LGCI
Lahlaf Geotechnical Consulting, Inc.

December 12, 2019

Mr. Robert Para Jr., AIA
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Re: Preliminary Geotechnical Review Services
Proposed Doherty High School
Chandler Magnet School Site
Worcester, Massachusetts
LGCI Project No. 1922

Dear Mr. Para:

Lahlaf Geotechnical Consulting, Inc. (LGCI) has performed a site visit and completed a preliminary review of the geotechnical data available for the Chandler Magnet School site (Chandler Site) in relation to the proposed Doherty High School in Worcester, Massachusetts. Our services were performed in accordance with our proposal No. 19087 dated October 14, 2019. Ms. Kathryn Crockett of Lamoureux Pagano & Associates, Inc. (LPA) authorized our services by signing our proposal on November 13, 2019.

This letter includes a summary of our field observations, a summary of the subsurface data we reviewed, our opinion about possible foundation issues during construction, and our recommendations for subsurface explorations.

1. Reviewed Documents

LGCI reviewed the following documents:

- "Custom Soil Resource Report for Worcester County, Massachusetts, Northeastern Part," (Soil Survey Report) National Cooperative Soil Survey/National Resources Conservation Services, USDA (Map and soil description printed November 15, 2019 from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

- "Surficial Materials Map of the North Worcester, Massachusetts," prepared by Stone, J.R. and Stone, B.D. for U.S. Geological Survey, 2018, Scientific Investigation Map 3402, Quadrangle 126 – North Worcester.

- "Plot Plan showing Location of Buildings, Chandler Street Junior High School," (Plot Plan), prepared by Architects Collaborative, Cambridge, MA, dated July 16, 1951, and provided to us via e-mail by LPA on August 23, 2019.

- "Aerial View," provided to us by LPA via e-mail on September 5, 2019.

- Drawing C-1 titled: "Concept Plan, Chandler Magnet School," (Concept Plan), prepared by Nitsch Engineering, Inc., dated October 15, 2019, provided to us by LPA via e-mail on October 31, 2019.

- Sketch showing concept plan titled: "3.3.3 - Final Evaluation of Alternatives, Preliminary Design Options, Option C.2 - New Construction on Chandler Magnet Site (Proposed Scheme), provided to us by LPA via e-mail on December 6, 2019.

- Sketches showing preliminary grading (Preliminary Grading Plans) provided to us by LPA via e-mail December 6, 2019.

2. Site Location Description

We understand that one of the sites being considered for the proposed Doherty High School is the Chandler Site located at 525 Chandler Street in Worcester, Massachusetts as shown in Figure 1. The site has an irregular shape and is bordered by Chandler Street on the southern side, by May Street and private properties on the eastern side, and by wooded land and private properties on the northern and western sides. The site is an active elementary school. The site is occupied by the existing one- to two- story school building, athletic fields, and paved driveways and parking lots. We understand that the existing school was constructed in the early 1950's. The existing building is located on the southern side of the site. A paved driveway looping off of Chandler Street is located on the southern side of the existing building. Two paved parking lots are located on the eastern and northern sides (one on each side) of the existing building. Athletic fields are located on the northern side of the site, north of the existing building. The area west of the athletic fields is wooded.

Based on the Aerial View and the Plot Plan, utilities at the site include a 36-inch and 42-inch drain lines, and an 8-inch and a 10-inch sewer lines. Based on the Concept Plan, the existing grades at the site range between about El. 568 feet near Chandler Street and about El. 690 feet on the northwestern side of the site. The site sits flat at about El. 572 feet around the existing building. The grades slope upward from the northern side of the parking lot just north of the existing building toward the existing athletic fields to between El. 590 feet and El. 592 feet. The site steeply slopes up from about El. 590 feet to about El. 690 feet within the wooded area west of the existing athletic fields. Based on historical topographic maps, included in Attachment A, a cut into the existing slope on the western side of the existing athletic fields The historical topographic maps also show that a stream crossed the site. The stream was filled between 1948 and 1960, possibly when the existing school was constructed. It appears that the material cut from the hill was used to fill the stream to create the area currently used as athletic fields.

3. Project Description

We understand that the City of Worcester is considering the Chandler Site as one of three possible sites for the proposed Doherty High School. We understand that if the Chandler Site is selected, the proposed construction would consist of a high school building mostly on the southern side of the site. The proposed building footprint will overlap with the northern portion of the existing building and the existing parking lot north of the existing building. The western portion of the proposed building will extend beyond the property limits and will require land-taking on the western side of the lower portion of the site.

Based on the Preliminary Grading Plans, we estimate that the proposed building will have a footprint of about 165,000 square feet and will be four (4) stories high. Based on the Concept Plan, the existing grades range between about El. 572 feet on the southern side and about El. 576 feet on the northern side with a local high near the northwestern corner of the proposed building at about El. 600 feet. Based on the Proposed Scheme and the Preliminary Grading Plans, we understand that the proposed floors will be configured as follows:

- The first floor and second floors will extend over the entire footprint of the proposed building. The first floor will have a finished floor elevation (FFE) of El. 468 feet; thus, requiring cuts of between 2 feet on the southern side of the proposed building and up to 32 feet near the northwestern corner of the proposed building. The area east of the first floor will not be excavated. The second floor will have an FFE of El. 588 feet.
- The third floor of the proposed building will approximately extend over the eastern half of the proposed building footprint, while the other half will be open to the proposed gymnasium or cafeteria or will consist of a roof. The third floor will have an FFE of El. 603 feet.
- The fourth floor of the proposed building will approximately extend over the eastern third of the proposed building footprint while its western portion will be a roof. The fourth floor will have an FFE of El. 618 feet.

The proposed athletic fields will mostly remain in their current location, i.e., north of the proposed building but will extend further west from the current western limits into the existing hill.

Based on the Preliminary Grading Plans, the proposed exterior grade will range between about El. 575 feet near the southeastern corner of the proposed building and El. 590 feet near the northwestern corner of the proposed building; thus, requiring about 5 feet of fill near the southeastern corner of the proposed building and cuts of about 10 feet near the northwestern corner of the proposed building. The grades within the proposed athletic fields will range between about El. 590 feet and El. 595 feet; thus, requiring about 3 feet of fill within the majority of the proposed fields, expect on the western side where cuts of up to 10 feet will be required. We understand that site retaining walls will be requiring along the western edge of the proposed construction area.

Field Observations

An LGCI representative visited the site on December 5, 2019. The purpose of our visit was to observe site features such as wet areas and other features that may impact construction.

The site was mostly covered with about one foot of snow at the time of our visit and site features were concealed by the snow.

Photographs of the sites are included in Attachment B.

4. Summary of Existing Subsurface Data

Soil Survey Report – Based on the Soil Survey Report listed in Section 1, the soils at the site are classified primarily as Smoothed Udorthents. Udorthents are defined as "made land over firm loamy basal till." The Soil Survey Report does not include the thickness of the A and B horizons. However, it includes a depth to groundwater that is deeper than 80 inches.

A copy of the Soil Survey Report and Map are included in Attachment C.

Surficial Geologic Map – The Surficial Geologic Map (listed in Section 1) indicates that the natural soils in the general vicinity of the site consist of artificial fill, thin till, thick till, and coarse deposits. Based on the Surficial Geologic Map, the artificial till consist of earth and manmade materials that have been artificially placed. The Surficial Geologic Map indicates that the artificial fill is present on the eastern side of the existing athletic field. The thin and thick till consist of a non-stratified matrix of sand, some silt, and little clay containing scattered pebbles to boulders. Boulders are more commonly found within the thin till. The Surficial Geologic Map indicates that the thin till is present on the northern side of the existing building and on the western side of the existing athletic fields and is generally less than 10 to 15 feet thick. The Surficial Geologic Map indicates that the thick till is present in the hill west of the existing athletic fields and is generally greater than 10 to 15 feet thick. The coarse deposits consist of gravel deposits, sand and gravel deposits, and sand deposits. These deposits are present on the southwestern side of the site.

The Surficial Geologic Map of the site is shown in Figure 2.

Previous Explorations – Based on the Plot Plan, twelve (12) borings were advanced at the site at an unspecified date. The logs of five (5) of the borings advanced (Boring No. 1, Boring No. 3, Boring No. 7, Boring No. 8, and Boring No. 10) are shown in the Plot Plan. The locations and boring logs of Boring No. 2, Boring No. 4, Boring No. 5, Boring No. 6, Boring No. 9, Boring No. 10A, and Boring No. 11 are not shown in the Plot Plan. Boring No. 1, Boring No. 3, Boring No. 7, and Boring No. 8 were advanced at the location of the existing athletic fields and extended to depths ranging between 4.1 and 8.8 feet beneath the ground surface. Boring No. 10 was advanced in the play yard west of the existing building and extended to a depth of 7 feet beneath the ground surface.

The locations of the borings and the logs you provided to us are included in Attachment D.

Boring No. 1, Boring No. 3, Boring No. 7, and Boring No. 8 generally indicated compact fine sand with clay and gravel that extended to the termination depth of Boring No. 8 at 7 feet beneath the ground surface. In Boring No. 1, Boring No. 3, and Boring No. 7 the compact fine sand with clay and gravel extended to the top of a very compact sand with clay and gravel, at depths ranging between 2 and 3.7 feet beneath the ground surface. Underlying the compact fine sand with clay and gravel was a very compact fine sand with clay and gravel that extended to the termination depth of Boring No. 1, Boring No. 3, and Boring No. 7.

Boring No. 10 generally indicated loam that extended to a depth of 1.4 feet beneath the ground surface. Underlying the loam was a compact fine sand with clay and gravel that extended to the termination depth of Boring No. 10 at a depth of 7 feet beneath the ground surface.

A rock obstruction was encountered in Boring No. 1, Boring No. 7, Boring No. 8, and Boring No. 10 at depths of 8.8, 4.1, 7, and 7 feet beneath the ground surface respectively.

The Plot Plan and the logs of the previous borings suggest that the western side of the existing athletic fields was cut and that the eastern side was filled.

5. Preliminary Recommendations

Please note that the review of available information summarized in this letter is not a substitute for a subsurface exploration program. The information gathered as part of this review may be incomplete and the recommendations derived therefrom are at best preliminary in nature and must be confirmed with actual subsurface explorations, laboratory testing, and geotechnical analyses.

Based on our review of the documents listed in Section 1, our understanding of the proposed construction, and our review of the previous explorations at the site, there are a few issues that we would like to highlight for consideration and discussion.

- Based on the previous borings the natural soils at the site are dense (compact) sand and gravel (glacial till). The natural glacial till is suitable to support the proposed building with footings and slabs placed on Structural Fill placed directly on top of the glacial till.

- The Plot Plan and the historical topographic maps indicate the presence of fill within the northern portion of the proposed building. Existing fill that was not placed with strict moisture, density, and gradation control presents the risk of unpredictable settlements that may result in the poor performance of floor slabs and foundations. While the proposed grades may require removing most of the existing fill, the proposed excavations to reach the proposed FFE may not locally extend deeper than the bottom of the existing fill and the possible underlying loam and loose sand. These materials are not suitable to support the proposed building and should be entirely removed and replaced with Structural Fill.

- We believe that the fill formerly placed to raise the grades within the existing athletic fields was glacial till cut from the southern side of the site. The glacial till is generally silty and the existing fill is anticipated not to meet the gradation requirements for Ordinary Fill or Structural Fill.

6. Recommendations for Subsurface Explorations

To explore for the presence of fill within the proposed building footprint and to explore for the possible presence of shallow rock along the proposed site retaining walls, we recommend performing additional explorations at the site if this site is selected. The additional explorations should include at least twelve (12) soil borings, including at least six (6) borings to rock, and two (2) groundwater observation wells. The geotechnical explorations should also include at least eight (8) test pits to explore for rock in shallow till areas.

The geotechnical explorations should be coordinated with the work of an environmental engineer to pre-characterize the site soils that will be generated during the deep cuts and that will need to be disposed of offsite.

7. Limitations

Our letter is based on project information provided to us at the time of this letter. If changes to the type, size, and location of the proposed structure or to the site grading are made, the recommendations contained in this letter shall not be considered valid unless the changes are reviewed, and the conclusions and recommendations modified in writing by LGCI. LGCI cannot accept responsibility for designs based solely on these preliminary recommendations.

It is not part of our scope to perform a more detailed site history; therefore, we have not explored for or researched the locations of buried utilities or other structures in the area of the proposed construction. Our scope did not include environmental services or services related to moisture, mold, or other biological contaminates in or around the site.

The recommendations in this letter are based in part on the data obtained from the review of existing subsurface data. The recommendations contained in this letter are at best preliminary in nature and must be confirmed with actual subsurface explorations, laboratory testing, and geotechnical analyses.

Our letter has been prepared in accordance with generally accepted engineering practices and in accordance with the terms and conditions set forth in our agreement. No other warranty, expressed or implied, is made. This report has been prepared for the exclusive use of Lamoureux Pagano & Associates, Inc. for the specific application to the proposed Chandler Site at the Doherty High School in Worcester, Massachusetts as conceived at this time.

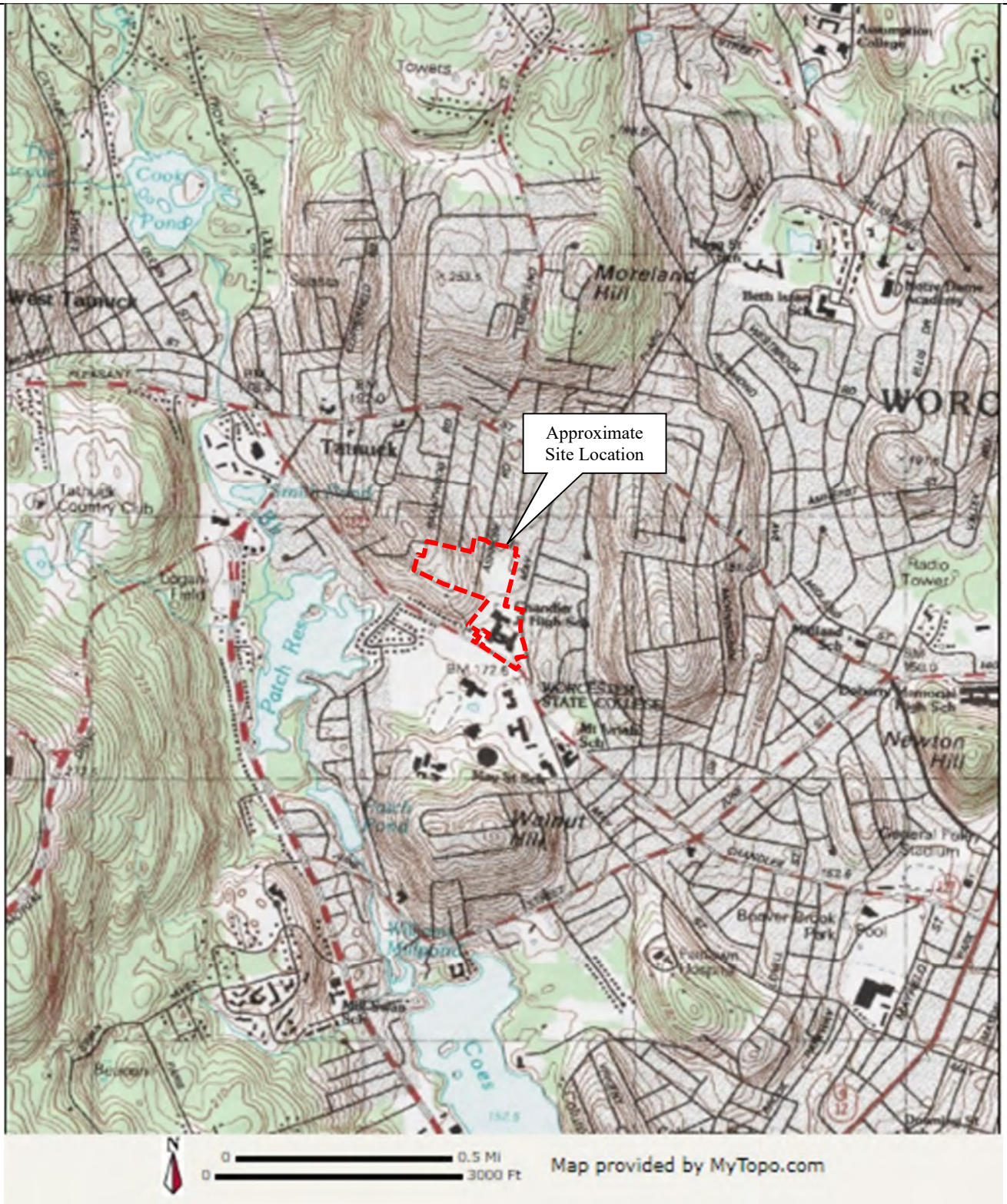
If you have any questions or need further assistance, please contact us at (978) 330-5912.

Very truly yours,

Lahlaf Geotechnical Consulting, Inc.

Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal Engineer

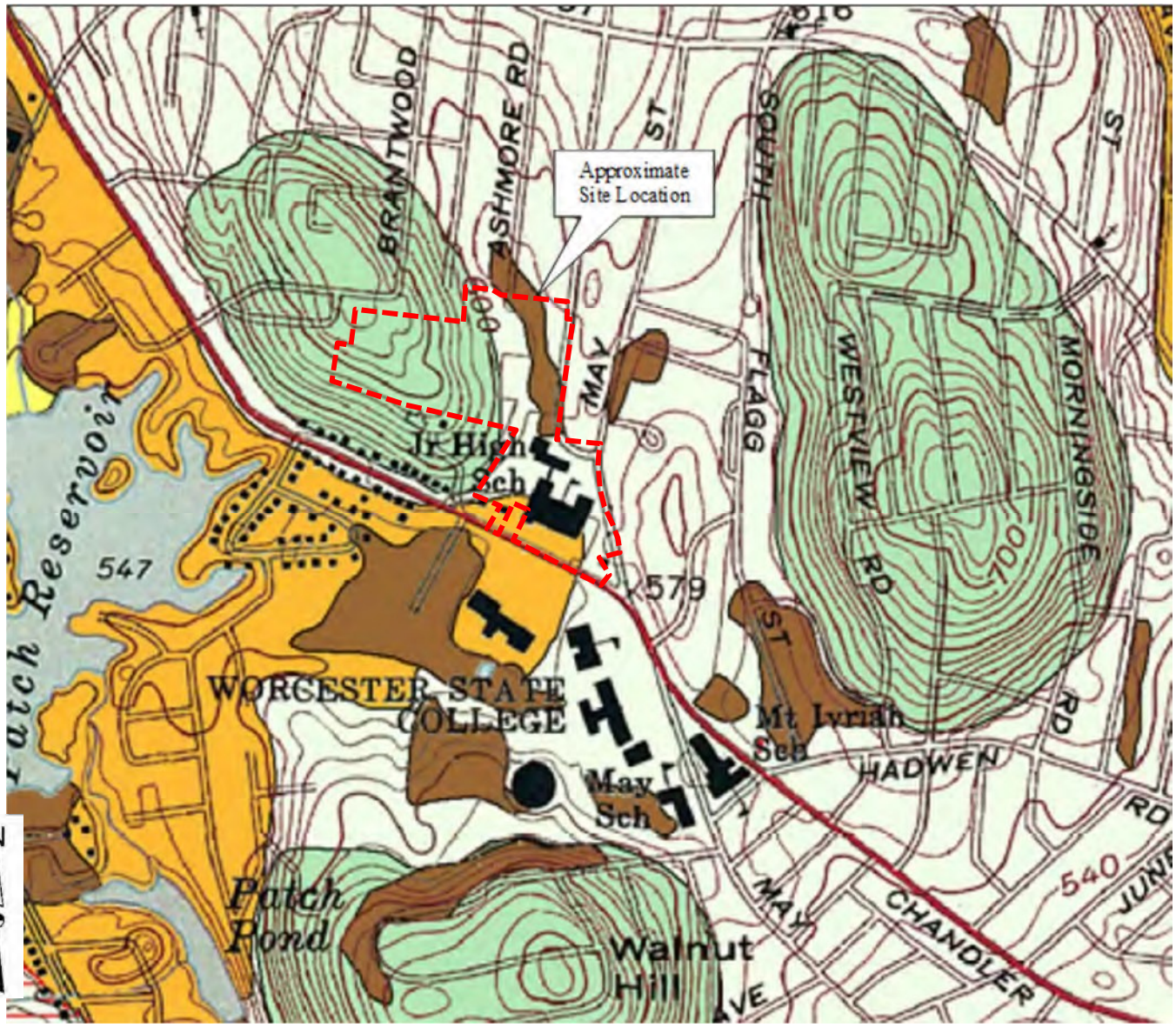
Attachments: Figure 1 – Site Location Map
Figure 2 – Surficial Geologic Map
Attachment A – Historical Topo Maps
Attachment B – Photographs
Attachment C – Excerpts of Soil Survey Report
Attachment D – Locations and Logs of Previous Borings



Contour Intervals: 3 meters

Figure based on USGS topographic map of Worcester, MA obtained from www.mytopo.com/maps

Client:	Project:	Figure 1 – Site Location Map (Chandler Site)	
Lamoureux Pagano & Associates, Inc.	Proposed Doherty High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Worcester, MA	LGCI Project No.: 1922	Date: Nov. 2019



Artificial fill—Earth materials and manmade materials that have been artificially emplaced, primarily in highwa and railroad embankments and in dams; unit may also include landfills, urban-development areas, and filled coastal wetlands

Coarse deposits consist of *gravel deposits*, *sand and gravel deposits*, and *sand deposits*, not differentiated in this report. *Gravel deposits* are composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; minor amounts of sand occur within gravel beds, and sand comprises a few separate layers. Gravel layers generally are poorly sorted, and bedding commonly is distorted and faulted due to postdepositional collapse related to melting of ice. *Sand and gravel deposits* occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. Sand and gravel layers generally range between 25 and 50 percent gravel particles and between 50 and 75 percent sand particles. Layers are well sorted to poorly sorted; bedding may be distorted and faulted due to postdepositional collapse. *Sand deposits* are composed mainly of very coarse to fine sand, commonly in well-sorted layers. Coarser layers may contain up to 25 percent gravel particles, generally granules and pebbles; finer layers may contain some very fine sand, silt, and clay

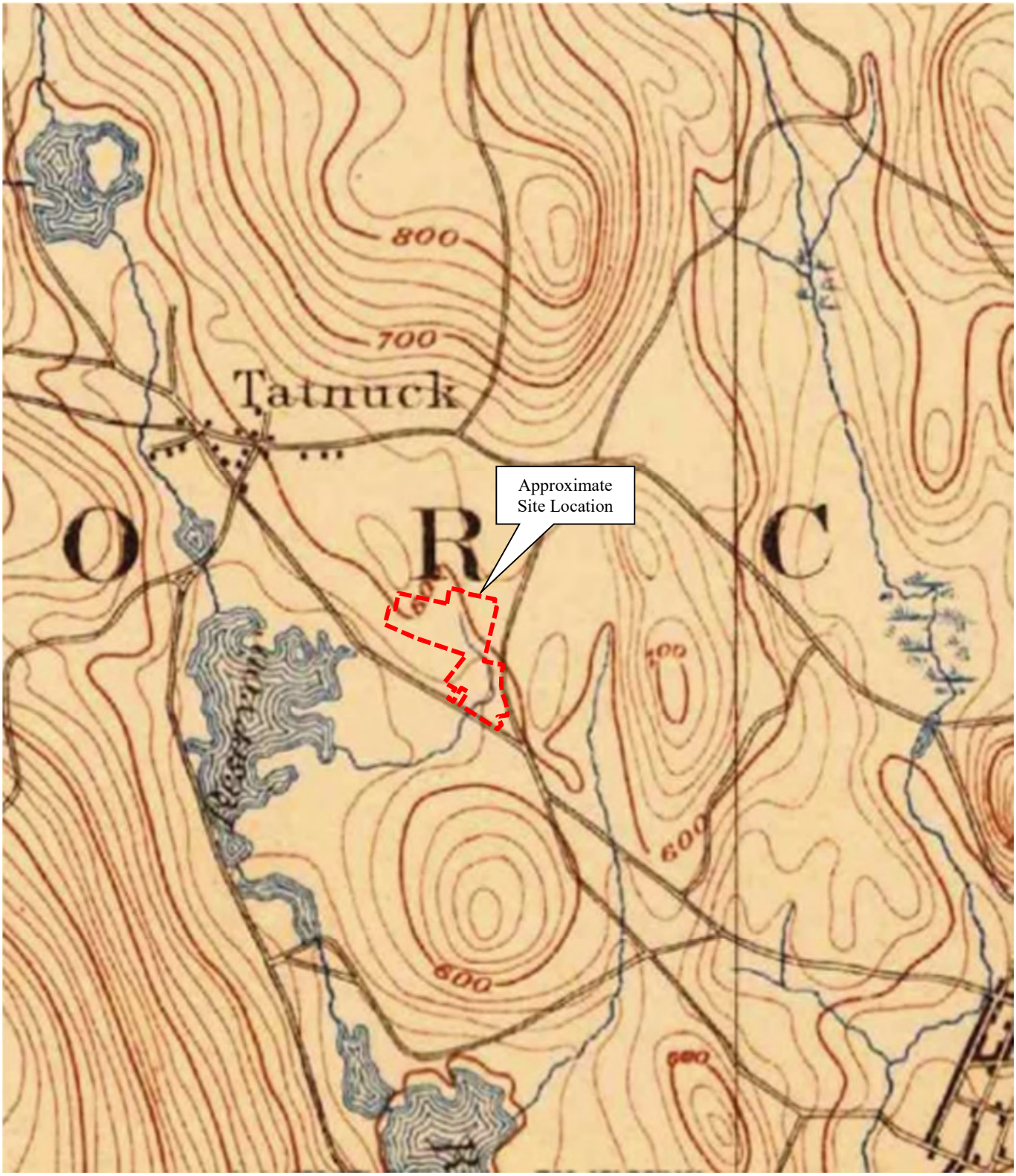
Thin till—Nonsorted, nonstratified matrix of sand, some silt, and little clay containing scattered pebble, cobble, and boulder clasts; large surface boulders are common; unit was mapped where till is generally less than 10 to 15 ft thick including areas of shallow bedrock. Predominantly consists of upper till of the last glaciation; loose to moderately compact, generally sandy, commonly stony. Two facies are present in some places: a looser, coarser grained ablation facies, melted out from supraglacial position, and an underlying more compact, finer grained lodgement facies deposited subglacially. In general, both ablation and lodgement facies of upper till derived from fine-grained bedrock are finer grained, more compact, less stony and have fewer surface boulders than upper till derived from coarse-grained crystalline rocks. Across Massachusetts, fine-grained bedrock sources include the red Mesozoic sedimentary rocks of the Connecticut Valley lowland, marble in the western river valleys, and fine-grained schists in upland areas

Thick till—Nonsorted, nonstratified matrix of sand, some silt, and little clay containing scattered pebbles, cobbles, and boulders in the shallow subsurface; at greater depths consists of compact, nonsorted matrix of silt, very fine sand, and some clay containing scattered small gravel clasts. Mapped in areas where till is greater than 10 to 15 ft thick; mostly in drumlin landforms in which till thickness commonly exceeds 100 ft (maximum recorded thickness is 230 ft). Although upper till of late Wisconsinan age is the surface deposit, lower till of probable Illinoian age constitutes the bulk of the material in thick-till areas. Lower till is moderately to very compact and is commonly finer grained and less stony than upper till. An oxidized zone, the lower part of a soil profile formed during a period of interglacial weathering, is generally present in the upper part of the lower till. This zone commonly shows closely spaced joints that are stained with iron and manganese oxides

Figure based on map titled: "Surficial Materials Map of the North Worcester, Massachusetts," prepared by Stone, J.R. and Stone, B.D. for U.S. Geological Survey, 2018, Scientific Investigation Map 3402, Quadrangle 126 – North Worcester.

Client:	Project:	Figure 2 – Surficial Geologic Map (Chandler Site)	
Lamoureux Pagano & Associates, Inc.	Proposed Doherty High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Worcester, MA	LGCI Project No.: 1922	Date: Nov. 2019

Attachment A – Historical Topo Maps



Contour Intervals: 3 meters

Figure based on USGS topographic map of Worcester, MA obtained from www.mytopo.com/maps

Client:	Project:	Figure A1 – 1886 Historical Topo Map (Chandler Site)	
Lamoureux Pagano & Associates, Inc.	Proposed Doherty High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Worcester, MA	LGCI Project No.: 1922	Date: Nov. 2019

Contour Intervals: 3 meters

Figure based on USGS topographic map of Worcester, MA obtained from www.mytopo.com/maps

Client:	Project:	Figure A2 – 1948 Historical Topo Map (Chandler Site)	
Lamoureux Pagano & Associates, Inc.	Proposed Doherty High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Worcester, MA	LGCI Project No.: 1922	Date: Nov. 2019

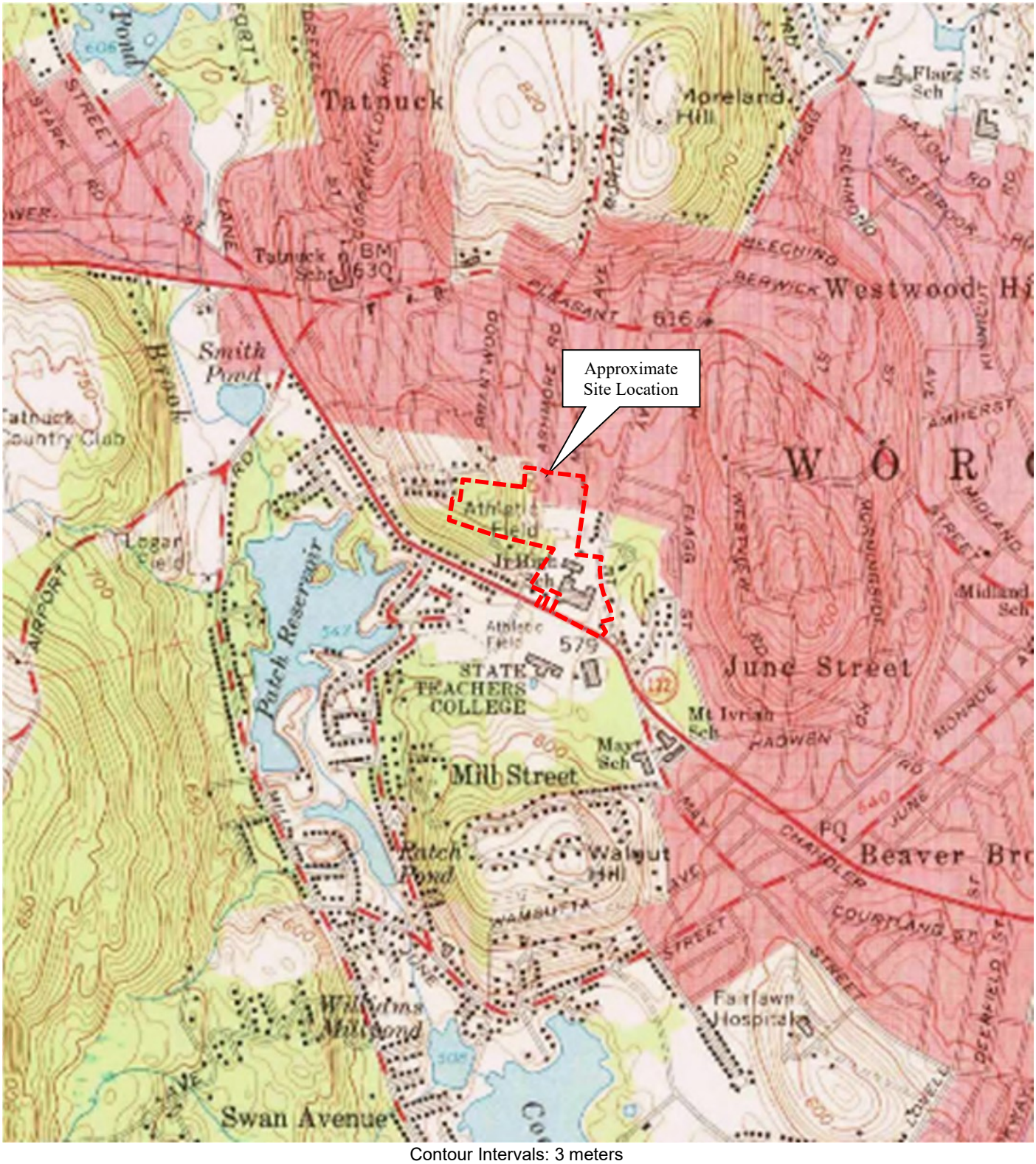


Figure based on USGS topographic map of Worcester, MA obtained from www.mytopo.com/maps

Client:	Project:	Figure A3 – 1960 Historical Topo Map (Chandler Site)	
Lamoureux Pagano & Associates, Inc.	Proposed Doherty High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Worcester, MA	LGCI Project No.: 1922	Date: Nov. 2019

Attachment B – Photographs

Photo No. 1: View showing the existing flat field north of the existing building with a sharp increase in the grade East within the wooded area

Photo No. 2: Close up of the steep rise in the grade east of the existing field into the wooded area

Photo No. 3: View facing south showing the gradual rise in the grade from the existing building to the existing field

Photo No. 4: Close up of the sharp rise in grade within the wooded area East of the existing building