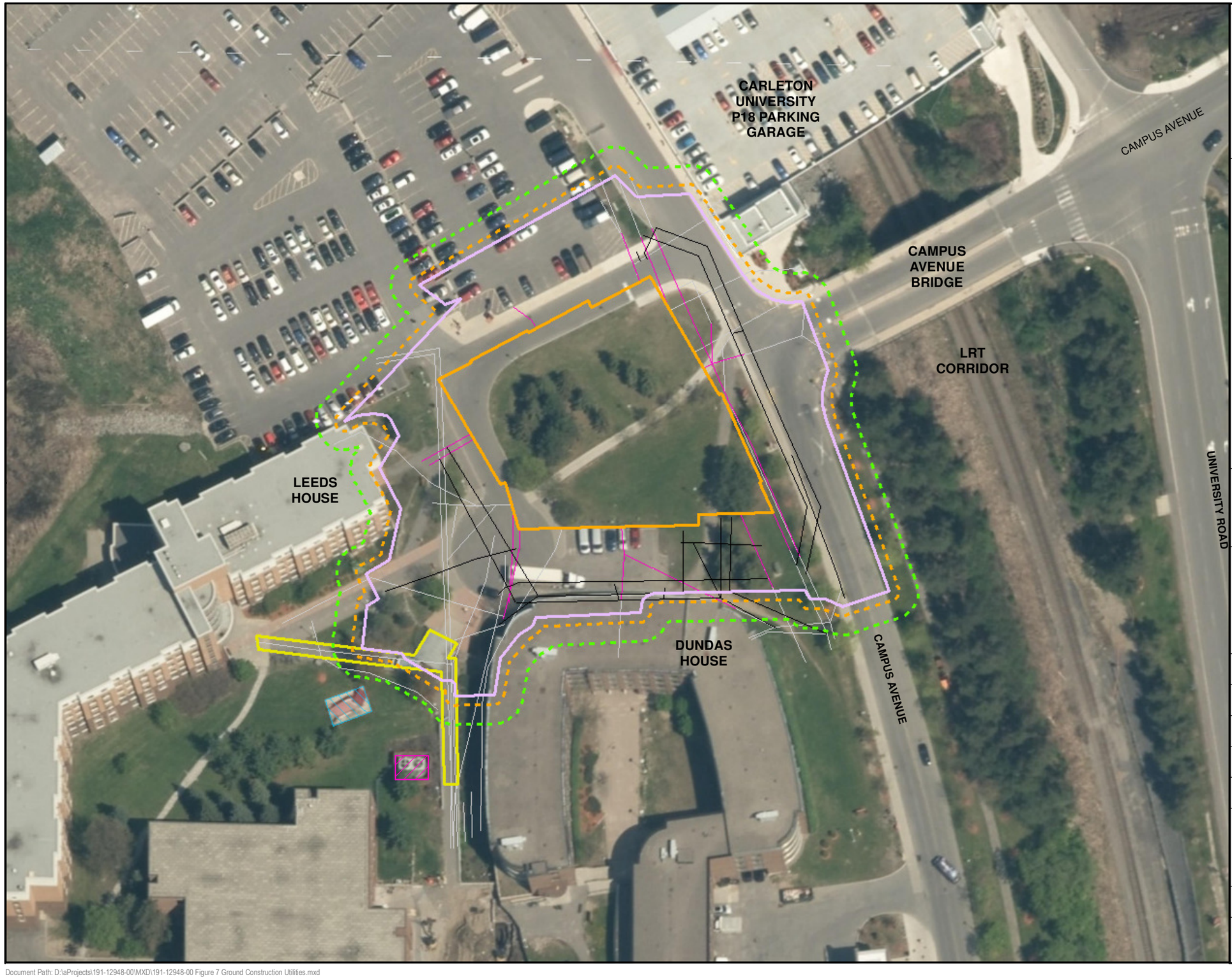
| FIGURE NO: | SCALE: |
|---|---|
| 6 | 1:800 |

TITLE:
LEVEL 1 GENERAL CONSTRUCTION ACTIVITIES

DISCIPLINE:
ENVIRONMENT

| ISSUE: | REV.: |
|---|---|
| | - |

Document Path: D:\aProjects\191-12948-00\MXD\191-12948-00 Figure 6 Ground Construction.mxd

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## LEGEND

- PROPOSED BUILDING FOOTPRINT
- CONSTRUCTION ACTIVITIES
- EXISTING TUNNEL
- COOLING TOWER & BRICK WALL
- CONCRETE PAD & MOUNMENT
- PROPOSED UNDERGROUND SERVICES
- ABANDONED UTILITIES
- EXISTING UNDERGROUND SERVICES
- CITY LIMITS ZOI
- TABLE 3 LIMITS ZOI

N W E S

8 4 0 8 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2020.

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CHECKED BY: -

| FIGURE NO: | SCALE: |
|---|---|
| 7 | 1:800 |

TITLE:
UNDERGROUND SERVICES
LEVEL 1 GENERAL CONSTRUCTION ACTIVITIES

DISCIPLINE:
ENVIRONMENT

| ISSUE: | REV.: |
|---|---|
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