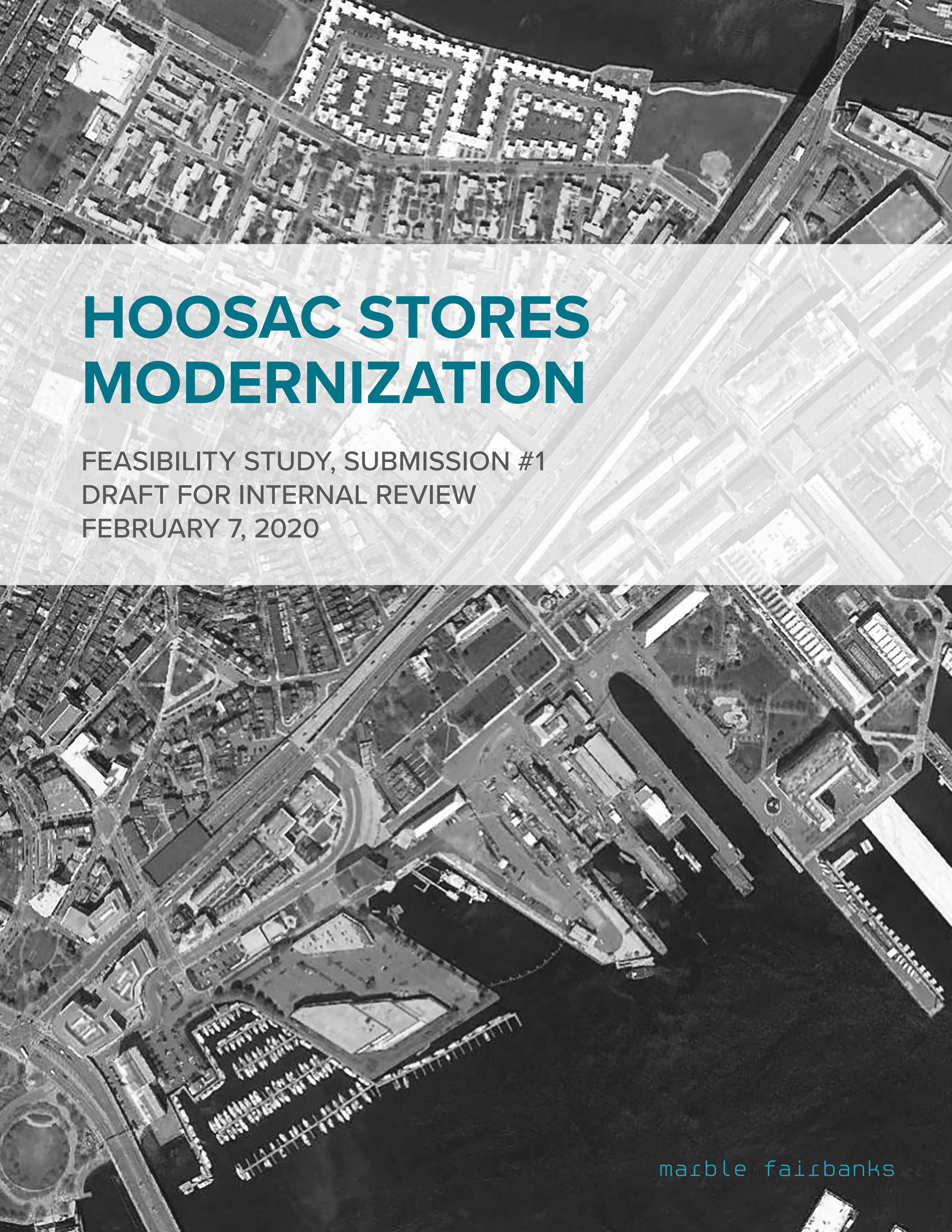

HOOSAC STORES MODERNIZATION

FEASIBILITY STUDY, SUBMISSION #1
DRAFT FOR INTERNAL REVIEW
FEBRUARY 7, 2020

marble fairbanks

HOOSAC STORES FEASIBILITY STUDY
FOR HOOSAC STORES MODERNIZATION

115 CONSTITUTION ROAD
CHARLESTOWN, MA 02129

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EXECUTIVE SUMMARY

Introduction

After completing the second submission for the Program Development Study (PDS) for the Hoosac Stores Modernization project for the National Parks of Boston (NPB/NPS), several issues arose as to the viability of the existing Hoosac Stores building as a new home for the USS Constitution Museum (USSCM), National Parks of Boston staff, and the Navy Yard Orientation Center. As a result, Marble Fairbanks was directed by the General Services Administration (GSA) to conduct a simplified feasibility study of the existing Hoosac Stores building by developing five Possible Alternatives that were to be narrowed to three Viable Alternatives and finally to a Preferred Alternative that reconciled the desired program area with the existing building area, with a consideration of how to best utilize the adjacent site. Additionally, the Feasibility Study was to include a structural and materials conditions analysis of the Hoosac Stores building, a HazMat analysis and an historic preservation assessment of the various Alternatives.

Sub-consultants for this project include:

Jacobs Engineering Group, Inc. [Jacobs]: Cost Estimating, Financial Planning, MEP/FP, Structure, LEED, Geotech, Civil, IT
Nover-Armstrong [now BETA Group]: HazMat
Public Archaeology Lab [PAL]: Preservation

Phase 1 began in September of 2019 and commenced with several months of invasive on-site probes, geotechnical borings, material testing and analysis to determine the physical condition of the existing building, led by Jacobs. Concurrently, Marble Fairbanks worked with Parks to develop and reconcile the new programming needs of the user groups with the work previously done in the Workplace Recommendation Report (WRR), and with the work done by Jacobs in their own PDS of the existing Building 22-28 complex, the current home of the USSCM.

In January of 2020, the design team led a presentation and workshop at the Navy Yard with representatives from the USSCM, the GSA, NPS, and the Navy to review over a dozen different Alternatives to the site. These Alternatives were weighed against Decision Drivers that were designed to raise conversations around shared priorities and desires and, at the end of that meeting, five Possible Alternatives were chosen to be further reviewed and priced out using a rough order of magnitude (RoM) costing strategy.

Submission 1 of the feasibility study included here, contains the results of all structural and materials analysis and the five Possibly Alternatives along with an extensive appendix documenting the process of the work of this phase. The Viable and Preferred Alternatives will be presented in Submission 2 of the Feasibility Study.

At the end of the Feasibility Study, the design team return to the PDS scope of work and continue that process from where it was left off.

Possible Alternatives workshop held on January 17th 2020 at the USSCM

EXISTING CONDITIONS INVESTIGATIONS

Asset Conditions

In addition to the visual observations made of the existing Hoosac Stores building and the historic documentation that was collected and reviewed during the PDS process, Jacobs provided a complete geotechnical, subsurface, and structural analysis of the building for this Feasibility Study. Material samples were also collected though borings into the exterior walls and the interior wood and iron structural elements.

Through the investigation of the building foundation, the design team found that the building structural columns rest on stacks of loosely laid granite blocks that then rest on timber piles. The timber piles sit below the groundwater table and therefore could “last indefinitely.” Additionally, because the building structure and foundation was built to support extensive gravity loads due to its original use as a warehouse, any future design loads on the building would be easily carried by the existing foundation.

However, because the loosely laid granite stones are not anchored together, the existing footings have minimal capacity to resist lateral loads (such as wind loads or seismic loads). Any new construction would require a retrofit for lateral stability. Jacobs outlines several approaches to this problem in their report.

The consultant team also found the load-bearing masonry walls, despite localized areas of deterioration, were in generally good shape, with the inner wythes of brick relatively intact and sound and with a compressive strength well above modern ASCE standards.

The structural grading of the interior structural timber framing ranged from the highest possible quality (Select Structural or No. 1 Grade) to some that were ranked lowest (No. 3 Grade). The consultant team also noted the existence of cast iron columns and the steel girders that had structural values similar to modern day standards.

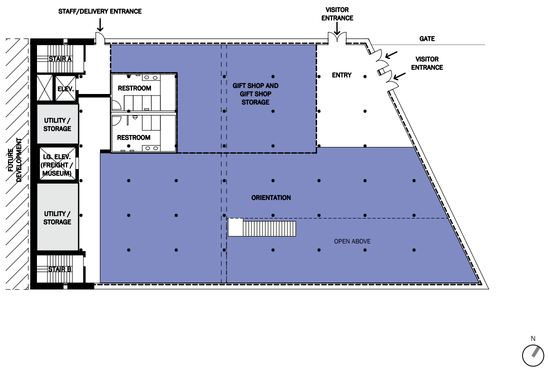
The area of the interior building structure in worst condition is the roof level beams, which the consultant recommended to be removed and replaced in any proposed Alternative.

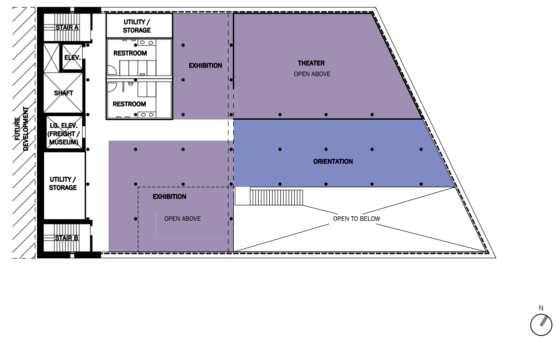
The complete report can be found in the Appendix.

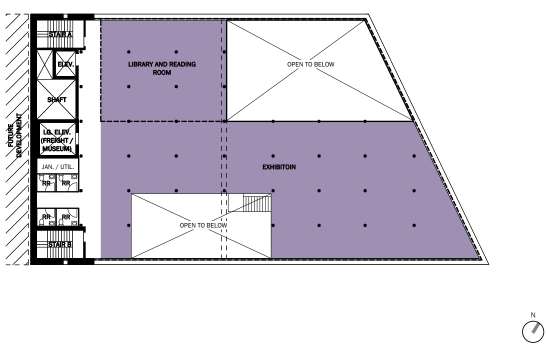
Portions of the existing Hoosac Stores building exterior facade

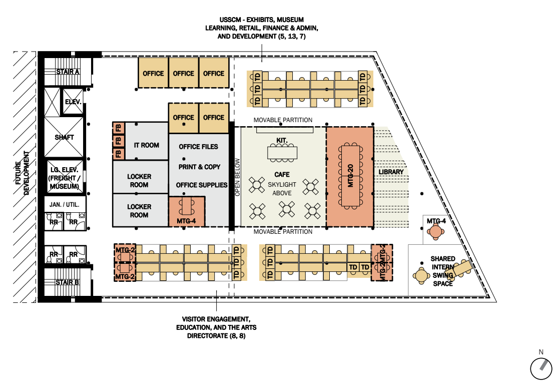
Customer Housing Conditions

The Test Fit and Housing Program for the Hoosac Building from the Workplace Recommendation Report (WRR) was used as a starting point in developing the program for the Feasibility Study Alternatives. Because the WRR looked primarily at workplace, it did not accommodate any desired program growth outside of these areas. The revised Housing Program looks at what it would mean for the program to exist solely within the footprint of the existing Hoosac Stores building in addition to what it would take to accommodate future USSCM growth. The NPS program was revised slightly to reflect the reorganization of certain directorate's organizational charts but did not substantially change from the program laid out in the WRR. Refer to the "Needs Assessment" later in this report for further information.









Test fits of the Hoosac Stores as illustrated in the Workplace Recommendation Report.

Site Conditions

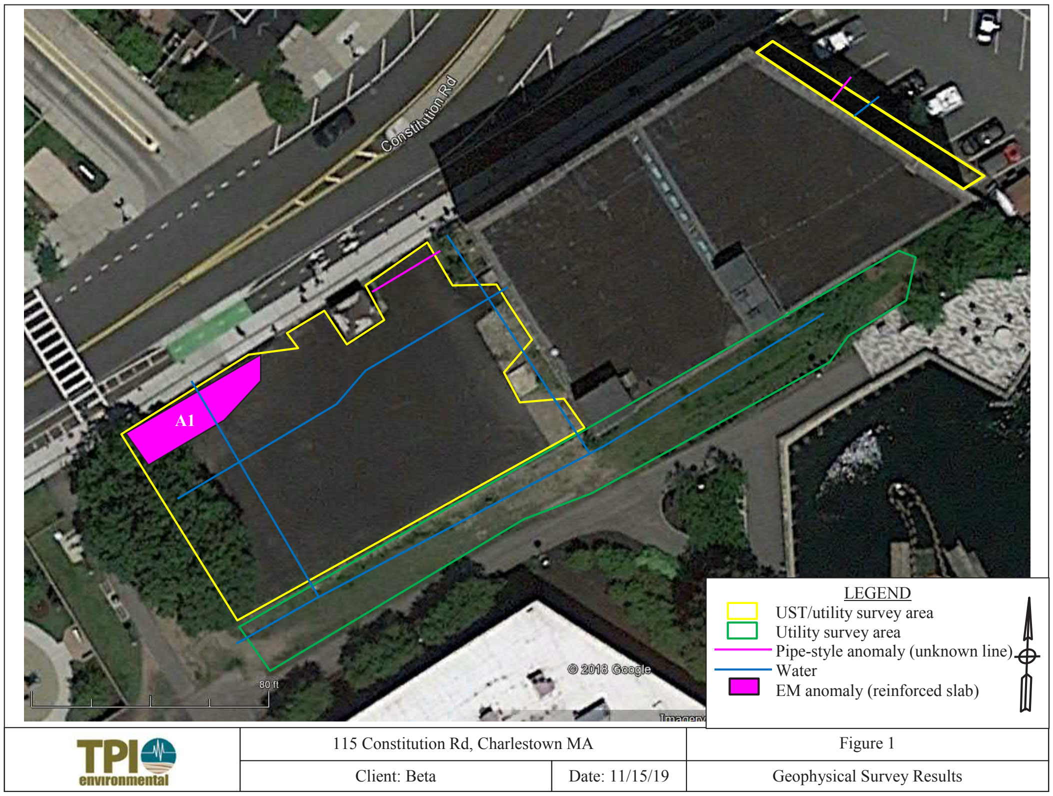
HAZMAT

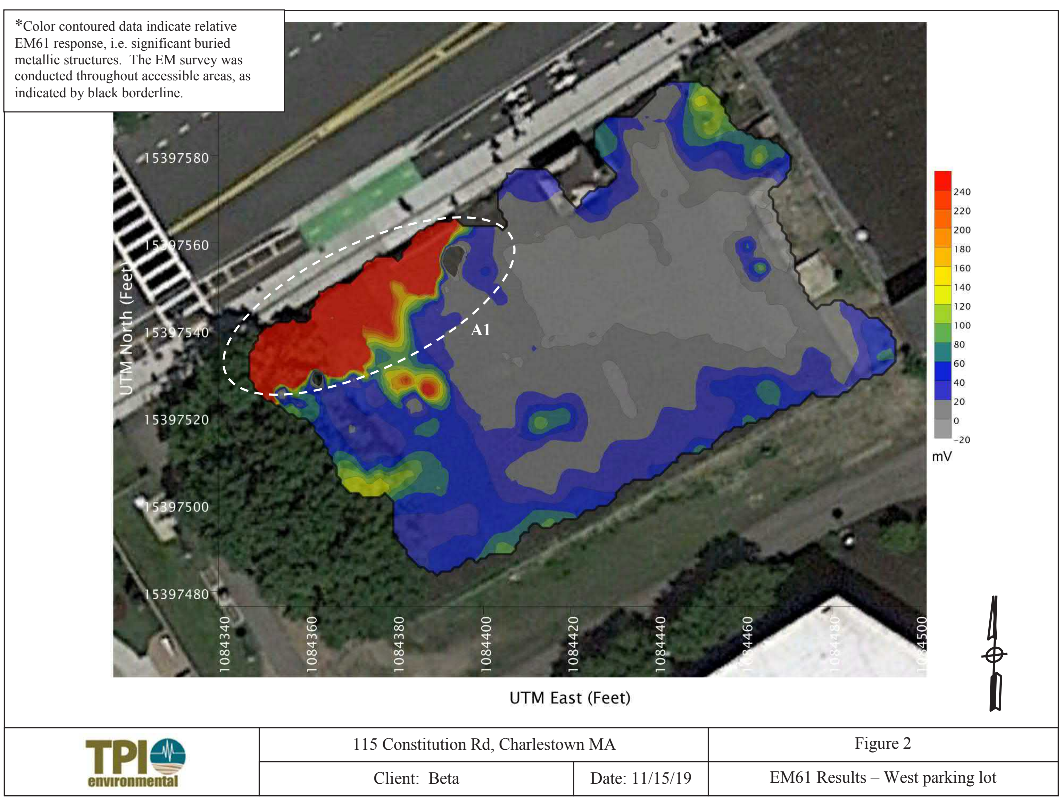
The HazMat consultant team performed an environmental and hazardous material test that analyzed the adjacent site and the soil below the building to supplement the work already performed on the Hoosac Stores building itself. The tests revealed nothing outside of acceptable standards apart from arsenic. However, arsenic is "exempt from notification to MassDEP because it is considered naturally occurring due to the presence of Boston Blue Clay." Additionally, a geophysical survey of the site was done with ground penetrating radar. It identified a concrete reinforced slab in the corner of the property and the presence of what appeared to be a few underground utilities passing through the site. No large, underground storage tanks of any kind were detected.

The complete report can be found in the Appendix.

ZONING

The design team also had further conversations with NPS regarding the development challenges around zoning that this site would face. As noted in PDS Submission #2, as it exists, the Hoosac Building is already non-compliant with modern zoning. Any changes to the building would bring it further into non-compliance, especially adding square footage to meet current program desires. NPS noted that they want to take a common sense, contextual approach to the building strategy, develop a design based on this approach, and then present it to BPDA. NPS also noted that views to the water are important and that a viewshed model would be desired to explain how views would be affected from surrounding properties. Views at the lower level (such as through the building and to the water) would be important for neighbors to understand as part of the design development and proposal.





Plans from the GPR survey performed as part of the environmental assessment

NEEDS ASSESSMENT

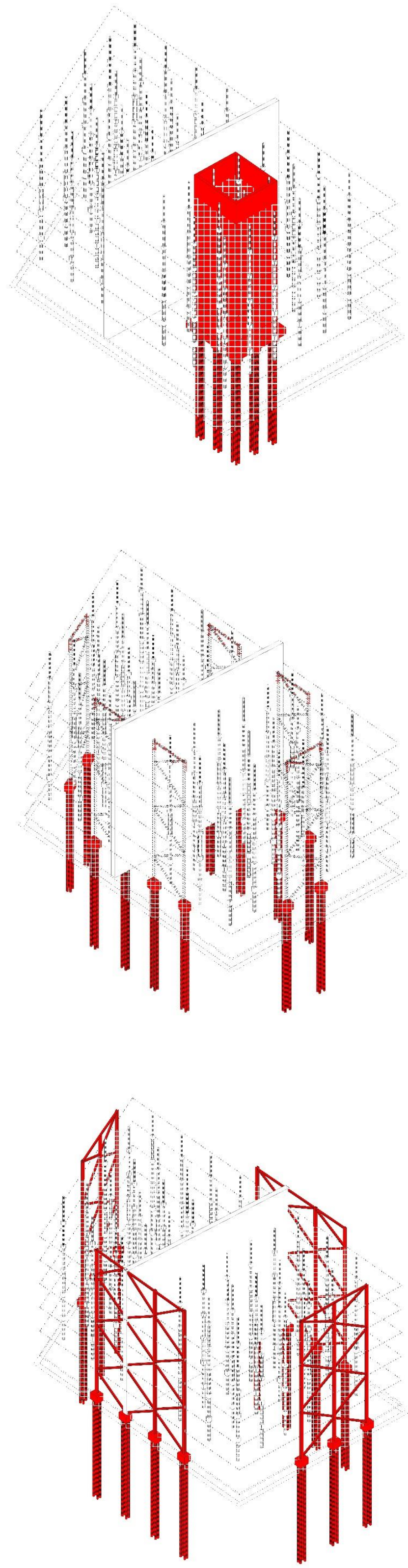
Interviews

Per the direction of NPS on a “Programming Review” call with Marble Fairbanks on 10/18/2019, no additional interviews of the customer would be necessary by the design team. However, in further developing the breakdown of program for the USSCM during Submission #2, the design team will need to interface with the Museum to ensure needs are met and enough shared resources are accommodated.

View of Hoosac Stores from Constitution Road

Asset Goals and Needs

The results of the invasive testing of the existing Hoosac Stores building and the desired growth of the USSCM drove the approaches to the building the design team studied. The recommendations for the renovation of the existing building can be found in the reports in the Appendix. Program goals can be found in the subsequent “Customer Goals and Needs” section of this report.



Suggested approaches to lateral stability of existing Hoosac Stores

Customer Goals and Needs

The design team used the Workplace Recommendation Report and the Hoosac Stores Test Fits as a starting point in developing the revised Housing Plan. The design team confirmed with NPS that the recommendations laid out in that report are still valid moving forward. This includes a reduction in the number of private offices, the standardization of office and workstation sizes, and the 1:1 relationship between seats for users and seats in shared meeting spaces, among others.

The Workplace Recommendation Report looked to fit the entire existing footprint of the USSCM into the existing Hoosac Stores building by sharing spaces (such as the theater, meeting rooms, and other admin resource spaces) and by economizing and standardizing the USSCM's office space using the WRR recommendations. The Orientation Center remains the same size as the existing Navy Yard Visitor Center in all cases.

Moving forward from the WRR, the revised Hosing Plan has been updated to reflect the following directives:

- Increase NPS curatorial space from 1,450 NSF to 2,600 NSF
- Increase overall USSCM size from an existing 32,352 GSF* to approximately 60,000 GSF (only in Alternates that can accommodate the additional square footage)
- Remove NEMS program from the Housing Plan
- Create dedicated Resource Spaces for both NPS and the USSCM instead of sharing (such as office files, supplies, printing, etc)
- Create dedicated Meeting Space for NPS and reduce the number of shared Meeting Spaces
- Create individual libraries for NPS and USSCM and one larger, shared Reading Room

The Housing Plan on the subsequent pages notes existing square footage of spaces where applicable and uses these numbers in planning Alternate #1 where the USSCM and NPS occupy only the existing Hoosac Stores building. In Alternates #2-#5, proposed square footage is used to meet NPS's needs and the growth goals of the USSCM. Any additional space outside of that claimed by the Orientation space, NPS, or the USSCM is considered leasable.

It should be noted that the grossing factor for the USSCM is based on the current museum space (Building 22-28). The grossing factor for NPS is based on the grossing factor used in the Workplace Recommendation Report. These values may change as program gets further refined. It is important to note that net square footage (NSF) is exclusive of the building support spaces that make up the gross square foot (GSF) number, such as building structure, circulation, restrooms, mechanical space, utility rooms, etc. Further reading on this topic can be found in the ANSI/BOMA Floor Measurement Standards used by the GSA.

* Note that the existing USSCM gross square footage number was provided by Jacobs in their takeoff of Buildings 22 and 28 (provided to the GSA on 10/21/2019) and does not include the basement (because of its condition). NPS's gross square footage number for use in the Housing Program were taken from a Revit model of these buildings developed by Jacobs and provided to Marble Fairbanks in the summer of 2019. A breakdown of these takeoffs can be found in the Appendix.

Hoosac Stores Housing Plan

Marble Fairbanks | JACOBS

2/7/2020

	Qty	Unit Size Existing NSF	Unit Size Proposed NSF	Alternate #1 NSF	Alternates #2 - #5 NSF
USS Constitution Museum [USSCM]					
Public / Non-Collections					
Theater	1	1,296 nsf		part of shared resources	
Retail Store & Retail Store Storage	1	1,681 nsf	2,500 nsf	1,681 nsf	2,500 nsf
Existing Library & Reading Room	1	916 nsf		916 nsf	
USSCM Library	1		300 nsf		300 nsf
Reading Room	1				shared
Introductory Film Space	1		600 nsf		600 nsf
Classroom 1 [seats 50 @ 20 nsf/person]	1		1,000 nsf		1,000 nsf
Classroom 1 [seats 50 @ 20 nsf/person]	1		1,000 nsf		1,000 nsf
Function Space [seats 200 @ 15 nsf/person]	1		3,000 nsf		3,000 nsf
Visitor Services					
Nursing Room					
First Aid					
AV Room / Studio					
Public / Collections					
Exhibitions [including lobby]	1	9,299 nsf	18,500 nsf	9,299 nsf	18,500 nsf
Non-Public / Collections					
Collections, Storage & Archives	1	2,076 nsf	4,500 nsf	2,076 nsf	4,500 nsf
Catalog Processing & Photography Space	1	430 nsf	400 nsf	430 nsf	400 nsf
Exhibit Prep and Repair	1		800 nsf		800 nsf
Collections Receiving					
Curatorial Supplies					
Isolation Room					
Non-Public / Non-Collections [Admin and Offices]					
Existing Offices and Workstations [not using GSA standards]	1	3,709 nsf		3,709 nsf	
Office Type 4	13		100 nsf		1,300 nsf
Workstation Type 3	16		48 nsf		768 nsf
Touchdown Space [shared between two people]	3		20 nsf		60 nsf
Workstation Type 3 [for interns]	5		48 nsf		240 nsf
Meeting Space	1	325 nsf		part of shared resources	
Break Room / Kitchenette	1	200 nsf		part of shared resources	
Office Files	1		200 nsf	incl in exist. offices	200 nsf
Office / Supplies Storage	1		200 nsf	incl in exist. offices	200 nsf
Business Center [printing, copying]	1		100 nsf	incl in exist. offices	100 nsf
Mail Room				part of shared resources	
Docent Education / Training Room / Lounge					
Trustee Space					
Security Office					
Number of people accommodated in USSCM workspace [excluding interns]		34			
Non-Public / Non-Collections [Storage and Support]					
Caterer's Serving Pantry / Kitchen	1	244 nsf	560 nsf	244 nsf	560 nsf
Storage / Cloakrooms	1	1,507 nsf	3,750 nsf	1,507 nsf	3,750 nsf
Workshop	1	421 nsf	1,200 nsf	421 nsf	1,200 nsf
Shipping and Receiving	1	259 nsf	500 nsf	259 nsf	500 nsf
Sign and Frame Shop					
Exhibit Production and Maintenance					
Spray Booth					
Dust Collection					
Computer / IT				part of shared resources	
Shipping / Wrapping / Crating					
Total Net Square Foot Area				20,542 nsf	41,478 nsf
Grossing Factor for USSCM space [based on existing USSCM]				69%	69%
Total Gross Square Foot Area				29,718 gsf	60,005 gsf
National Parks of Boston [NPB]					
Offices / Workstations					
Office of the Superintendent					

Hoosac Stores Housing Plan

Marble Fairbanks | JACOBS

2/7/2020

	Qty	Unit Size Existing NSF	Unit Size Proposed NSF	Alternate #1 NSF	Alternates #2 - #5 NSF
Office Type 4	3		100 nsf	300 nsf	300 nsf
Workstation Type 3	1		48 nsf	48 nsf	48 nsf
Resource Preservation and Planning Directorate					
Office Type 4	1		100 nsf	100 nsf	100 nsf
Workstation Type 3	13		48 nsf	624 nsf	624 nsf
Admin and Business Services Directorate					
Office Type 4	5		100 nsf	500 nsf	500 nsf
Workstation Type 3	4		48 nsf	192 nsf	192 nsf
Visitor and Resource Protection Directorate					
Office Type 4	1		100 nsf	100 nsf	100 nsf
Visitor Engagement, Education, and the Arts Directorate					
Office Type 4	1		100 nsf	100 nsf	100 nsf
Workstation Type 3	8		48 nsf	384 nsf	384 nsf
Touchdown Space [shared between two people]	8		20 nsf	160 nsf	160 nsf
Number of people accommodated in NPB workspace [excluding interns]		53			
Meeting Spaces					
Focus Booth [1 person]	9		16 nsf	144 nsf	144 nsf
Meeting Room [2 people]	6		42 nsf	252 nsf	252 nsf
Meeting Room [4 people]	3		120 nsf	360 nsf	360 nsf
Meeting Room [8 people]	1		200 nsf	200 nsf	200 nsf
Open Meeting Table [4 people]	1		100 nsf	100 nsf	100 nsf
Open Meeting Table [8 people]	1		200 nsf	200 nsf	200 nsf
Resource Spaces					
NPB Library	1		300 nsf	300 nsf	300 nsf
Reading Room	1				shared
Office Files	3		200 nsf	600 nsf	600 nsf
Office / Supplies Storage	3		200 nsf	600 nsf	600 nsf
Business Center [printing, copying]	3		100 nsf	300 nsf	300 nsf
Intern Swing Space [seats 10]	1		360 nsf	360 nsf	360 nsf
Theater				part of shared resources	
Reading Room				part of shared resources	
Break Room / Kitchenette				part of shared resources	
IT Room				part of shared resources	
Mail Room				part of shared resources	
Special Support Spaces					
Locker Rooms	2		200 nsf	400 nsf	400 nsf
NPB Collection Storage [curatorial spaces]	1	2,600 nsf		2,600 nsf	2,600 nsf
Design Studio	1		500 nsf	500 nsf	500 nsf
Total Net Square Foot Area				9,424 nsf	9,424 nsf
Grossing Factor for NPB space				55%	55%
Total Gross Square Foot Area				17,135 gsf	17,135 gsf
Shared Resources					
Meeting Spaces					
Meeting Room [12 people]	1		300 nsf	300 nsf	300 nsf
Meeting Room / Training Room [20 people]	1		500 nsf	500 nsf	500 nsf
Resource Spaces					
Theater	1	1,296 nsf		1,296 nsf	1,296 nsf
Reading Room	1		900 nsf	900 nsf	900 nsf
Break Room / Kitchenette	3		150 nsf	450 nsf	450 nsf
IT Room	3		100 nsf	300 nsf	300 nsf
Office Equipment / Mail Processing	1		400 nsf	400 nsf	400 nsf
Total Net Square Foot Area				4,146 nsf	4,146 nsf

Hoosac Stores Housing Plan

Marble Fairbanks | JACOBS
2/7/2020

	Qty	Unit Size Existing NSF	Unit Size Proposed NSF	Alternate #1 NSF	Alternates #2 - #5 NSF
Grossing Factor for shared space				55%	55%
Total Gross Square Foot Area				7,538 gsf	7,538 gsf
Orientation					
Total Gross Square Foot Area				6,200 gsf	6,200 gsf
Total Gross Square Foot Area Required for Non-Leasable Program				**60,590 gsf**	**90,878 gsf**

IDENTIFICATION OF POSSIBLE ALTERNATIVES

Approach

The design team developed several broad approaches for how to evaluate and arrive at the five Possible Alternates. This included extensive precedent research of buildings that were similar in material use, historic character, site conditions and program. These precedents were presented to give the client visual examples of the many design approaches possible with the Hoosac Stores building ranging from minimal modifications to significant modifications with additions. This led to five general categories of Alternatives to consider:

1. Hoosac Stores only - This category maintained all program within the existing area of the existing building with minimal façade modifications;
2. Hoosac Stores with minor additions or bump outs maintaining footprint – This category added floors on top of the existing building and more extensive façade modifications;
3. Hoosac Stores with use of the adjacent lot - This category included modifications to the existing building along with a new addition on the adjacent lot;
4. Partial demo and rebuild of floors within Hoosac Stores along with use of the adjacent lot – This category included rebuilding the floors of the existing building to better suit the program along with a new addition on the adjacent lot;
5. Demo of Hoosac Stores and build a new building across both sites – This category included a full demo of the existing building and a new building on both sites.

Within each of these categories, there were several Alternatives developed and that provided a wide range of options for the client to consider while narrowing the selection to the Five Possible Alternatives.

View of Hoosac Stores from the waterfront

Workshop

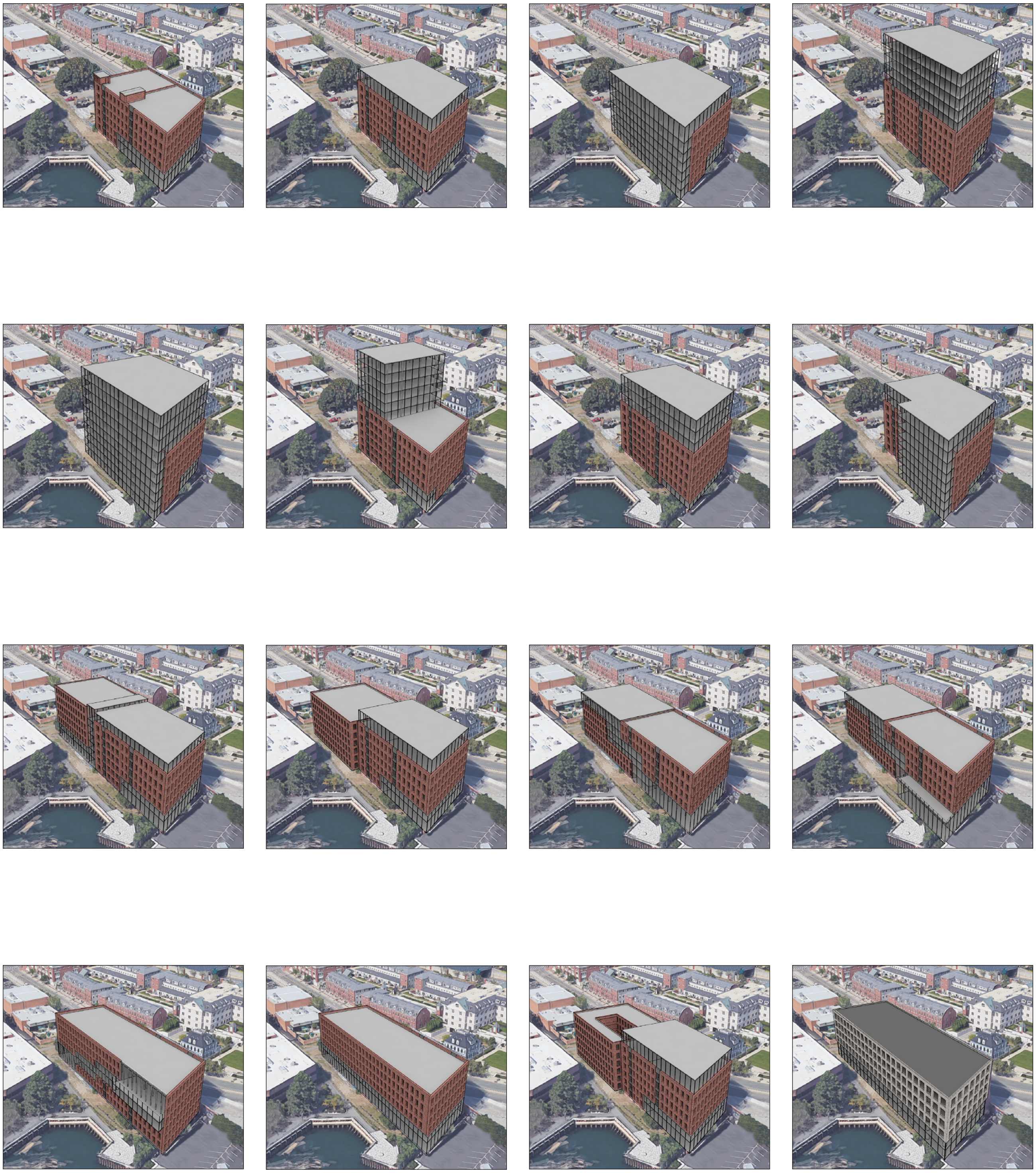
During a workshop held in January 2020 with a group of representatives from NPS, the USSCM, GSA, and the Navy, the design team presented 16 different Alternatives to the redevelopment of the Hoosac Stores building and the adjacent lot. Each Alternative was accompanied by a spider diagram that charted, on a scale from 1-5 (with 1 being the lowest and 5 being the highest), a score for seven specific Decision Drivers. This methodology was used to facilitate a focused discussion for how to evaluate each Alternative. These Decision Drivers included:

- Wow Factor (Exterior Expression)
- User Experience (Exterior to Interior Sequence)
- Historic Sensitivity / Conservation
- Ability to Meet Program
- Program Distribution
- Flexibility of Use Over Time (Adaptability)
- Ease of Phasing

After presenting all 16 Alternatives, the group split into five smaller groups and evaluated each option using their own spider diagram. The results of this process can be found in the Appendix. At the end of the day, the group established several guiding principles that allowed the design team to evaluate and synthesize the input and develop the five Possible Alternatives that are presented here. These principles included, but were not limited to:

- Expanding the building by more than two stories did not seem contextually appropriate
- The only way to meet the USSCM's desired programmatic goals would be to build up and out, beyond the existing walls of the Hoosac Stores
- Building on the adjacent lot would be critical in establishing an appropriate amount of leasable square footage
- NPS and USSCM program should be separated from the leasable square footage
- New space built with higher floor-to-floor heights and a less dense column grid would be more flexible space for exhibitions

These final Possible Alternatives were costed out and will be further evaluated to arrive at the three Viable Alternatives to development further in the next phase.



The collection of sixteen alternatives presented in the January 17th 2020 workshop

Comparative Analysis of Alternatives

Each Alternate has been reviewed by PAL, for consideration of historic preservation issues, and by Jacobs for RoM costing. These full reports can be found in the Appendix. Full Housing Plans for the Alternatives can be found in the "Needs Assessment: Customer Goals and Needs" portion of this report.

The following narratives for each of the Possible Alternatives describe the architectural and programmatic intent of the proposed interventions and were used, along with the graphic drawings and diagrams, to assist with costing.

As a baseline standard in Alternatives where the existing Hoosac Stores is retained (Alternates #1-#4), the following should be accounted for:

- 100% abatement of building as required in the PDS report dated 5/10/2019 by Nover-Armstrong (BETA Group, Inc.)
- Removal of all existing systems, stairs, partitions, and material stored
- 100% repointing, cleaning, and restoration of exterior brick and stone façade and historic cast iron accessories
- Waterproofing and insulation of existing structure as required to meet modern energy code and meet programmatic requirements.
- Complete removal and replacement of existing roof and roof structure
- 100% repair and cleaning of existing interior structure, including beams, columns, floors, and walls
- New structural system (including new sub-surface structure) as required to meet desired architectural and programmatic intent and provide lateral stability as required by modern building code
- Infill of existing shafts with new floor structure
- Approximately 4,300 sf of existing interior floor area should be assumed to be removed to accommodate double-height space.
- 100% fireproofing of existing structural beams and columns

It should be noted that the existing Hoosac Stores is approximately 65,700 GSF and has six floors.

In all the Alternates, the following should be assumed:

- New building systems (including fire suppression, plumbing, HVAC, electrical, fire alarm, IT, and security) and civil services as required to meet the programmatic functions as required in the PDS report dated 5/10/2019 by Jacobs. Assume all equipment to be located on the roof.
- New security standards as required in the PDS report dated 5/10/2019 by Applied Research Associates, Inc.
- New vertical transportation (stairs and elevators) as required to meet both public and private needs, including at least one freight elevator
- Furnishings, appliances, equipment,

lighting, and signage as required by the program
- 100% new finishes throughout, including non-bearing wall partitions, finished floors, etc
- Any lease out space should be assumed to be core and shell only with the fit out done by the lessee
- Building must meet LEED Gold standards and be ADA-accessible throughout
- Exhibition Space and Collection Storage should be finished and climate controlled to Smithsonian standards. All other spaces should be considered equivalent to Class A office space.
- Any open space at the ground level contained within the lot or on any roof not occupied by equipment should be landscaped.
- Approximately 20% of the NPS space should be assumed to be Collection Storage and conditioned as such
- Approximately 50% of the USSCM space should be assumed to be Exhibition Space and Collection Storage and should be conditioned as such

Comparative Analysis of Alternatives

ALTERNATE 1

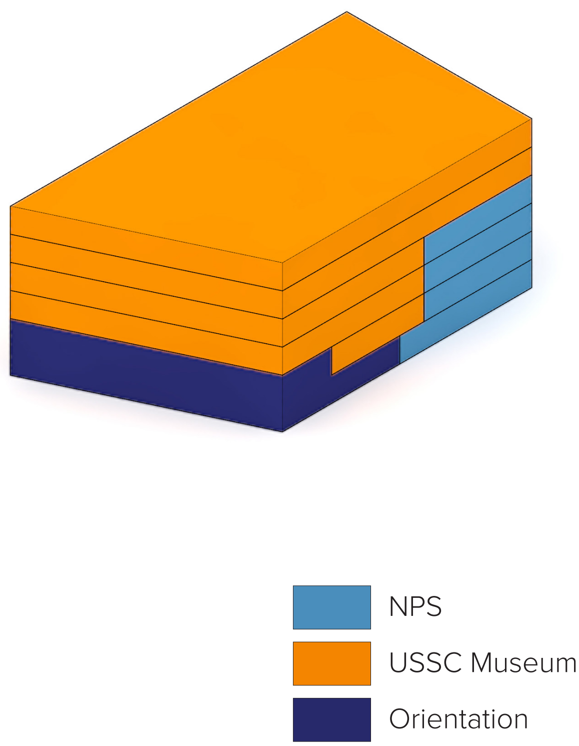
This Alternate is similar to the proposed Test Fit in the Workplace Recommendation Report issued on 7/23/2018 in that it keeps the existing footprint of the Hoosac Stores without expanding either upward or out to the west or south. To bring light into the interior space, approximately 12,413 sf of the existing 29,322 sf of brick façade is removed and replaced with 5,936 sf of punched window openings (Kawneer AA6600 as basis of design) and 5,203 sf of curtain wall (Kawneer 1600UT System 2 as basis of design).

This proposal scored generally high with the Historic Preservation decision driver when discussed with the client group. As PAL notes in their report "work proposed likely would technically have an adverse effect, but could potentially be appropriately minimized and mitigated through sensitive design and suitable materials." However, the scheme did tend to score lower when it came to creating a unique Wow Factor and also did not accommodate the USSCM's desire for future growth. There is also no leasable square footage in this option. It does retain the adjacent lot for future development or as potential landscaped open space.

Program breakdown is as follows:

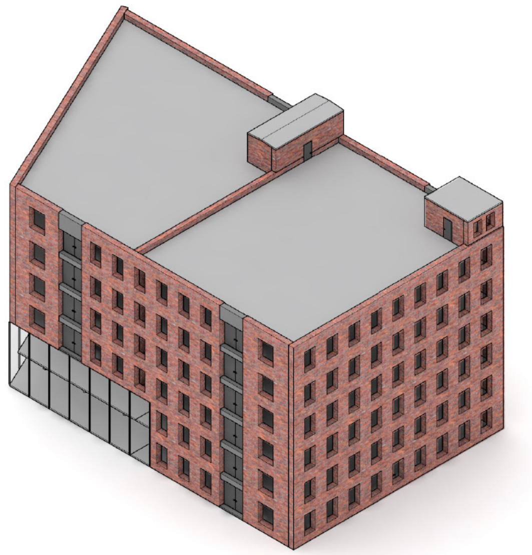
USSCM: 29,718 GSF
NPS: 17,135 GSF
Shared Space: 7,538 GSF
Orientation Space: 6,200 GSF
Leasable Space: 0 GSF

Total: 60,590 GSF

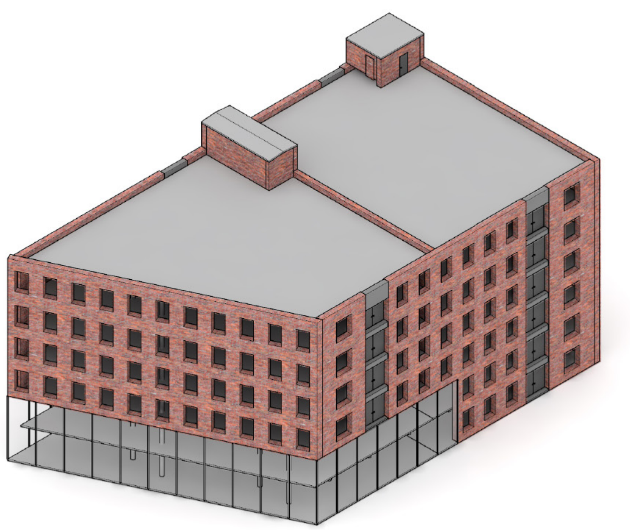


View of Hoosac Stores from Constitution Road.

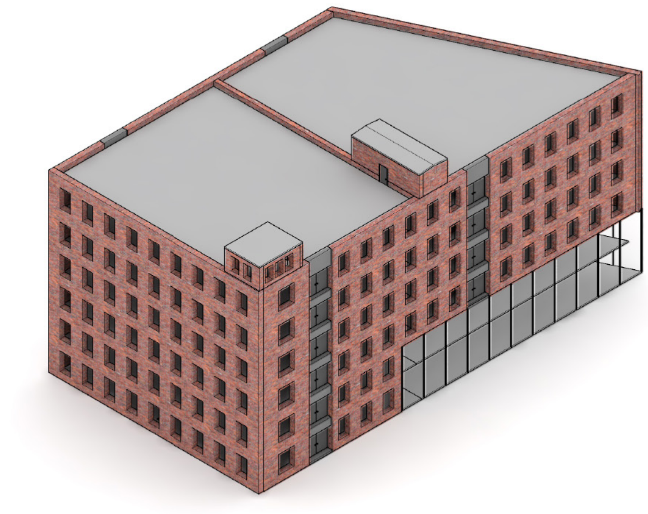
View of Hoosac Stores from the water.



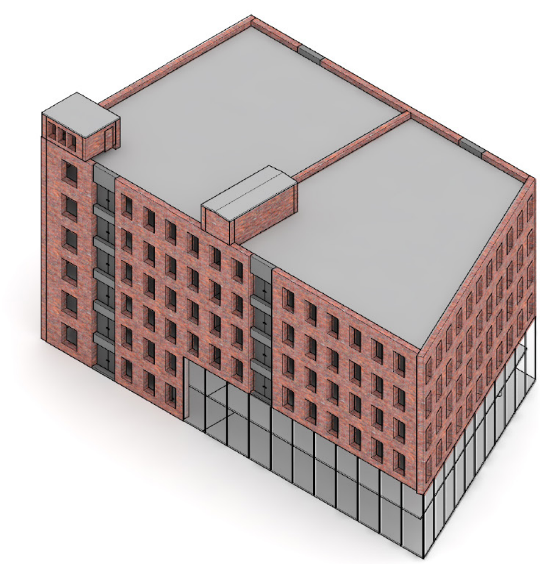
View of NW corner



View of NE corner



View of SW corner



View of SE corner

Comparative Analysis of Alternatives

ALTERNATE 2

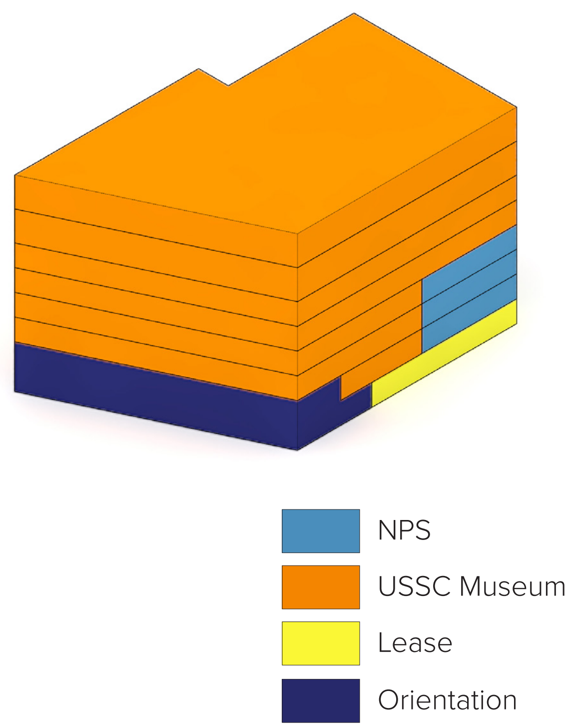
This Alternate expands the square footage of the existing Hoosac Stores by adding floors on top and a slight expansion towards the water to accommodate for desired growth by the USSCM. Here, two fully glazed floors would be added to the existing building and the building footprint would extend out to the south to capture the space available adjacent to the water. It is intended that the south façade of the existing Hoosac building would remain intact inside the new enclosure and that visitors would pass through this historic facade to access the new space at the south side of the building. The new floors on top of the existing structure are assumed to have 15-foot floor-to-floor heights. Approximately 15,757 sf of the existing 29,322 sf of brick façade is removed and replaced with 5,892 sf of punched window openings and 23,953 sf of curtain wall.

This proposal, as well as Alternates #3 and #4, add significant glass to the existing Hoosac building and therefore score lower in Historic Preservation. As noted from PAL's report, the addition of glass should not be so extensive "as to stand out and distract from historic building material." Additionally, adding floors to the building as shown runs counter to the Secretary of the Interior's (SOI) guidelines as "rooftop additions should not be more than one story in height and should be set back at least one full bay from the primary elevation of the building, as well as from the other elevations if the building is free-standing or highly visible." However, as noted in the program breakdown below, this approach does meet the USSCM's growth needs and provides a small amount of space left over for leasable space. The impact of dramatic south façade and the addition to the roof also scored higher on the Wow Factor with the group. This scheme also leaves the adjacent lot open for possible future development.

Program breakdown is as follows:

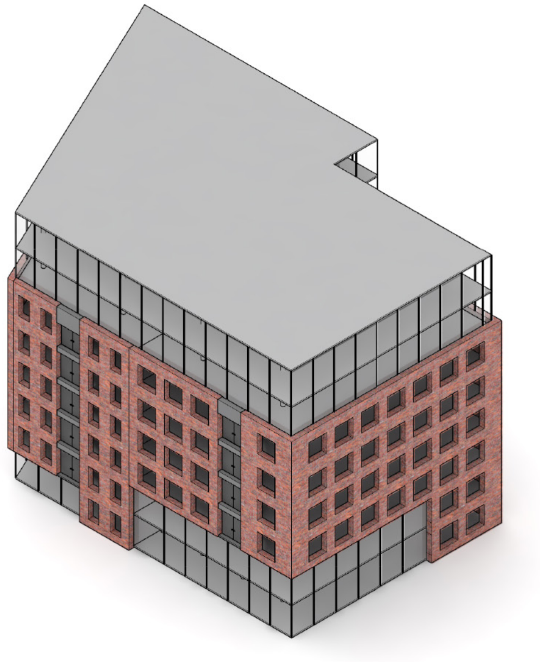
USSCM: 60,005 GSF
NPS: 17,135 GSF
Shared Space: 7,538 GSF
Orientation Space: 6,200 GSF
Leasable Space: 3,354 GSF

Total: 94,232 GSF

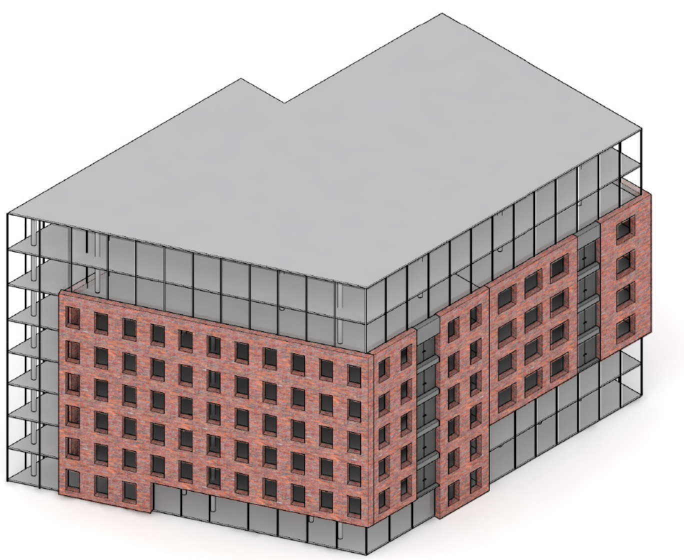


View of Hoosac Stores from Constitution Road.

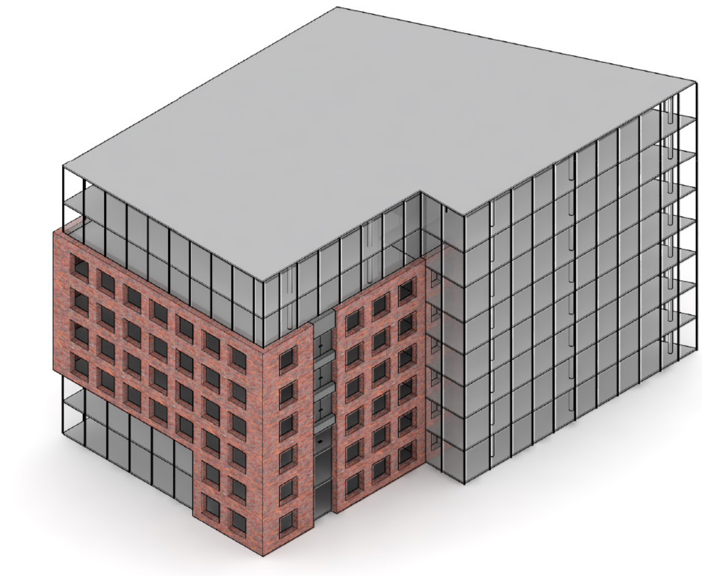
View of Hoosac Stores from the water.



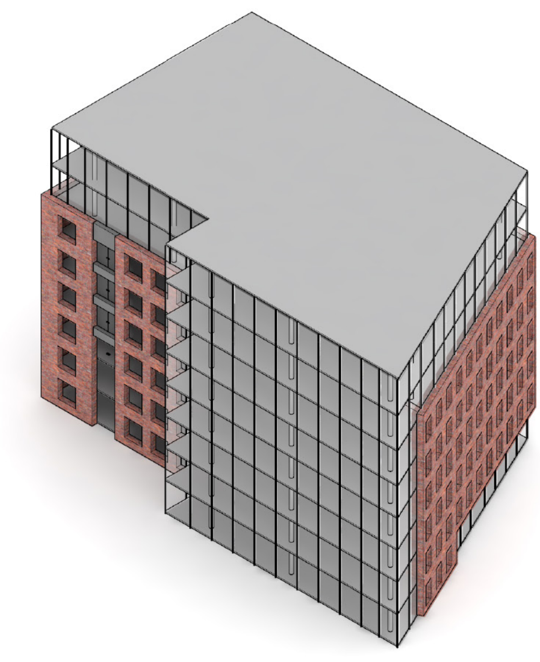
View of NW corner



View of NE corner



View of SW corner



View of SE corner

Comparative Analysis of Alternatives

ALTERNATE 3

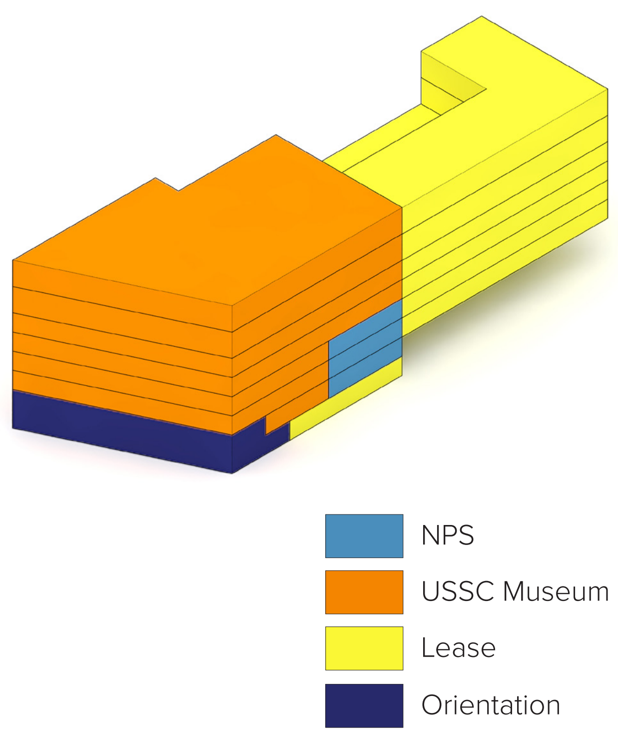
Alternate #3 assumed the same treatment of the existing Hoosac Stores as Alternate #2 but provides for a completely new building on the adjacent lot suitable for a hotel or residential program. This new building would have its own separate systems and a façade treatment that would have a contextual relationship to the renovated Hoosac building. Unlike Alternates #1 and #2, the west wall of the existing Hoosac Stores building would not have any new punched openings as it would serve as a party wall to the new building next door.

The historic preservation comments are similar to those of Alternate #2 and also suggest that "to avoid unifying two volumes as a single whole ... they be differentiated by a gap created by a small-scale hyphen or setback treatment." This would decrease the overall leasable space and such approach would have to be weighed against the square footage that would be lost. In both Alternate #3 and Alternate #4, phasing was scored generally higher by the client group because the Hoosac Stores building could be renovated before or after a new building was built next door as the two could be seen as being completed separate entities. This may assist in the long-term financial planning of the overall project.

Program breakdown is as follows:

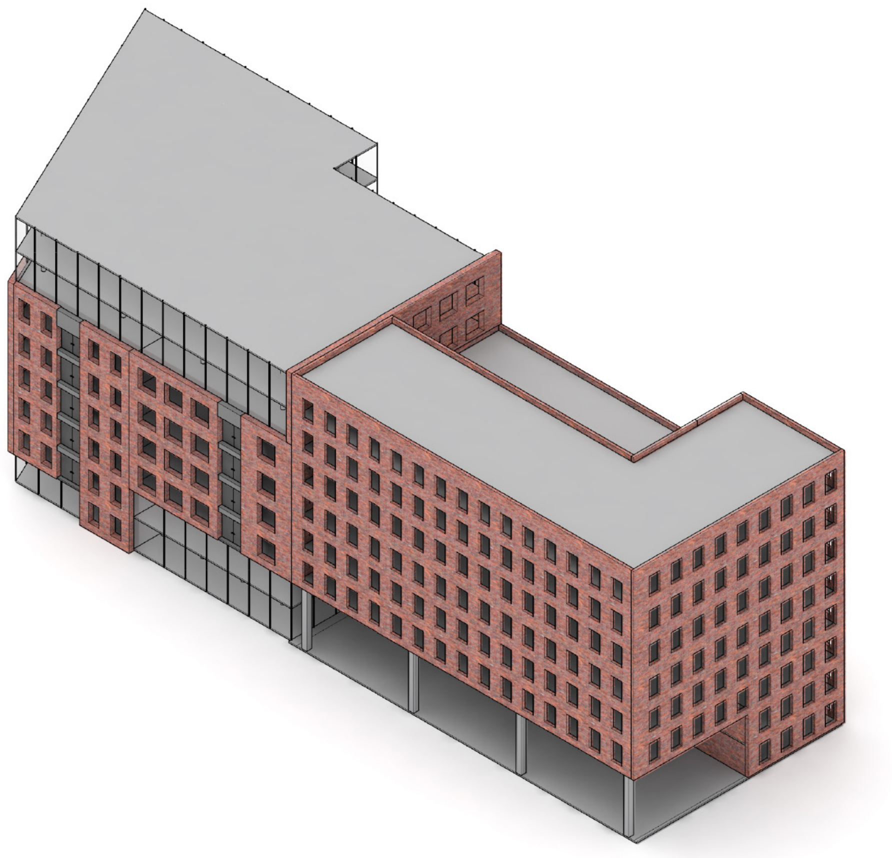
USSCM: 60,005 GSF
NPS: 17,135 GSF
Shared Space: 7,538 GSF
Orientation Space: 6,200 GSF
Leasable Space: 67,765 GSF

Total: 158,643 GSF

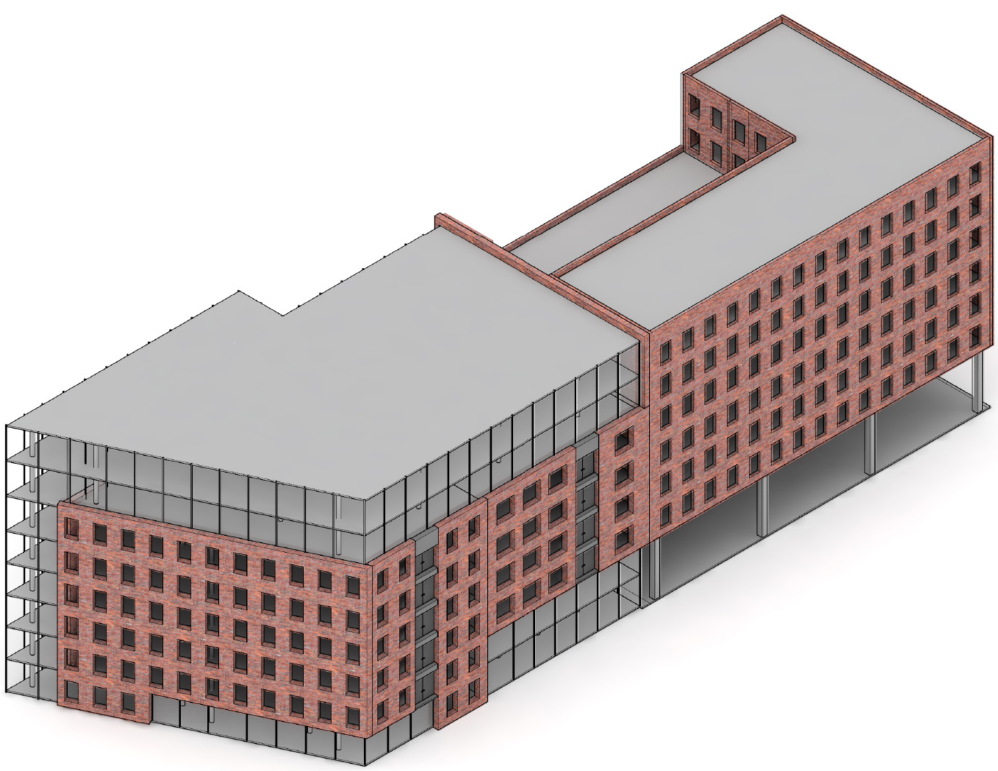


View of Hoosac Stores from Constitution Road.

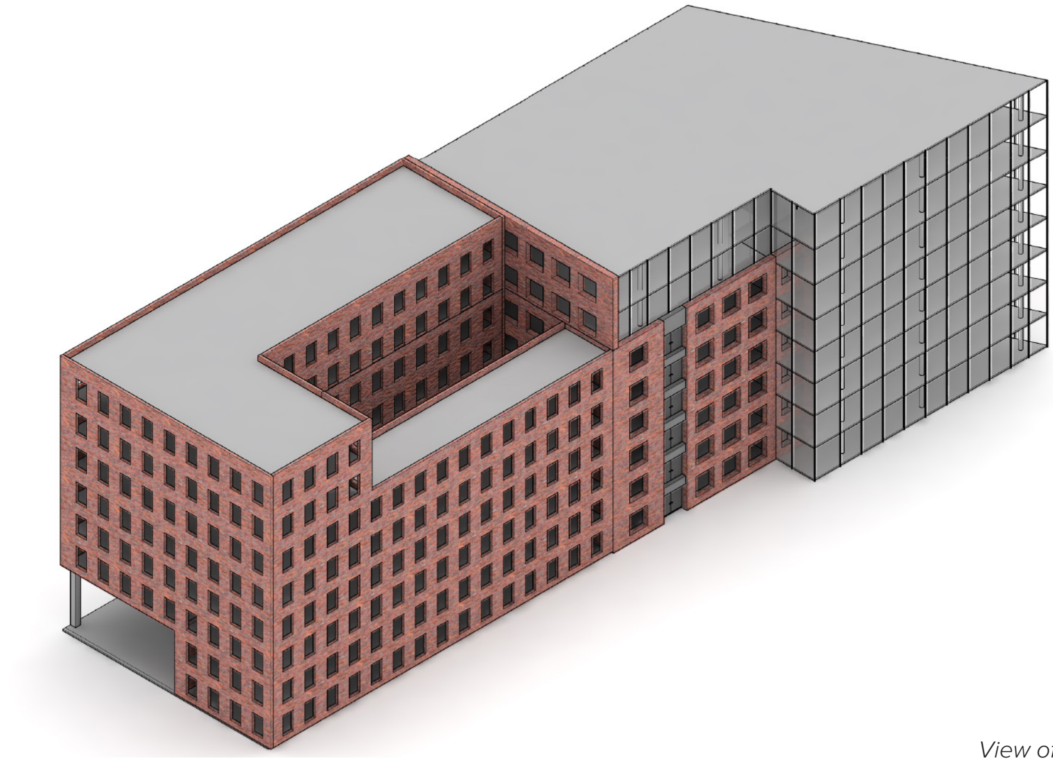
View of Hoosac Stores from the water.



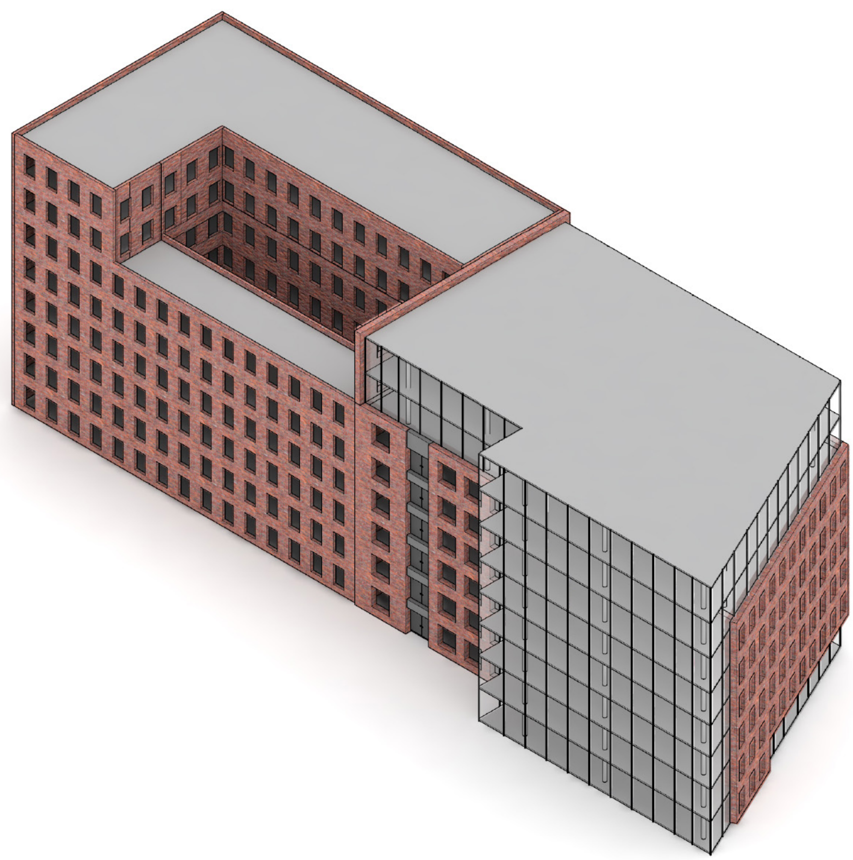
View of NW corner



View of NE corner



View of SW corner



View of SE corner

Comparative Analysis of Alternatives

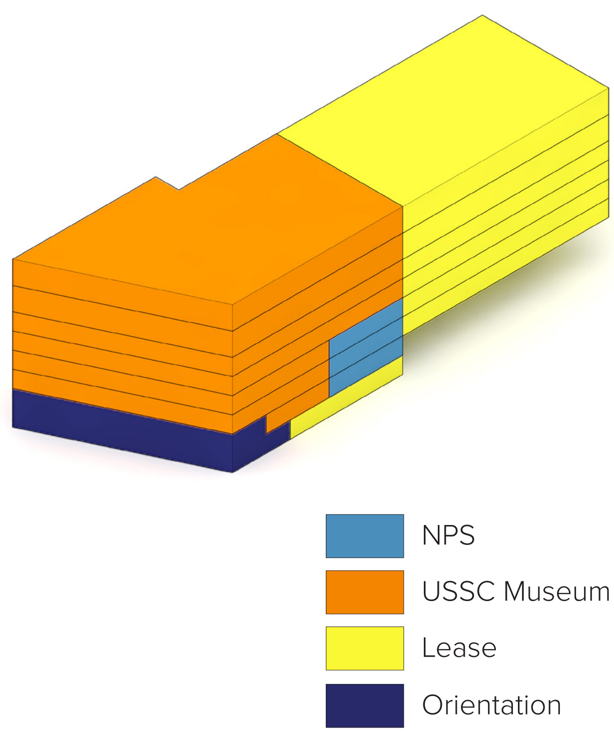
ALTERNATE 4

This Alternate is the same as Alternate #3 but fully builds out the adjacent lot to maximize square footage. Comments around historic preservation are similar to that of Alternate #3. This option includes almost 15,000 more GSF of leasable space.

Program breakdown is as follows:

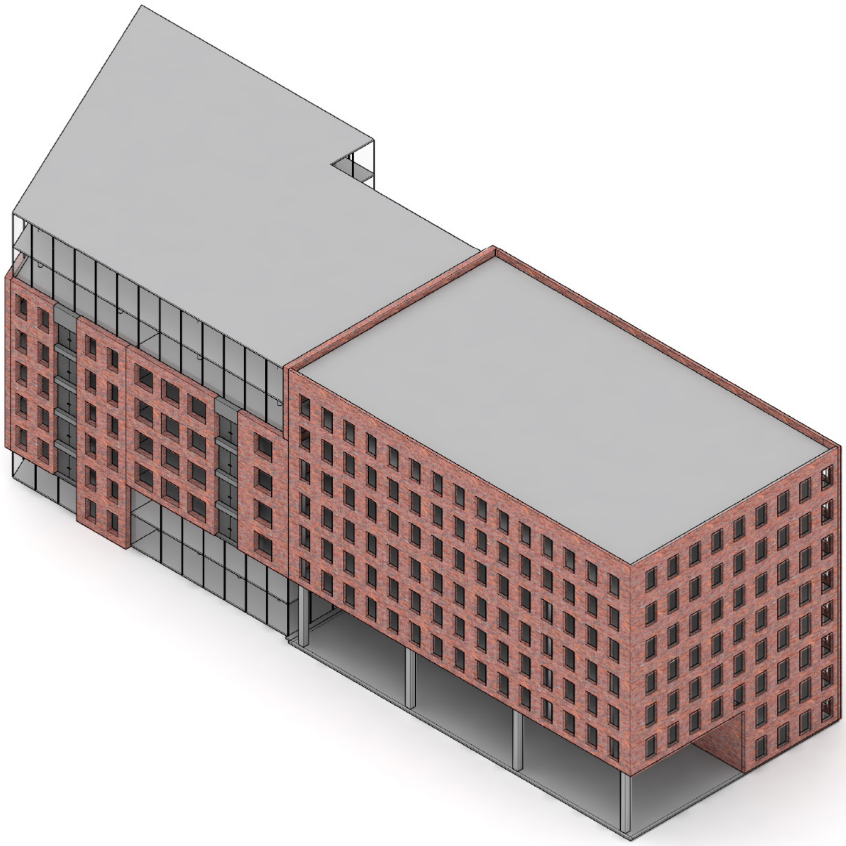
USSCM: 60,005 GSF
NPS: 17,135 GSF
Shared Space: 7,538 GSF
Orientation Space: 6,200 GSF
Leasable Space: 82,629 GSF

Total: 173,507 GSF

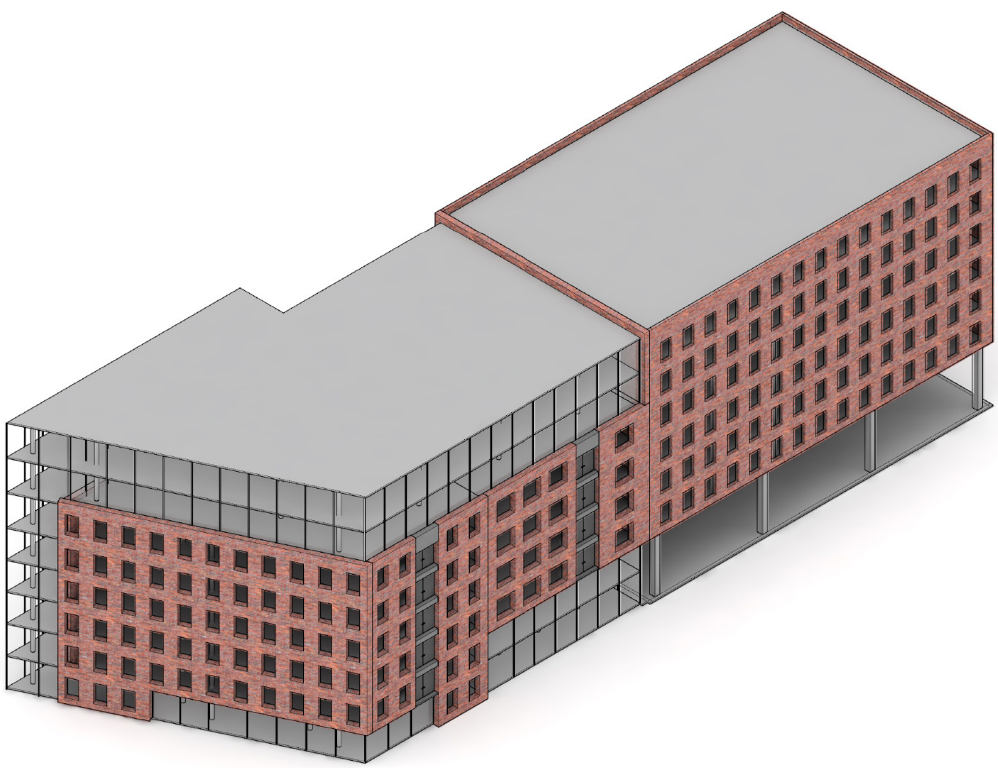


View of Hoosac Stores from Constitution Road.

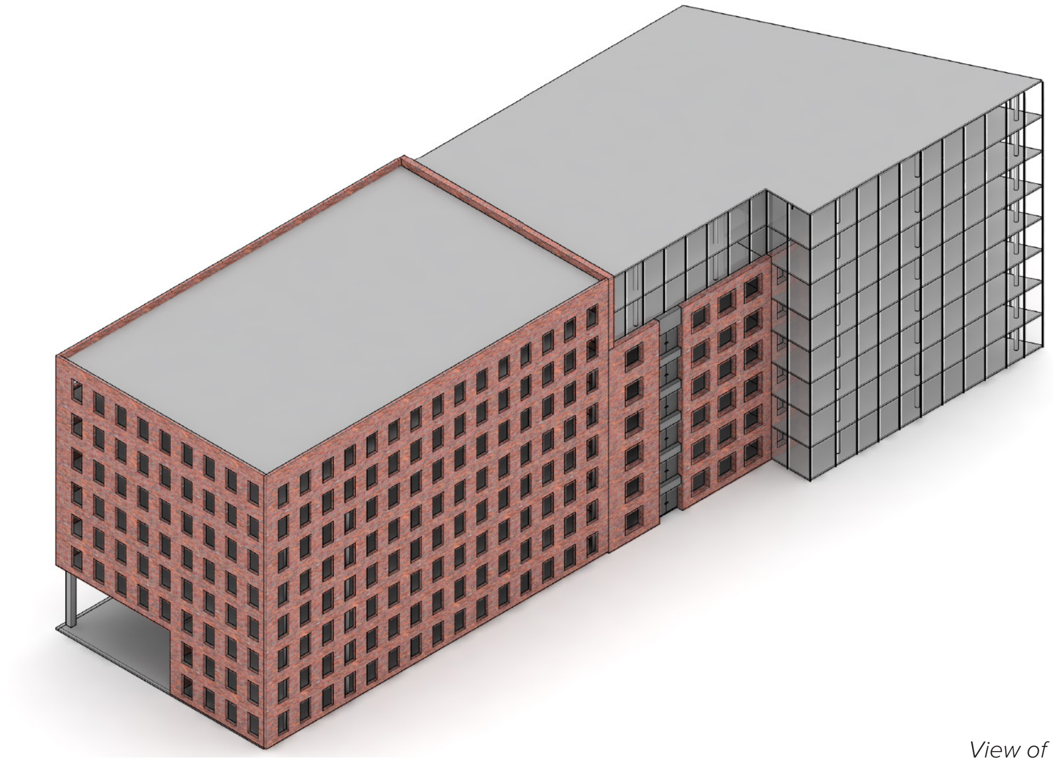
View of Hoosac Stores from the water.



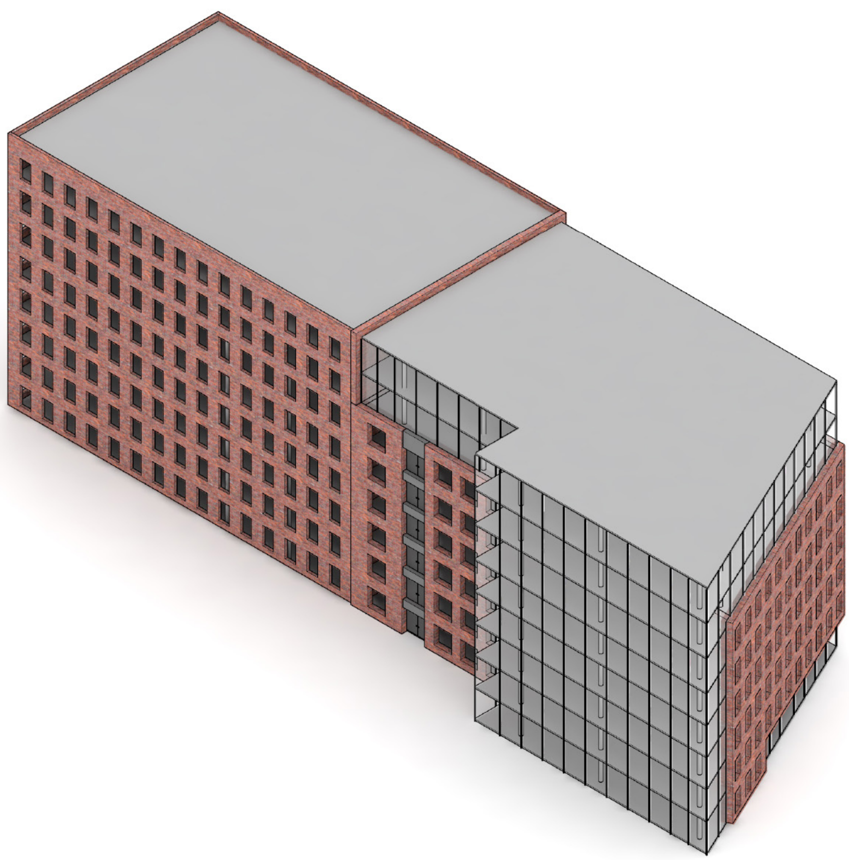
View of NW corner



View of NE corner



View of SW corner



View of SE corner

Comparative Analysis of Alternatives

ALTERNATE 5

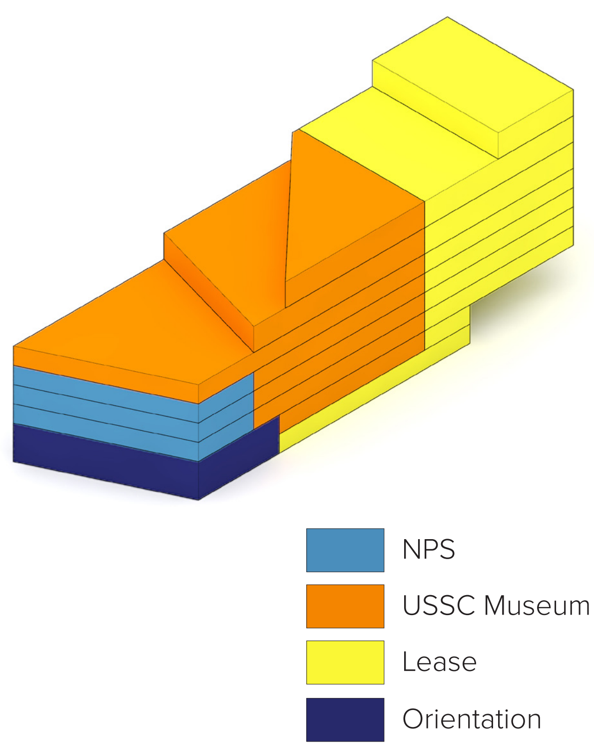
Alternate #5 proposes the complete demolition of the existing Hoosac Stores building. A new building would be built in its place and cover the Hoosac Stores site and the adjacent lot. For costing purposes, the facade was assumed to be 50% solid and 50% glass. Floor-to-floor heights are proposed at 11 feet for the first six floors and 15 feet on the floors above that.

This option scored the lowest in terms of Historic Presentation as it completely removes the existing Hoosac Stores building. PAL has concerns that the size and massing of this Alternative "is out of scale with historic Navy Yard." This concern could be addressed with further development of the design with minimal effect on the overall square footage.

Program breakdown is as follows:

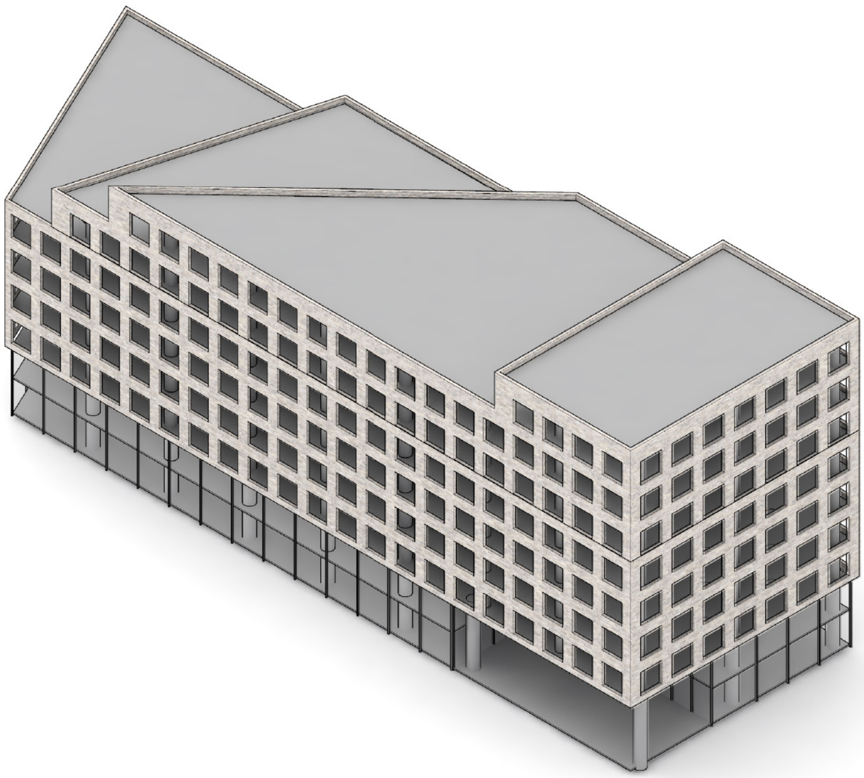
USSCM: 60,005 GSF
NPS: 17,135 GSF
Shared Space: 7,538 GSF
Orientation Space: 6,200 GSF
Leasable Space: 84,226 GSF

Total: 175,104 GSF

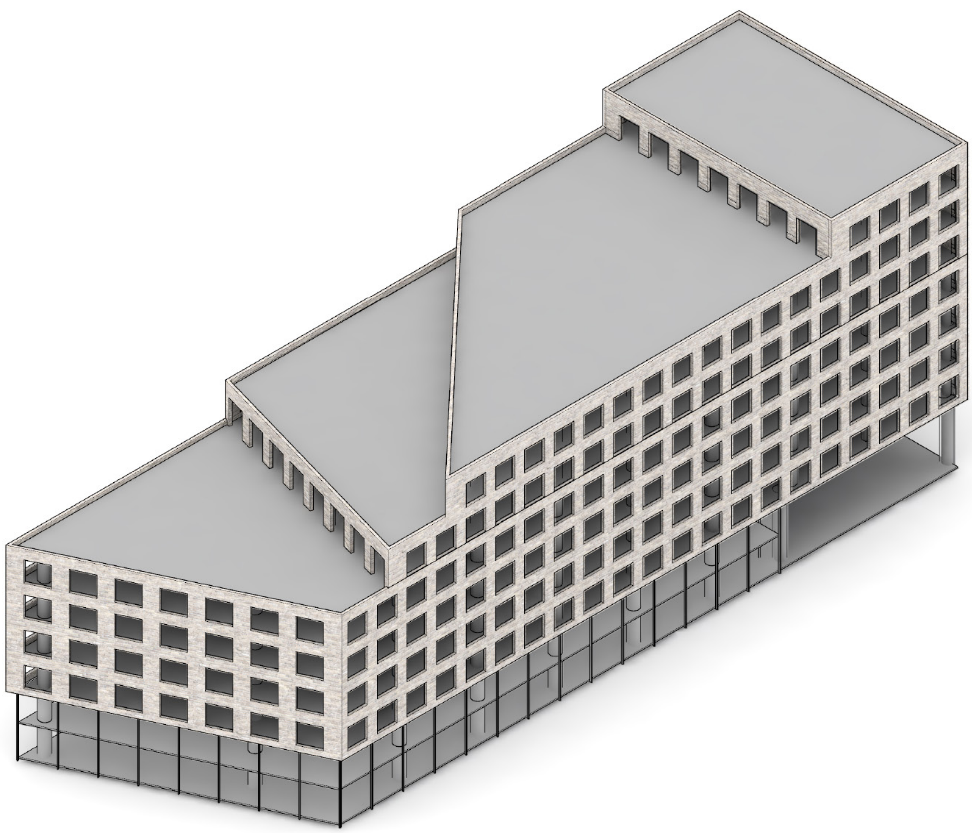


View of Hoosac Stores from Constitution Road.

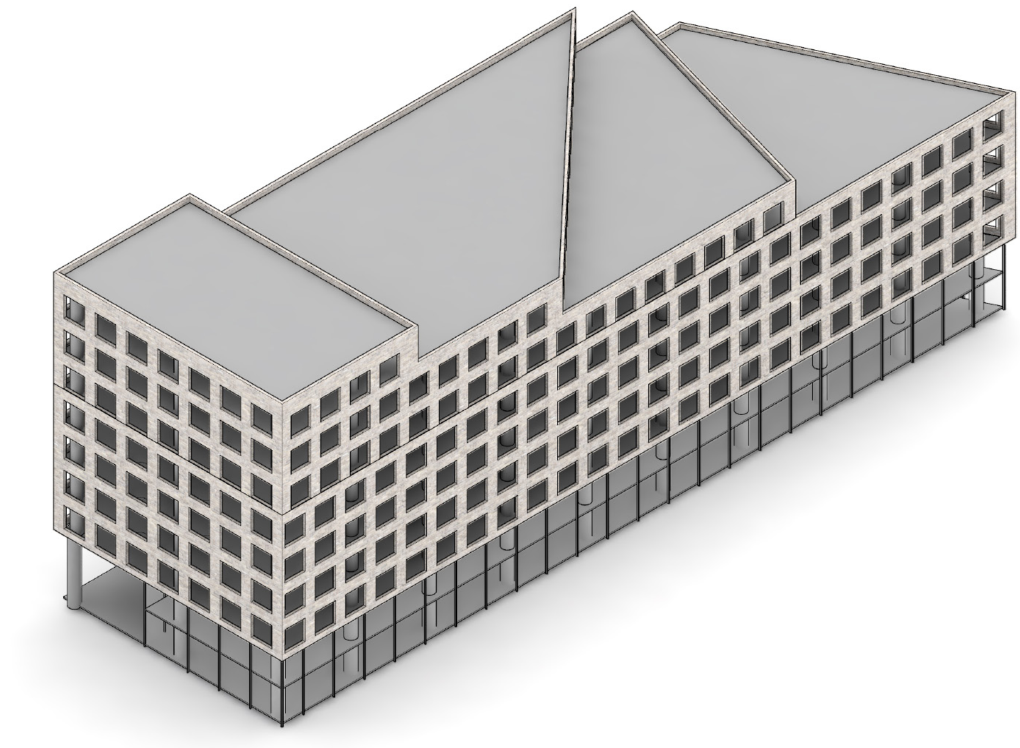
View of Hoosac Stores from the water.



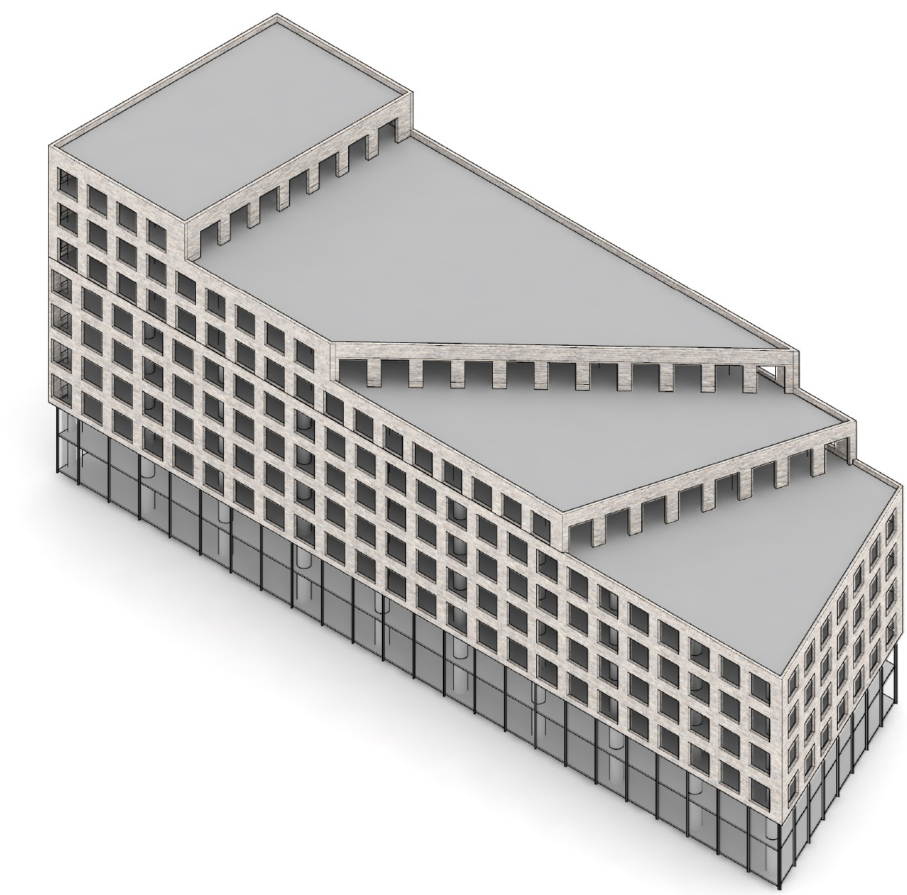
View of NW corner



View of NE corner



View of SW corner



View of SE corner

APPENDIX

Initial Findings, Precedents, and Decision Drivers Presentation

NOVEMBER 8, 2019

This presentation was given by the design team to NPS and USSCM in November 2019. The goal of this presentation was to review preliminary findings from the physical testing at the Hoosac Stores site, review issues of resiliency that will need to be addressed with the project, and review building precedents of how existing buildings have been adapted for new use. Additionally, we discussed project challenges and the Decision Drivers that would be used to evaluate the "Possible Alternatives" in the workshop in January.

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Structural and Material Testing Review

Preliminary Material Testing Results

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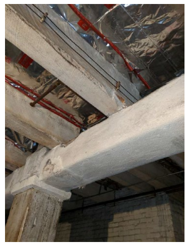
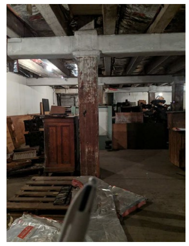
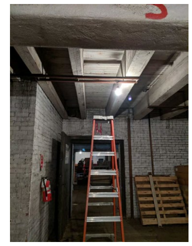
1 (E) COND. NO. 3 GRADE TYP

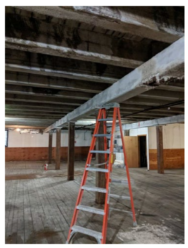

2 LEVEL 3 - BEAM SAMPLE LEVEL 4


3 (E) COND. LEVEL 3 COL. SAMPLE


4 LEVEL 3 COL. SAMPLE

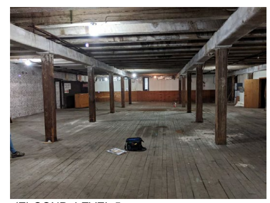

5 LEVEL 4 - DECKING SAMPLE AT LEVEL 5


6 (E) COND. COL. DAMAGE TYP


7 LEVEL 5 AT BEAM SAMPLE ABOVE


8 LEVEL 5 - BEAM SAMPLE LEVEL 6


9 LEVEL 5 COL. SAMPLE


10 (E) COND. LEVEL 5

Structural and Material Testing Review

Preliminary Material Testing Results

- Wood: Wood species of the columns and beams is southern pine based on our preliminary visual review. A representative number of columns and beams were graded and most were graded highly.
- Steel: We collected and tested two steel coupons from the top flange of the structural beams on floors 1 and 2 (Specimen IDs 1 and 2, respectively). One sample came in around A36 gr. 36 range, but one came in a little lower, so we may recommend capping the yield strength a little lower than 36ksi to cover any variability.
- Brick and Mortar: Compression testing results indicate that the brick compressive capacity in the good to excellent category according to ASCI41 standards. Note that mortar analysis results are anticipated to be available by end of next week.

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Structural and Material Testing Review

Preliminary Geotech Recommendations

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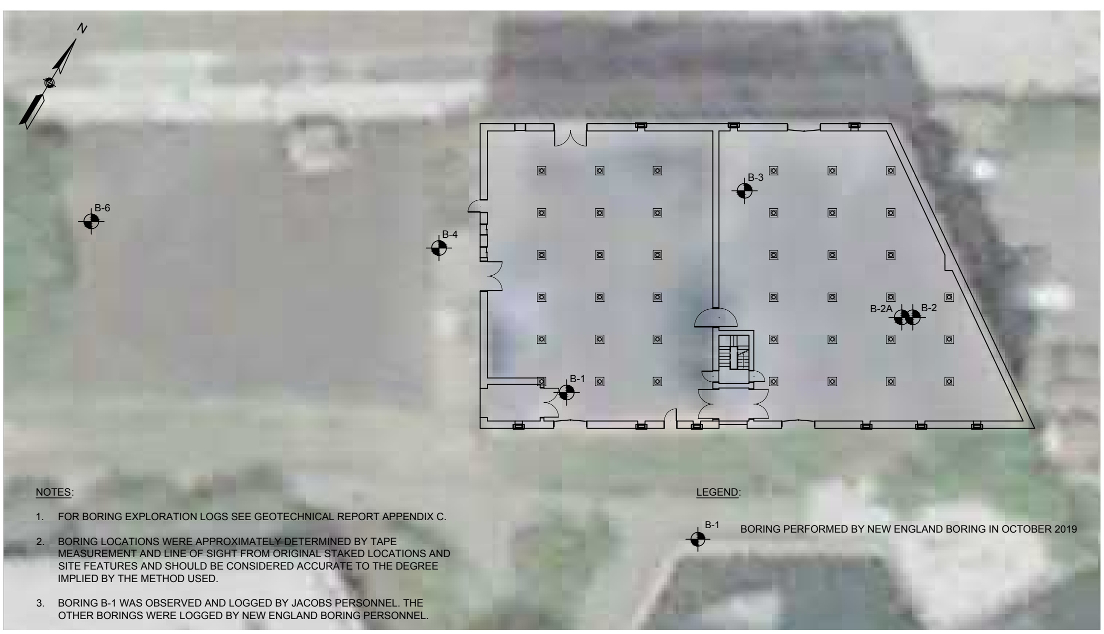

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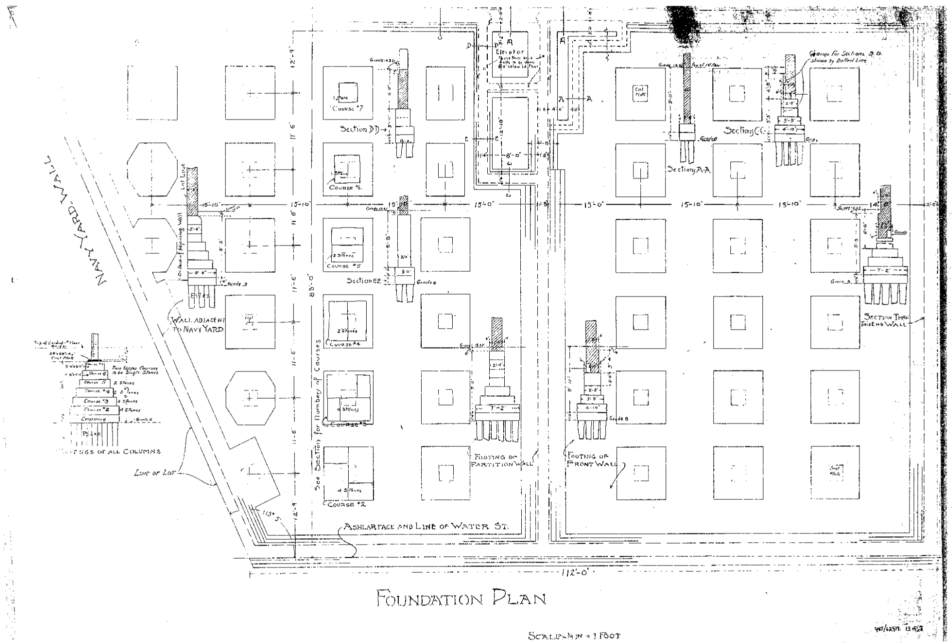

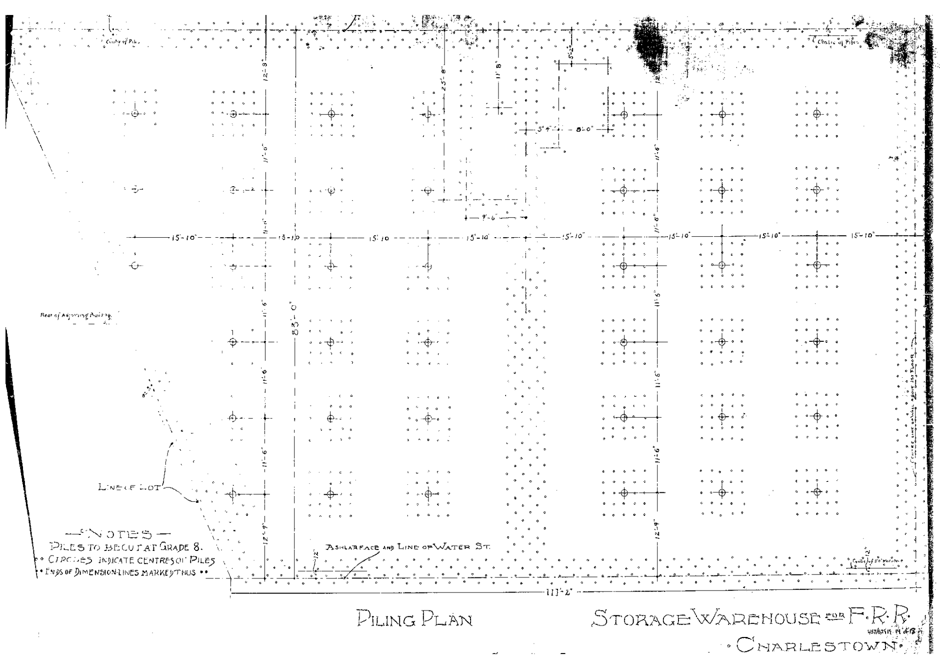

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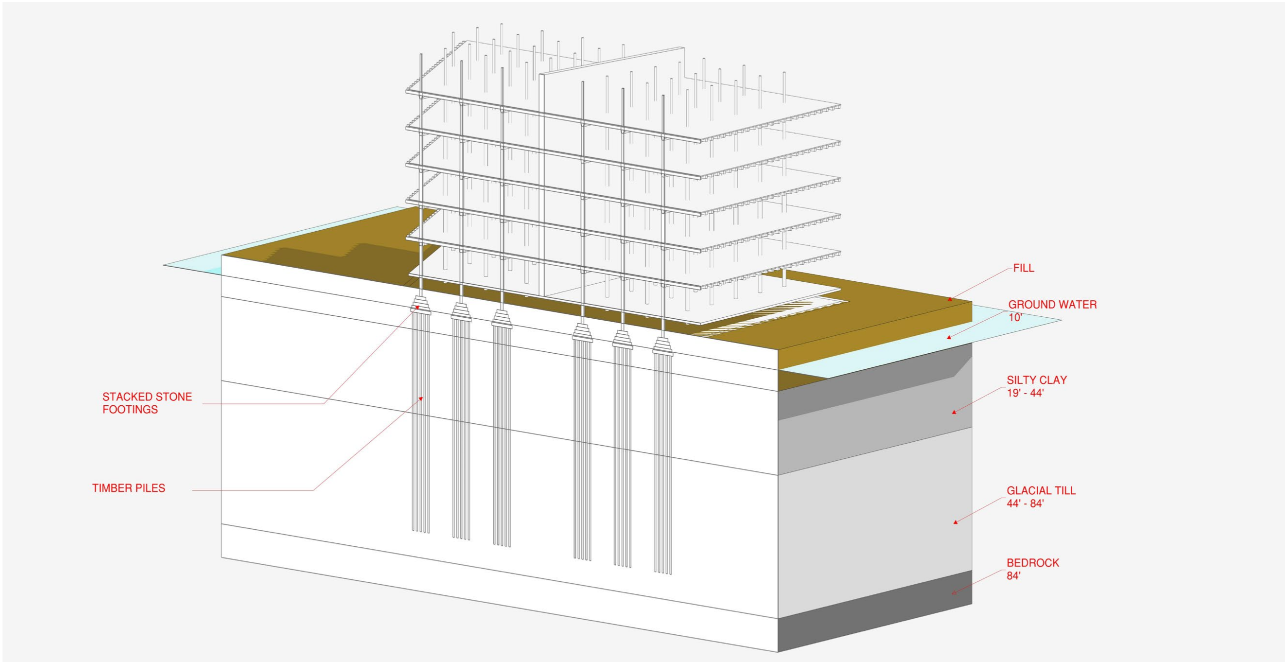

Structural and Material Testing Review

Preliminary Geotech Recommendations

- All the existing timber piles are permanently under the groundwater table. It is generally accepted that foundation timber piles finished below permanent groundwater table will last indefinitely. Therefore, it is expected that the existing footings can still carry the original vertical loads if there is no increase in the vertical loads in the final design.
- However, since the granite stones were simply stacked on top of the piles and on top of each other, the existing footings can not develop much lateral capacity to resist lateral loads (such as wind load and seismic load). Therefore, retrofitting design is required regarding to the lateral loading.

Structural and Material Testing Review
Possible Structural Remediation Strategies

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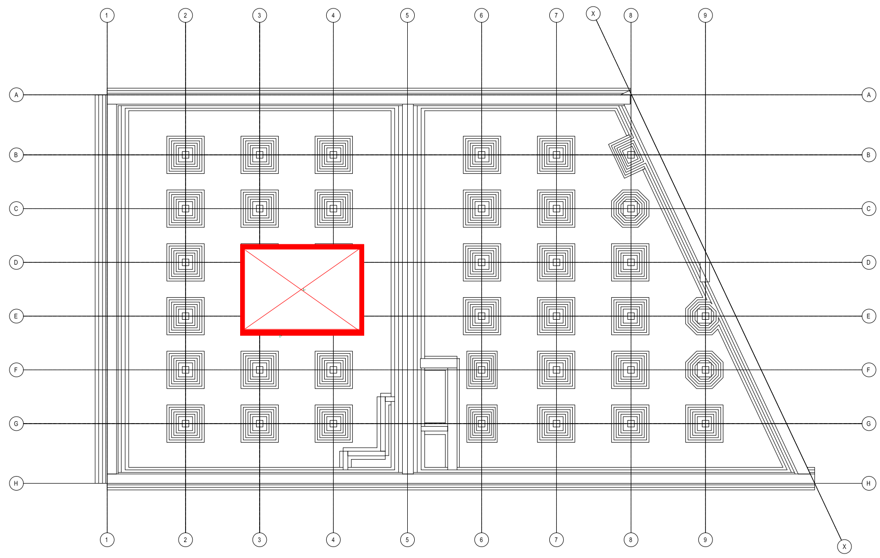
Structural and Material Testing Review
Possible Structural Remediation Strategies

- Option 1 - Shear Wall Construction, New Concrete Shear Walls
- This strategy consists of adding four new concrete shear walls around elevator and stair cores. These shear walls are placed within the interior of the building. This option provides a dramatic improvement on the torsional behavior of the building and can be constructed in phases to limit the disruption to the current building configuration.



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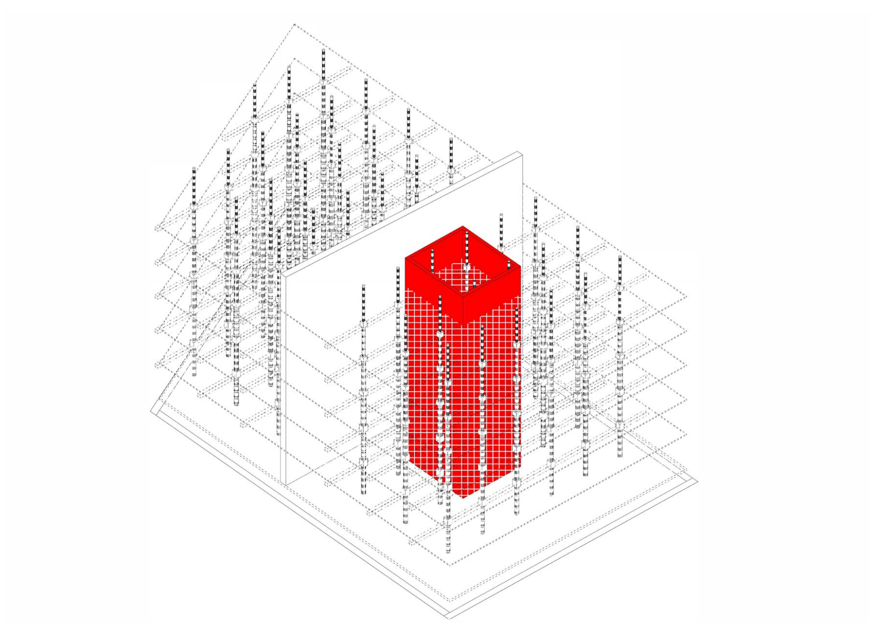

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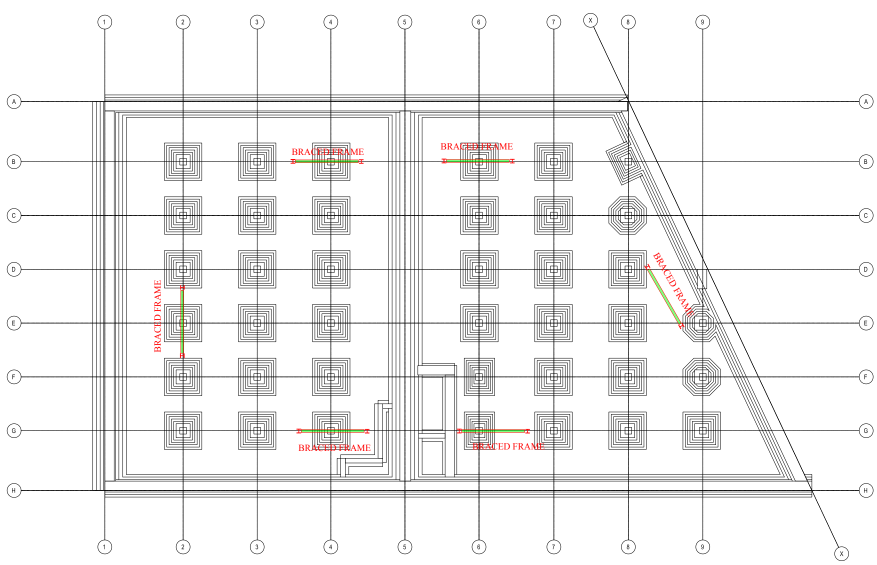
HOOSAC STORES, FEASIBILITY STUDY

Structural and Material Testing Review

Possible Structural Remediation Strategies

- Option 2 - Buckling Restrained Braced Frames in-line with existing column grids (interior side of building)
- This option positions the diagonal braces within the building. We found that the existing columns are sufficient to resist gravity loads but not to resist the additional lateral loads. We are taking advantage of the relative high capacity of the structure to reduce the gravity loads and combine with the new brace frames to resist the lateral loads.



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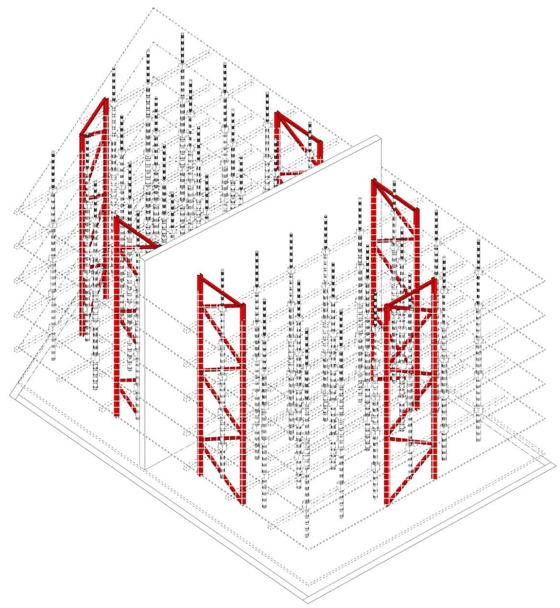
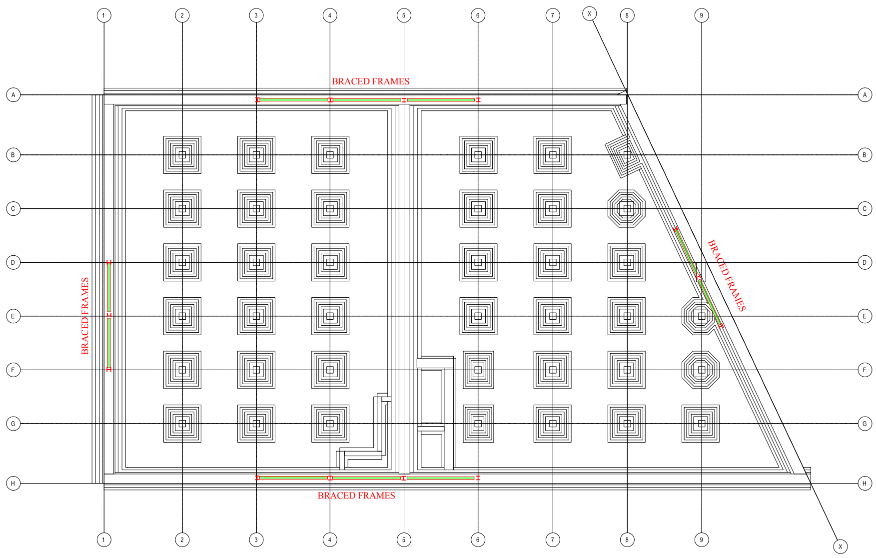
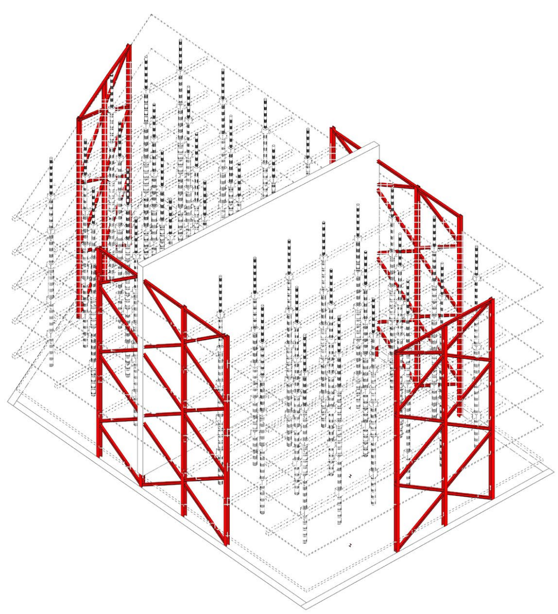


Structural and Material Testing Review

Possible Structural Remediation Strategies

- Option 3 - Buckling Restrained Braced Frames at Perimeter
- This option proposes to add new structural steel braced frames on each of the four sides of the building. The position of these brace frames will be coordinated with the architectural schemes. The new steel bracing will be on the inside surface of the exterior brick walls. The floor space on each side of the building will be decreased. Buckling restrained braces (BRB's) provide the lateral force resistance and will be configured in an X pattern. The new steel columns will be supported at the ground level by new reinforced concrete pile caps and micropiles.


BRACED FRAMES
BRACED FRAMES
BRACED FRAMES
BRACED FRAMES



Structural and Material Testing Review

Conclusion

- So far, overall existing building material seems to be in good to excellent condition (except for the roof).
- Existing piles can remain indefinitely and can carry the building's gravity loads.
- Liquefaction of the soil is not a concern.
- Structure will need to be added to address lateral forces.
- These are preliminary findings.

Flood Vulnerability

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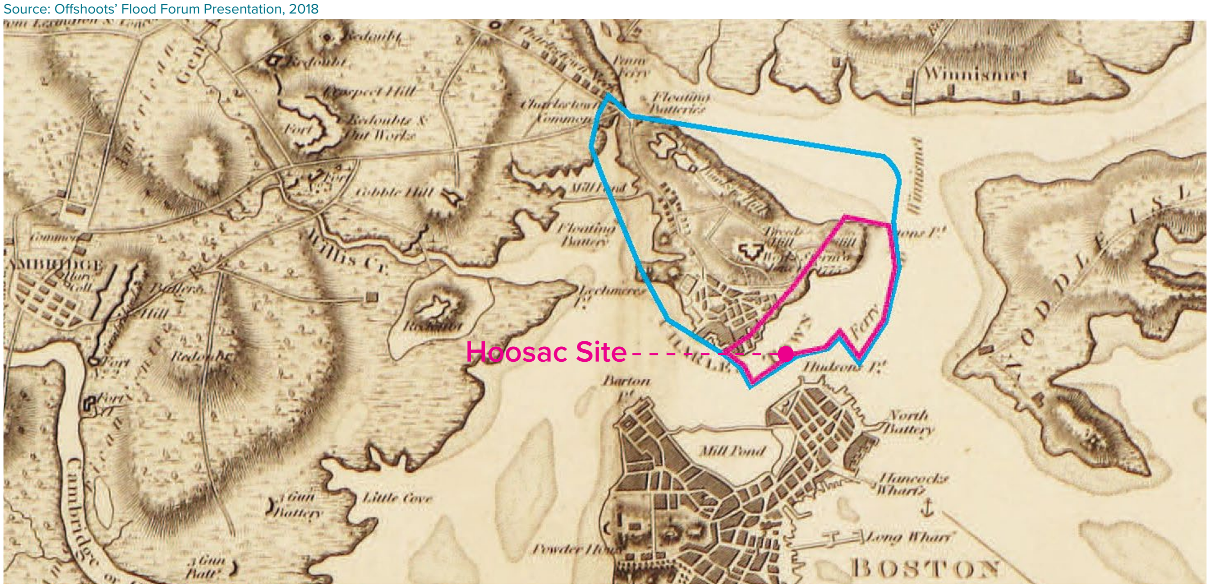
Charlestown Historic Fill - Boston, 1800

Source: Offshoots' Flood Forum Presentation, 2018



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HOOSAC STORES, FEASIBILITY STUDY

Context: Climate Change in Boston

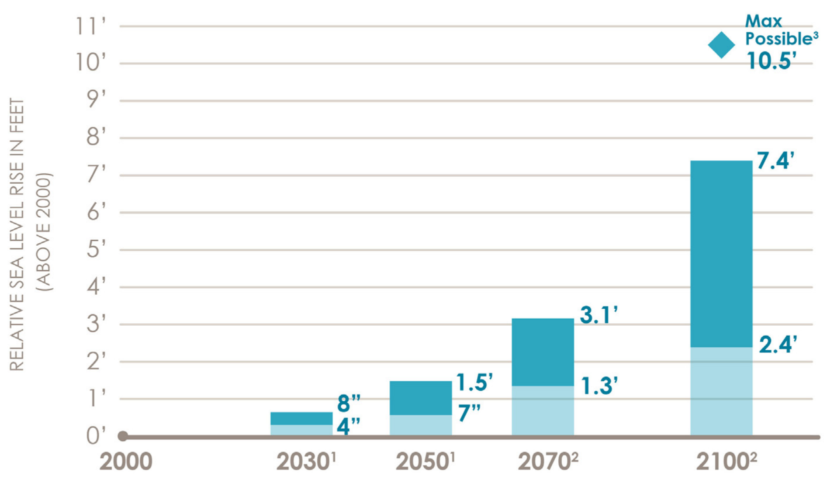
Source: Climate Ready Boston Executive Summary, City of Boston, 2016

Neighborhoods	Total Land Area (Acres)	LAND AREA EXPOSED (ACRES) 9" SLR 1% annual chance	21" SLR 1% annual chance	36" SLR 1% annual chance	36" SLR AMHT	PERCENT OF NEIGHBORHOOD EXPOSED 9" SLR 1% annual chance	21" SLR 1% annual chance	36" SLR 1% annual chance	36" SLR AMHT
I. Greatest Exposure & increasing throughout century									
Charlestown	870	120	310	460	110	14%	36%	54%	12%
Downtown	770	110	240	350	70	14%	31%	45%	10%
East Boston	3,340	540	1,040	1,680	480	16%	30%	49%	14%
Harbor Islands	820	200	230	260	200	25%	28%	32%	24%
South Boston	1,940	470	930	1,220	360	24%	48%	63%	19%
II. Lower Exposure today, but significant jump late century									
Allston / Brighton	2,940	30	70	240	20	1%	2%	7%	1%
Back Bay / Beacon Hill	460	<10	<10	80	<10	<1%	1%	17%	<1%
Roxbury	2,770	<10	<10	130	<10	<1%	<1%	5%	<1%
Dorchester	3,780	240	430	750	220	6%	11%	20%	6%
South End	640	<10	20	450	<10	<1%	3%	71%	<1%
III. Other Neighborhoods									
Fenway / Kenmore	620	<10	<10	<10	<10	<1%	<1%	<1%	<1%
Hyde Park	3,260	0	0	0	0	0	0	0	0
Jamaica Plain	2,260	0	0	0	0	0	0	0	0
Mattapan	1,560	0	0	0	0	0	0	0	0
Roslindale	2,250	0	0	0	0	0	0	0	0
West Roxbury	3,350	0	0	0	0	0	0	0	0
Boston Total	**31,720**	**1,720**	**3,280**	**5,630**	**1,470**	**8%**	**10%**	**18%**	**8%**

54% OF CHARLESTOWN EXPOSED WITH 36" SLR

Sea Level Rise Projections

Source: Climate Ready Boston, 2016

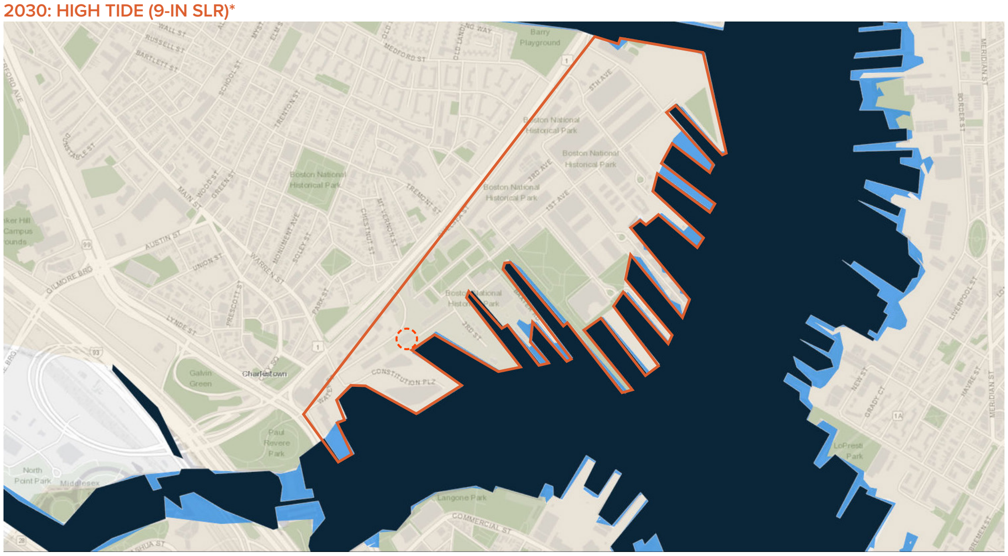


1 - Likely under all emission scenarios
2 - Likely under moderate to high emission scenarios
3 - Low probability under high emission scenario

High Tides at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2030: HIGH TIDE (9-IN SLR)*



*9” SLR means 9” above current tide levels

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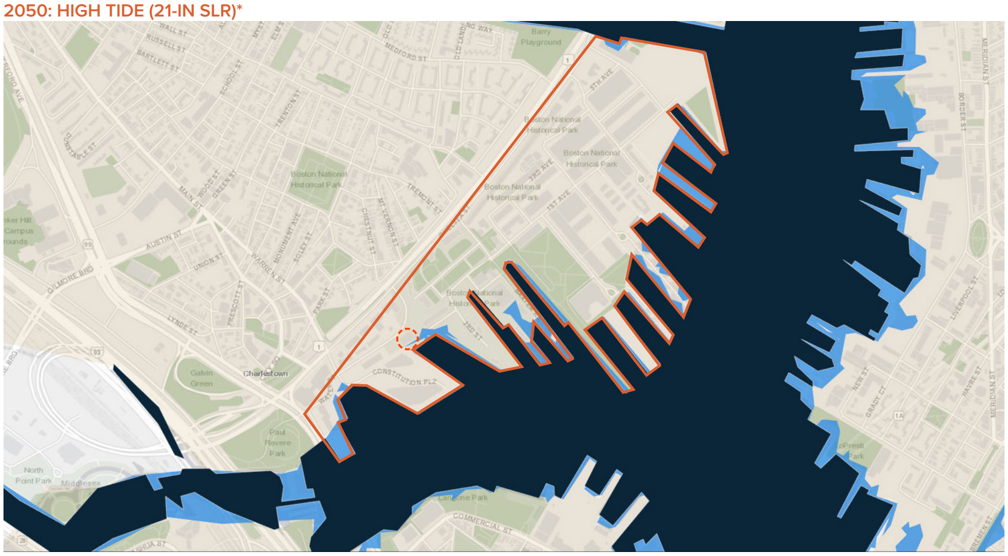
HOOSAC STORES, FEASIBILITY STUDY

High Tides at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2050: HIGH TIDE (21-IN SLR)*



*21” SLR means 21” above current tide levels

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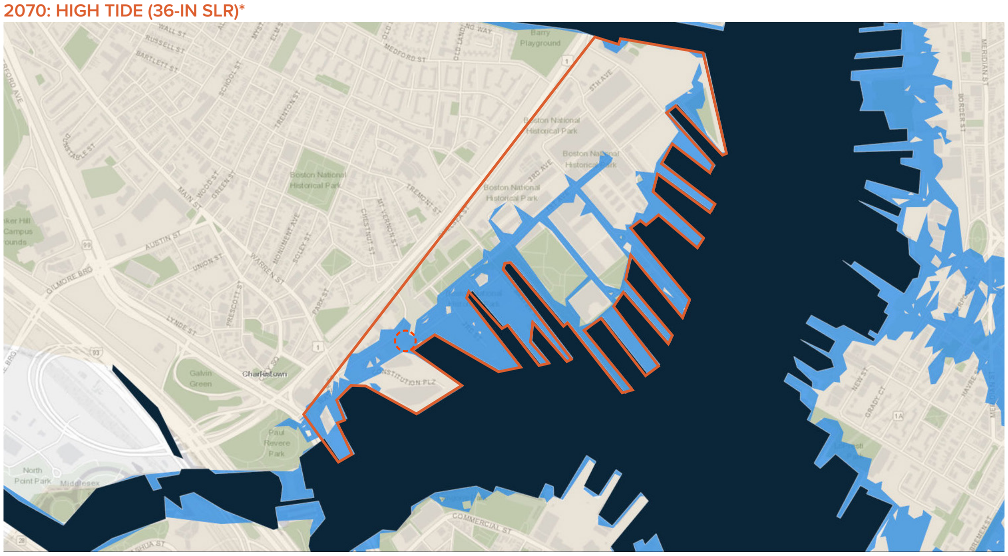
HOOSAC STORES, FEASIBILITY STUDY

High Tides at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2070: HIGH TIDE (36-IN SLR)*



*36" SLR means 36" above current tide levels

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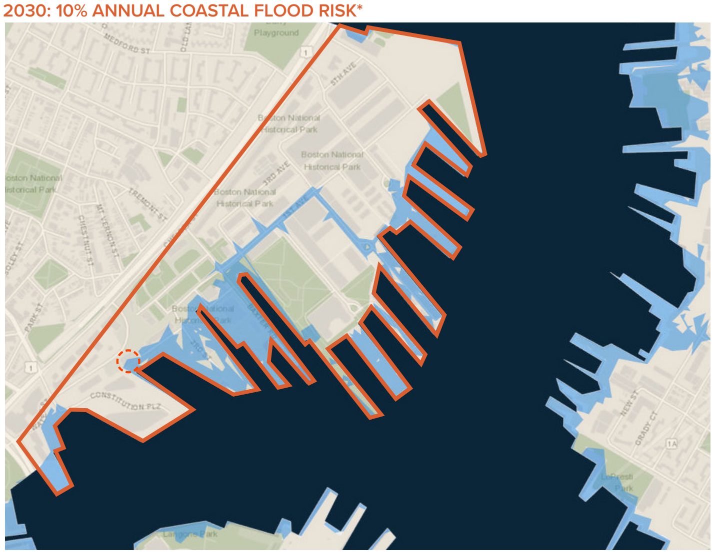
Annual Coastal Flood Risk at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2030: 10% ANNUAL COASTAL FLOOD RISK*



*10% annual coastal floods are also known as 10-year floods, which has a 1 in 10 chance of occurring in any given year

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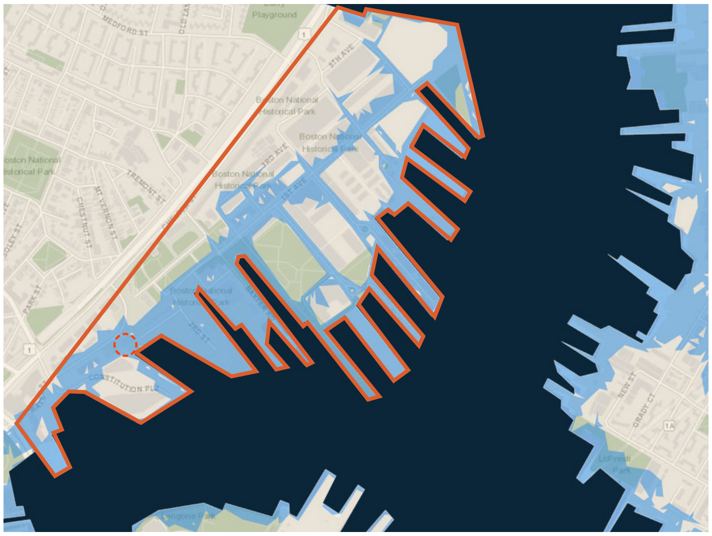
Annual Coastal Flood Risk at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2050: 10% ANNUAL COASTAL FLOOD RISK*

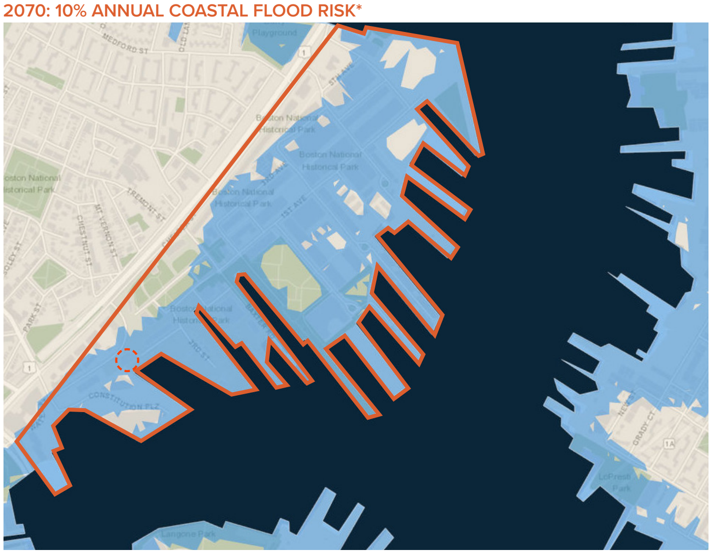


*10% annual coastal floods are also known as 10-year floods, which has a 1 in 10 chance of occurring in any given year

Annual Coastal Flood Risk at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2070: 10% ANNUAL COASTAL FLOOD RISK*

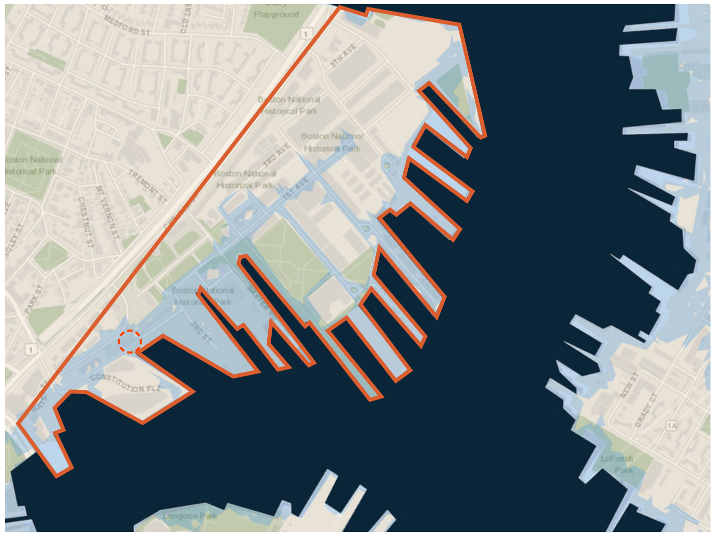


*10% annual coastal floods are also known as 10-year floods, which has a 1 in 10 chance of occurring in any given year

Annual Coastal Flood Risk at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2030: 1% ANNUAL COASTAL FLOOD RISK*



*1% annual chance flood is also referred to as the base flood or 100-year flood, which has a 1 in 100 chance of occurring in any given year.

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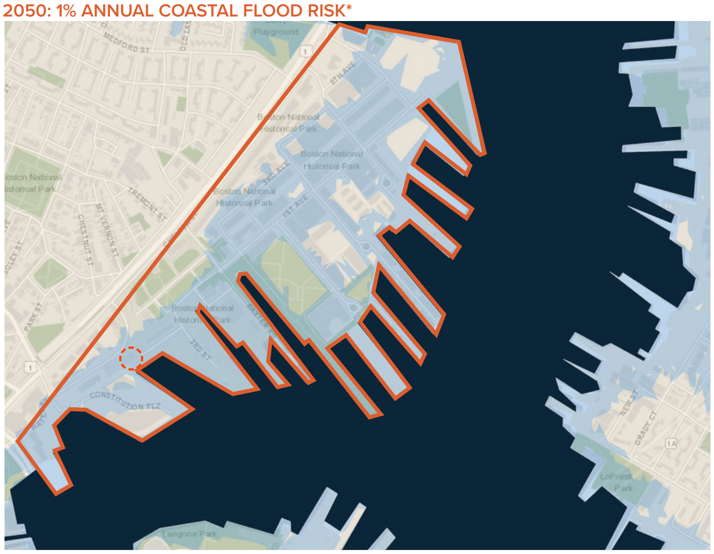
Annual Coastal Flood Risk at Charlestown Navy Yard

Source: Climate Ready Boston Map Explorer, City of Boston, 2019

2050: 1% ANNUAL COASTAL FLOOD RISK*



*1% annual chance flood is also referred to as the base flood or 100-year flood, which has a 1 in 100 chance of occurring in any given year.

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Annual Coastal Flood Risk at Charlestown Navy Yard

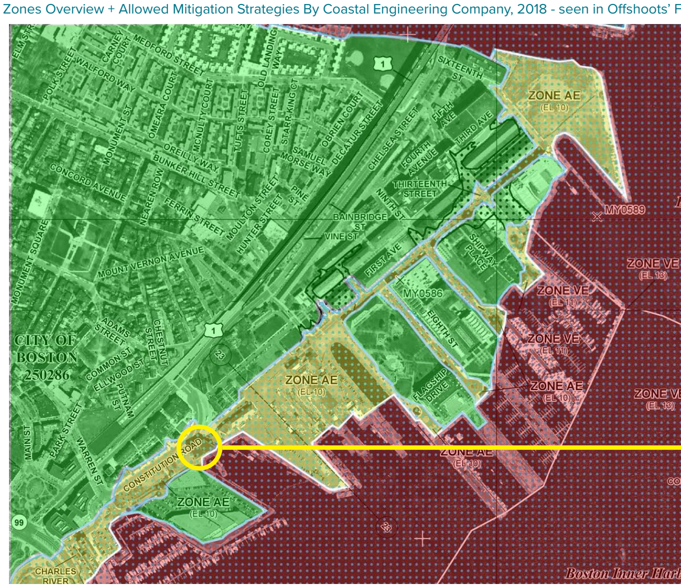
Source: Climate Ready Boston Map Explorer, City of Boston, 2019

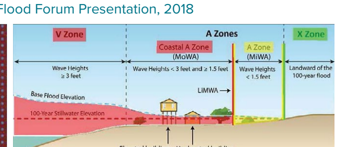
2070: 1% ANNUAL COASTAL FLOOD RISK*

*1% annual chance flood is also referred to as the base flood or 100-year flood, which has a 1 in 100 chance of occurring in any given year.

Charlestown Navy Yard FEMA Flood Zones

Source: Flood Zones Overview + Allowed Mitigation Strategies By Coastal Engineering Company, 2018 - seen in Offshoots' Flood Forum Presentation, 2018



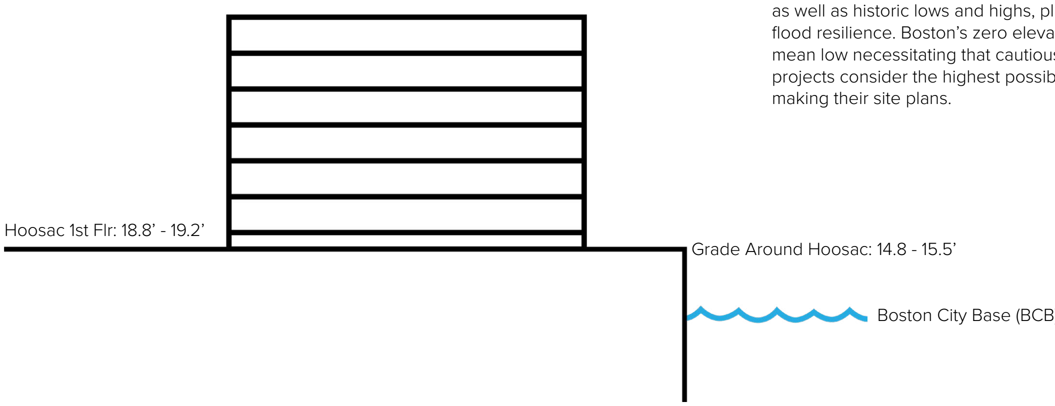


ZONE AE:
Zone AE and A1 – A30: Areas subject to inundation by the one percent annual chance flood event determined by detailed methods. Base flood elevations are shown within these zones. Mandatory flood insurance purchase requirements apply. (Zone AE is on new and revised maps in place of Zones A1 – A30.)
Source: evansville.gov.org /city/topic/ index.php?topicid=617

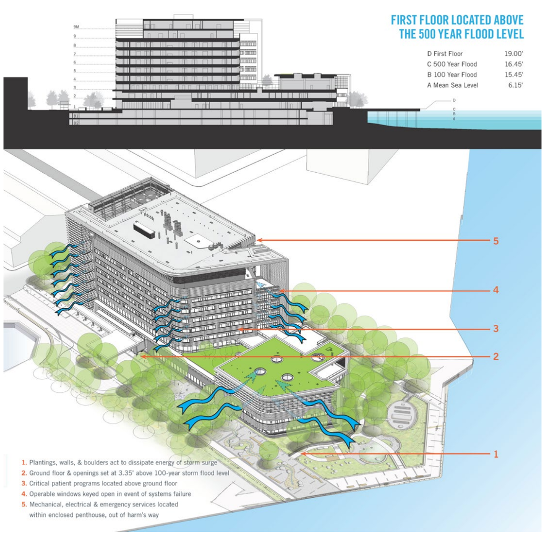
*Base Flood Elevation (BFE): defined by FEMA as the top of water elevation projected for a specified flooding scenarios. BFEs listed on FEMA Flood Insurance Rate Maps are based on the 1% Annual Chance Flood

Retrofitting the Hoosac Building: Preliminary Considerations

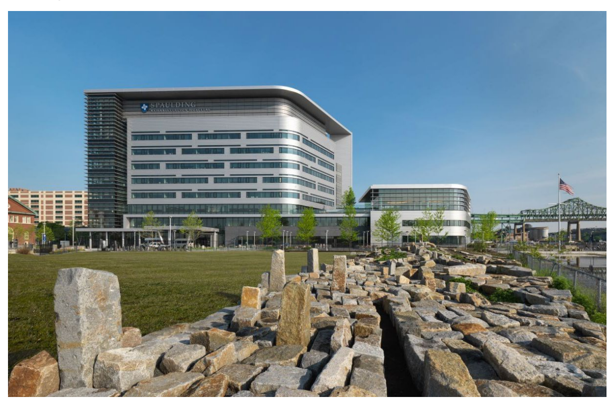
- The first floor elevation of Hoosac at the current entrances ranges from 18.8’ - 19.2’ above “Boston City Base” (BCB)
- Grade level around the base of Hoosac ranges from 14.8’ - 15.2’ above BCB
- Tidal datums, which include average lows and highs as well as historic lows and highs, play a major role in flood resilience. Boston’s zero elevation is set at the mean low necessitating that cautious development projects consider the highest possible tide when making their site plans.



Precedent: Spaulding Rehabilitation Hospital, Charlestown Navy Yard



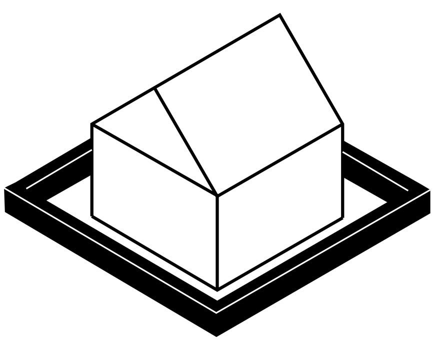
- Spaulding Rehabilitation Hospital in the Charlestown Navy Yard took a very conservative approach to resiliency and located the main floor at 19.0’ above BCB which is considered far beyond any city, state or federal requirements. (Source: DGT Associates Surveying & Engineering website)
- Image ©Perkins + Will

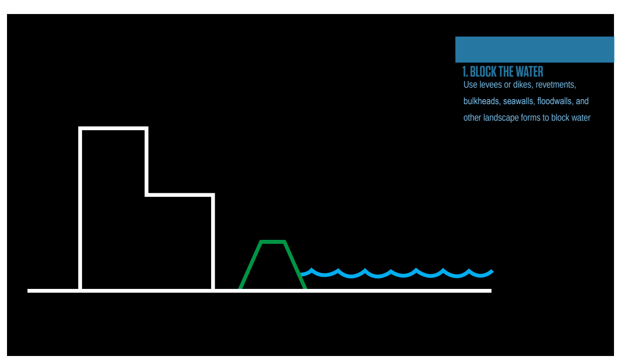


Resiliency Approaches

Resiliency Approaches - Block Water

- Local approach
- Would have to be integrated into building design





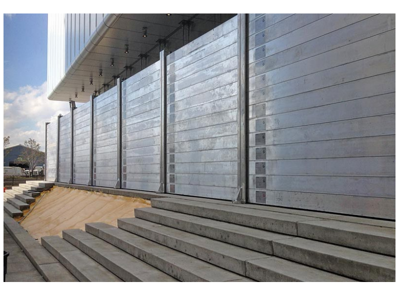
Resiliency Approaches - Block Water

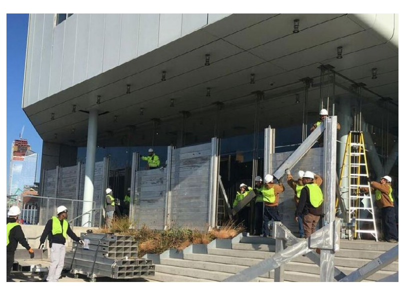
- Large-scale barrier approach
- concept from Charlestown Navy Yard CWC Floor Forum, 2018

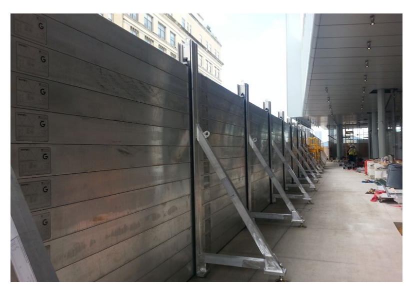
Block the Water : Navy Yard Barrier

Resiliency Approaches - Block Water

- The Whitney, whose lobby is 10 feet above sea-level, is now designed to be water-tight against a flood level of 16.5 feet—seven feet higher than waters reached during Hurricane Sandy.
- The fortification includes a 500-foot-long mobile wall, comprised of stacked aluminum beams, that can be erected in less than seven hours.

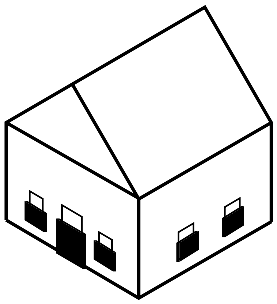


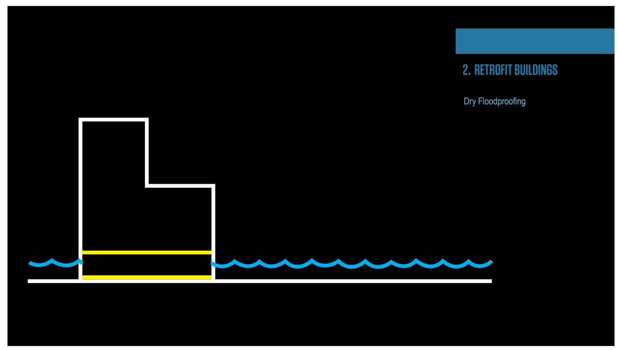




Resiliency Approaches - Dry Floodproofing

- Dry floodproofing means that techniques are applied to keep floodwaters from entering a structure.
- Openings can be temporarily closed with flood panels





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Resiliency Approaches - Dry Floodproofing

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Preliminary Massing Approaches / Building Precedents

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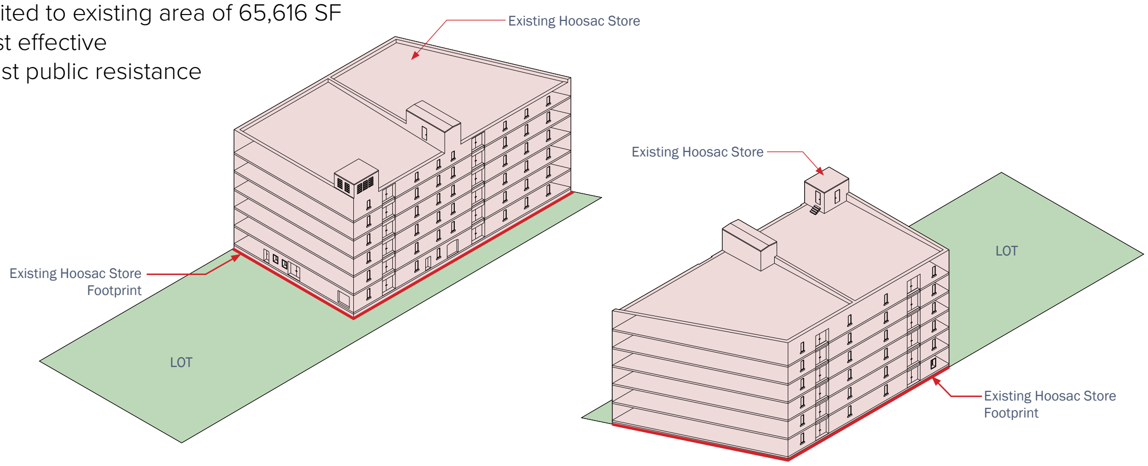
OPTION 1: Work Within Existing Building

- Limited to existing floor to ceiling heights
- Limited to existing area of 65,616 SF
- Cost effective
- Least public resistance



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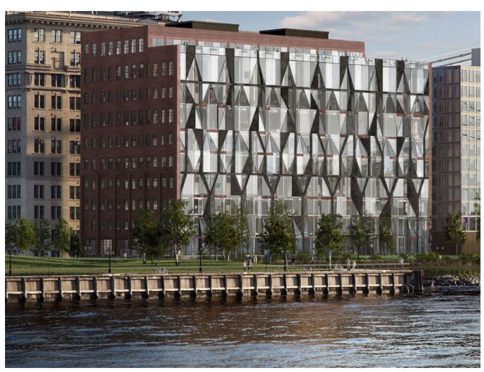
HOOSAC STORES, FEASIBILITY STUDY

OPTION 1: Work Within Existing Building

The Banknote Building, Bronx, NY

- Built in 1909 / Renovated in 2010
- 420,000 GSF
- Printing Plant -> Mixed-use
- Industrial-scale windows were replaced, flooding expansive interior loft spaces with natural light

OPTION 1: Work Within Existing Building

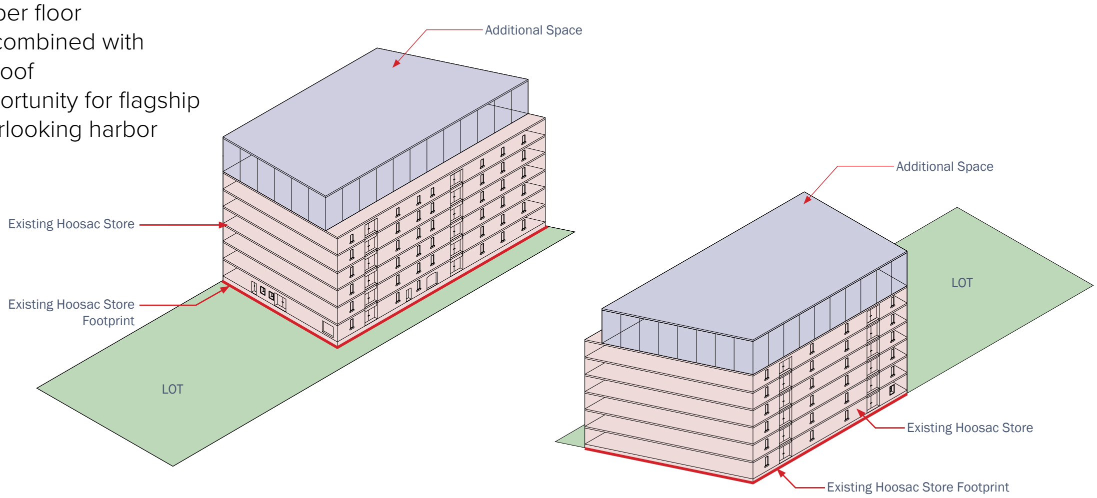


10 Jay St. Brooklyn, NY

- Industrial waterfront building
- Existing brick waterfront facade completely replaced with new glass facade

OPTION 2: Add Additional Floor(s)

- Increase floor area by approximately 10,000SF per floor
- Could be combined with replacing roof
- Offers opportunity for flagship space overlooking harbor



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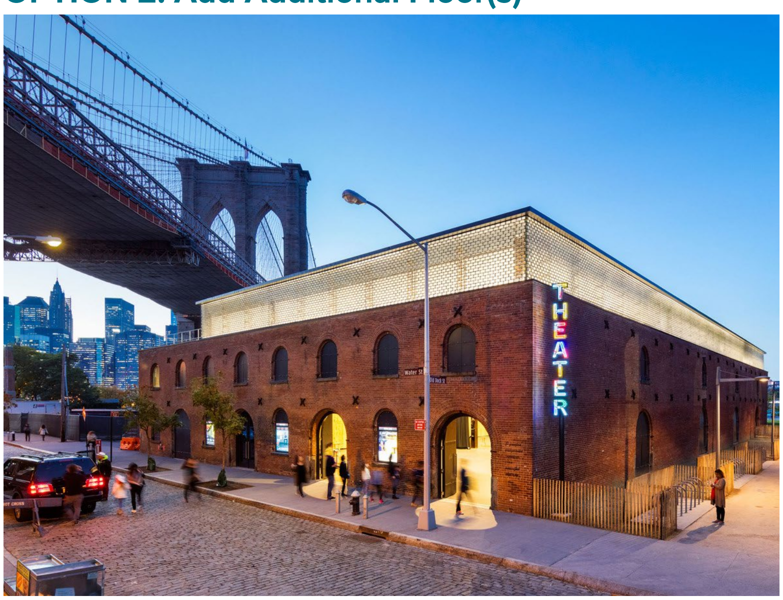
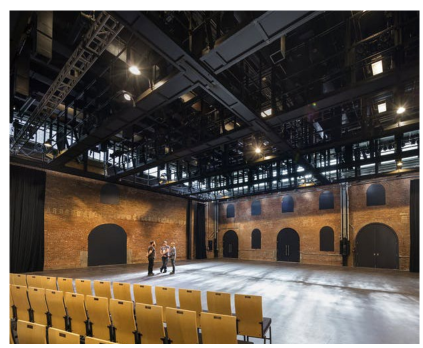
OPTION 2: Add Additional Floor(s)





St. Ann's Warehouse, Brooklyn, NY

- Built in 1860 / Renovated in 2015
- 25,500 GSF
- Tobacco Warehouse -> Art Theater
- An overall discrete volume is inserted snugly into the walls on three sides, allowing the historic arched doors and varied windows to remain untouched

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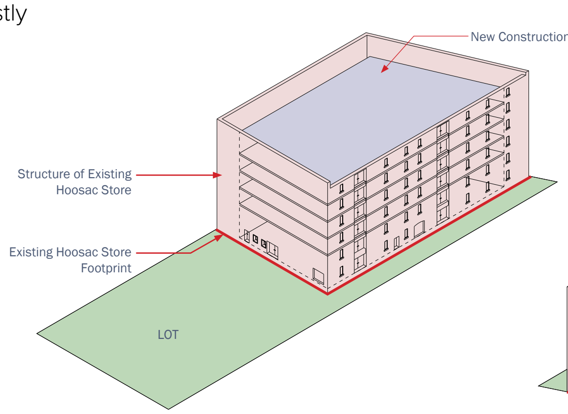
HOOSAC STORES, FEASIBILITY STUDY

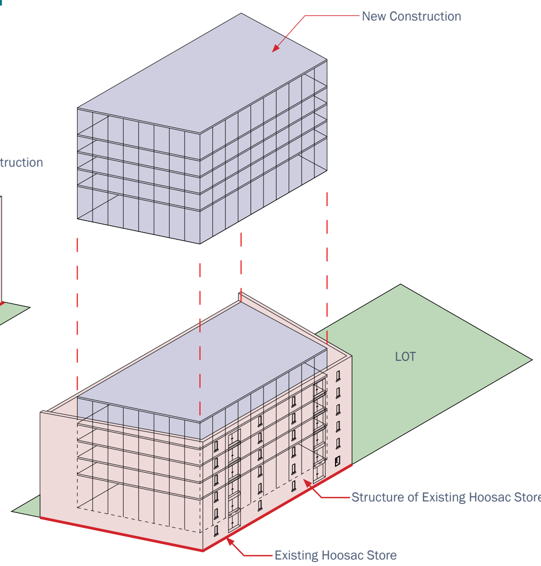
OPTION 2. Add Additional Floor(s)

Kendall Building, Antwerp, Belgium
- Renovated in 2011
- 13,000 GSF
- Warehouse -> Office

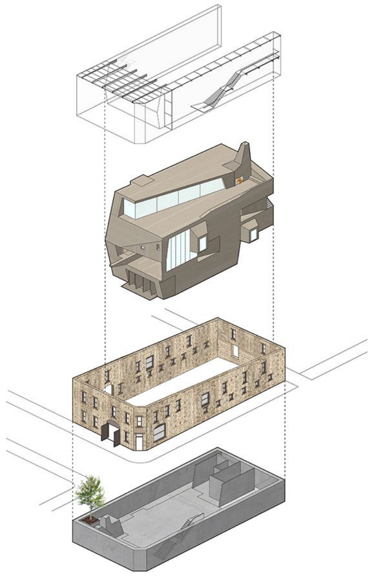
OPTION 3: Remove Interior, Retain Exterior

- Maintains historic exterior
- Complete flexibility with floor to ceiling heights
- More costly





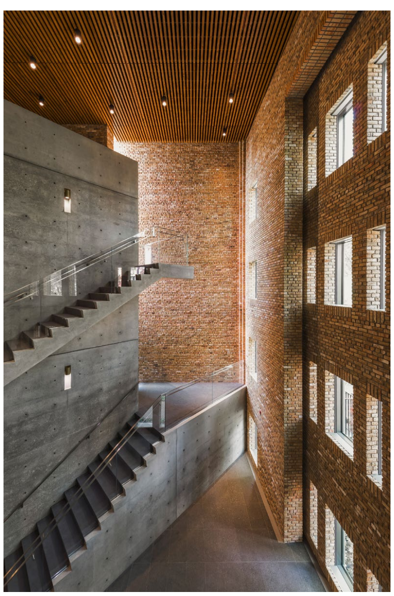
OPTION 3: Remove Interior, Retain Exterior

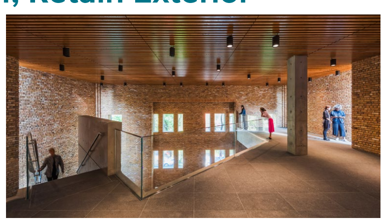


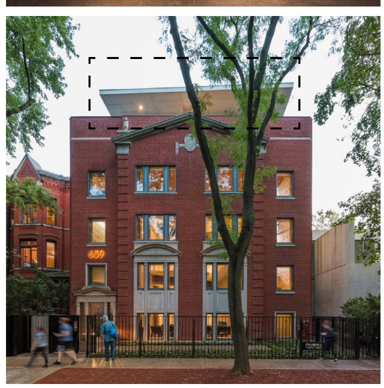
Telluride Center for the Arts

- The building is listed as a National Historic Landmark and has stood for over 100 years.
- Originally built in 1906, it was in use until its roof collapsed in 1979. Since then, the building has stood vacant and decaying.
- A contemporary, ark-like wooden structure is to be built inside the existing walls
- Between the new interior timber volume and the historic stone walls is the main circulation stairway, featuring exposed stone walls that are flooded with natural light from above

OPTION 3: Remove Interior, Retain Exterior



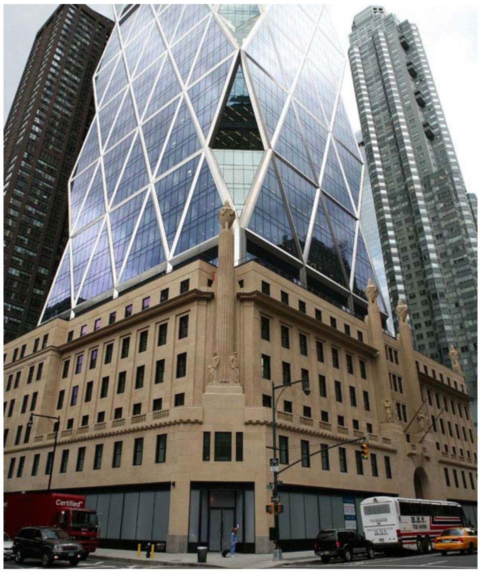


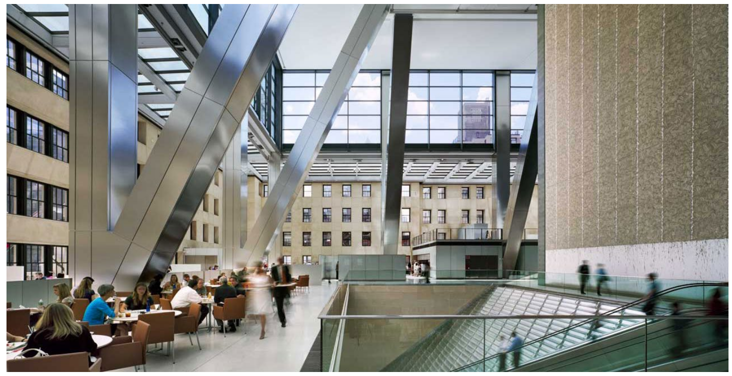


Wrightwood 659, Chicago, IL

- Built in 1920s / Renovated in 2018
- 37,200 GSF.
- Program changed from apartments to gallery
- 1929 brick building converted into an exhibition center
- The building's brick construction is made visible by stripping out interior finishes down to the brick
- A rooftop structure was added, a terrace facing north, and a vista of Chicago's skyline to the south

OPTION 3: Remove Interior, Retain Exterior

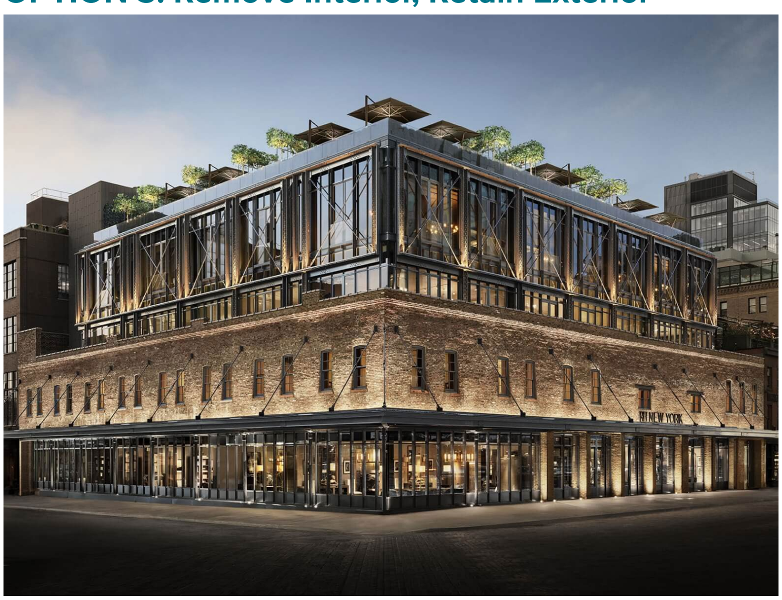




Hearst Tower, New York, NY

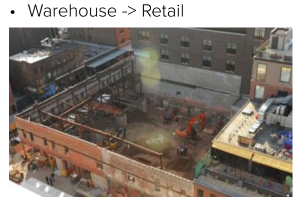
- Original 5-story building built in 1928 / Renovated in 2006
- New building has 855,000 GSF.
- Original and new use is for office

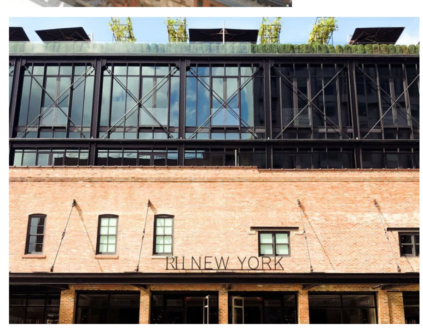
OPTION 3: Remove Interior, Retain Exterior



RH New York

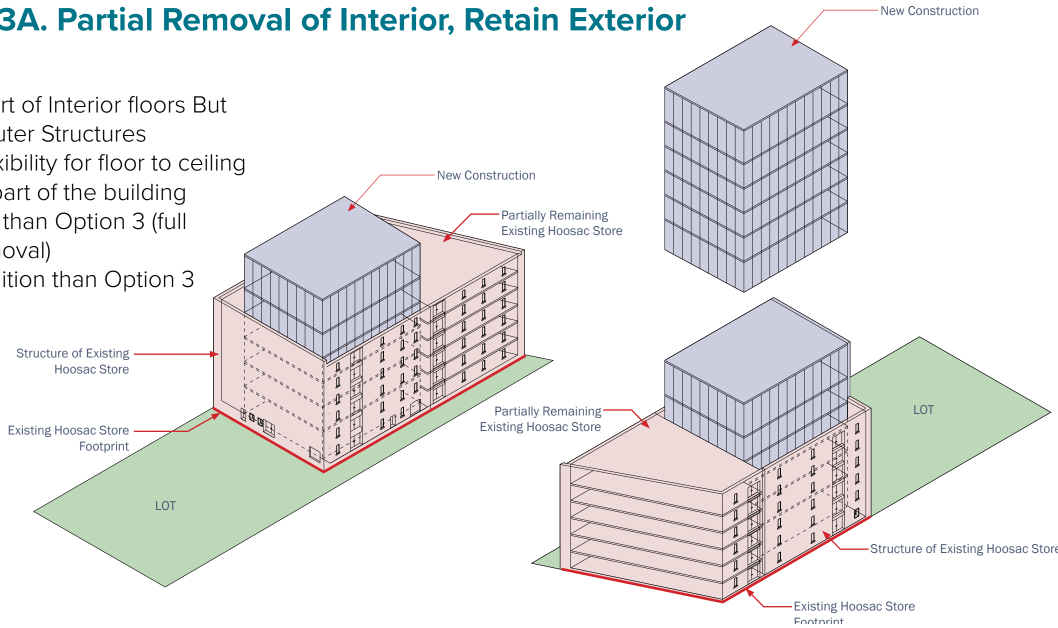
- Built in 1900s / Renovated in 2018
- 90,000 GSF.
- Warehouse -> Retail





OPTION 3A. Partial Removal of Interior, Retain Exterior

- Remove part of Interior floors But Keeping Outer Structures
- Provide flexibility for floor to ceiling heights in part of the building
- Less costly than Option 3 (full interior removal)
- Less demolition than Option 3



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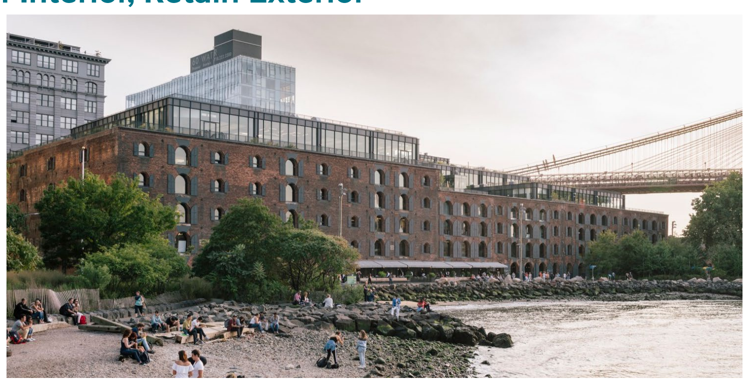
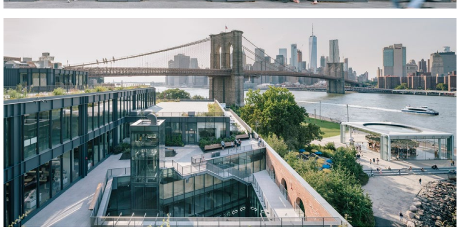
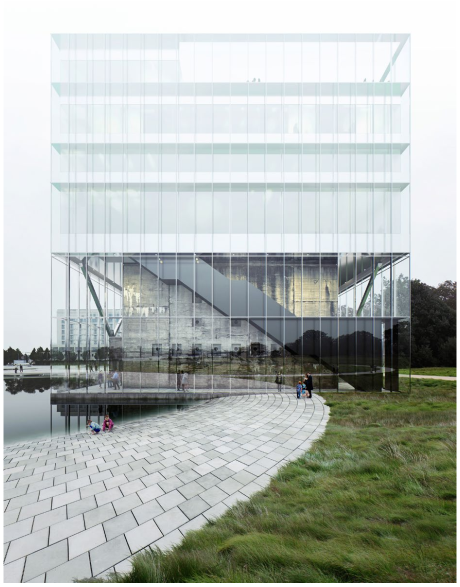




Empire Stores, Brooklyn, NY

- Built in 1869 / Renovated in 2017
- 450,000 GSF.
- Powerhouse -> Mixed-use Complex
- The campaign of adaptive re-use celebrates and preserves the building's monumental presence on the waterfront, while improving circulation between DUMBO's urban fabric and the 85-acre Brooklyn Bridge Park.

OPTION 4. Add Exterior Enclosure

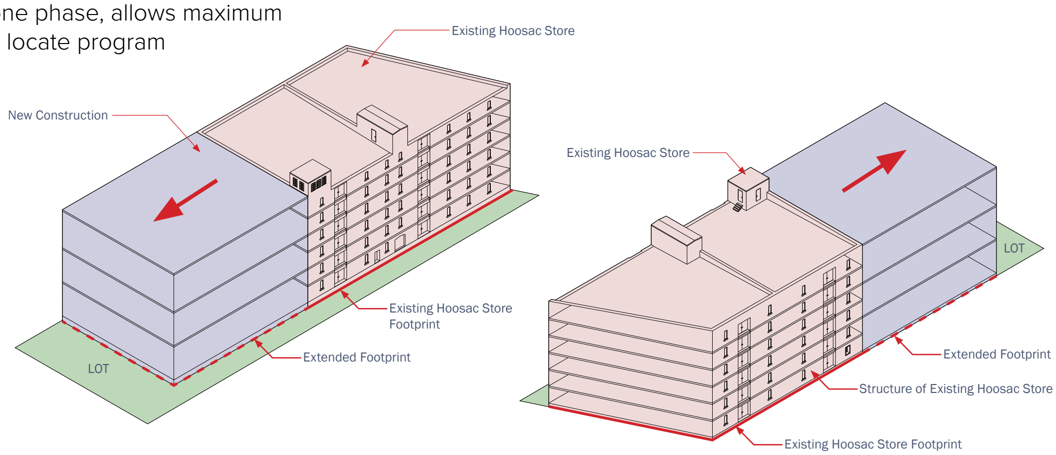


Trilateral Wadden Sea World Heritage Partnership Center

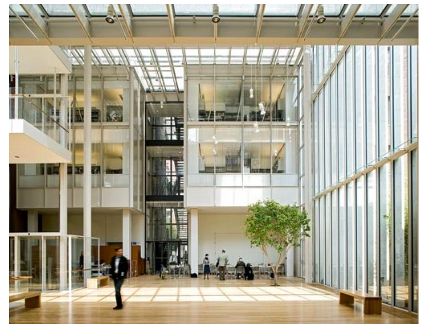
- Building on top of a 2nd world war naval bunker in a UNESCO World Heritage area on the German coast

OPTION 5: Utilize Adjacent Lot

- Maximizes allowable floor area across entire site (requires zoning approval)
- If done in one phase, allows maximum flexibility to locate program



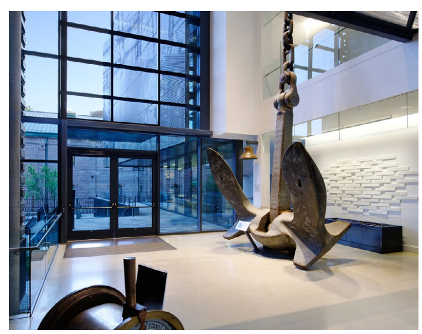
OPTION 5: Utilize Adjacent Lot



The Morgan Library & Museum, New York, NY

- Built in 1853 / Renovated in 2012
- 147,000 GSF.
- Library & Museum
- The expansion knits the campus together through the construction of a 72,000 SF modern, skylit atrium, which extends four stories below grade.

OPTION 5: Utilize Adjacent Lot



Building 92, Brooklyn, NY

- Part of Brooklyn Navy Yard
- Bult in 1857 / Renovated in 2011
- 32,000 GSF
- Commendant’s House -> Museum

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Project Challenges

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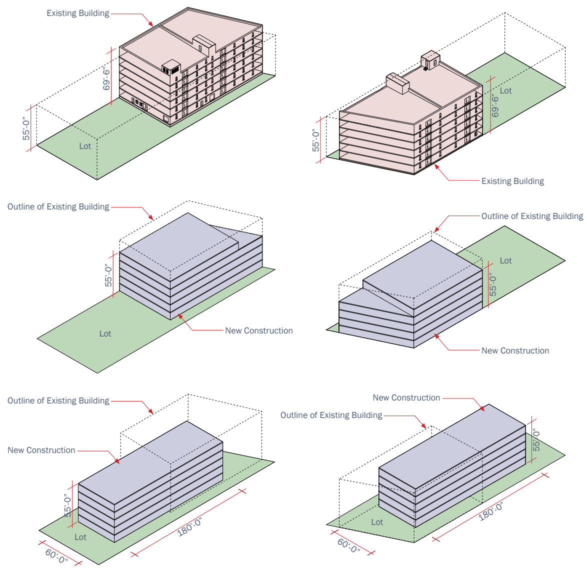
Zoning



Existing Building
- Lot Size: 26,615 SF
- Total Floor Area : 65,616 SF / 53,230 SF
- FAR : 2.47 / 2.00
- Building Height : 69'-6" / 55'-0"
- Number of Floor : 6
- Floor to Floor Height : 10'-11"

New Construction limited to Existing Footprint
- Total Floor Area : 53,230 SF
- FAR : 2.00
- Building Height : 55'-0"
- Number of Floor : 5
- Floor to Floor Height : 11'-0"

New Construction
- Total Floor Area : 53,230 SF
- FAR : 2.00
- Building Height : 55'-0"
- Number of Floor : 5
- Floor to Floor Height : 11'-0"

Program

	USSCM	NPS	Shared Building Resources	Lease out
Existing	31,647 gsf [1] 39,088 gsf [2]			
Proposed	65,058 gsf [3] 90,398 gsf [4]	10,051 gsf [5]	25,780 gsf [6]	??? gsf

Notes:

1. As determined by MFA and Jacobs
2. As provided by USSCM*
3. Original expanded program request to account for growth by USSCM*
4. Revised expanded program request to account for growth by USSCM*
5. Includes NPS directorates as indicated in Workplace Recommendation Report
6. Includes shared meeting spaces, resource spaces, and building services as indicated in Workplace Recommendation Report

* see "2019-07-11_SpaceAllocation_d04_USCCM.xlxs" provided to MFA on 2019-11-04

Outside Stakeholders

Regulatory

Mayor's Office of Neighborhood Services
Boston Planning and Development Agency
Boston Civic Design Commission
Massachusetts Historical Commission
Boston Landmarks Commission

Advisory

Charlestown Neighborhood Council
Friends of Charlestown Navy Yard
Charlestown Preservation Society
Freedom Trail Foundation

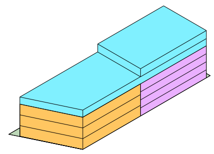
Additional Abutters

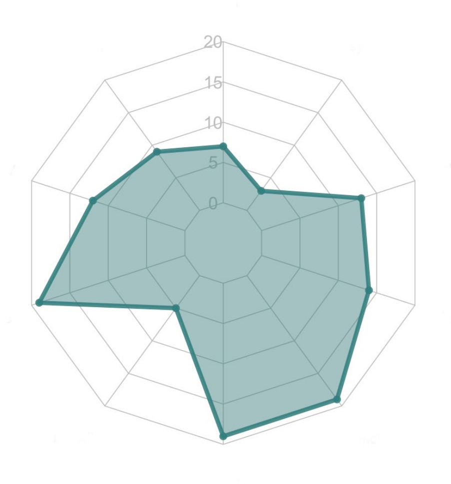
Massport
Constitution Plaza Associates
Nautica

Decision Drivers

Decision Drivers

Cost [initial, life cycle, proforma]
Historic Sensitivity
Ability to Meet Program
Flexibility of Use over Time
User Experience
Constructability
Sustainability
"Wow" Factor
Design Innovation
Innovative NPS Public-Private Partnership
Visibility
Workplace Innovation
Resiliency
Security
Phasing [short term and long term]





Schedule

	2019																	2020																		
	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	4-Nov	11-Nov	18-Nov	25-Nov	2-Dec	9-Dec	16-Dec	23-Dec	30-Dec	6-Jan	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May
TASKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Project Start Up																																				
CONTRACT AWARD, NOTICE TO PROCEED, AND KICK-OFF	9/9																																			
CONTRACT AWARD AND NOTICE TO PROCEED																																				
KICK-OFF MEETING [3.1.1]	9/11																																			
FEASIBILITY STUDY																																				
Submission 1 (1+2+3): Existing Conditions, Needs Assessment, and Possible Alternatives																																				
INITIAL OUTLINE AND WORK ACTIVITIES		9/16											12/3																							
PROPOSED EXECUTION AND SCHEDULE OF WORK ACTIVITIES PROVIDED TO CLIENT/USER [3.3.1]																																				
CLIENT/USER REVIEW AND COMMENT ON SCHEDULE; LOCK IN CRITICAL WORKSHOP DATES																																				
PROJECT GOALS AND REQUIREMENTS																																				
ON-SITE MEETINGS / SITE INVESTIGATIONS[5]									11/8																											
EXISTING CONDITIONS INVESTIGATION [3.3.2.1]																																				
GENERAL [3.3.2.1.1] [1]																																				
ASSET CONDITIONS [3.3.2.1.2] [1]																																				
CUSTOMER HOUSING CONDITIONS [3.3.2.1.3]																																				
PROPOSED SITE CONDITIONS [3.3.2.1.4]																																				
NEEDS ASSESSMENT [3.3.2.2]																																				
INTERVIEWS [3.3.2.2.1] [2]																																				
ASSET GOALS AND NEEDS [3.3.2.2.2]																																				
CUSTOMER GOALS AND NEEDS [3.3.2.2.3]																																				
ENGINEERING STAGE 1: GEOTECHNICAL AND STRUCTURAL STUDIES, ON-SITE PROBES, AND INVESTIAGTIONS																																				
MOBILIZATION OF SUBCONTRACTORS, NPS STORAGE REQUIREMENTS																																				
NPS TO CLEAR AND PREP AREAS FOR BORING, BRICK CORING, AND MATERIAL SAMPLES																																				
BRICK CORING TO TAKE PLACE																																				
MATERIAL SAMPLING AND STUDY TO TAKE PLACE																																				
BORING AND SOIL TESTING TO TAKE PLACE																																				
JACOBS GEOTECHNICAL EVALUATION																																				
SGH TO ANALYZE MATERIAL TEST RESULTS																																				
JACOBS STRUCTURAL EVALUATION																																				
JACOBS TO RECOMMEND SOLUTIONS BASED ON TESTING																																				
BETA TO CONDUCT GPR OF SITE, DELIVER REPORT																																				
PAL TO DELIVER HISTORIC REPORT ON HOOSAC LOT																																				
REPORT FROM JACOBS TO MFA DESCRIBING VIABILITY OF RETAINING EXISTING HOOSAC BUILDING													12/3																							
POSSIBLE ALTERNATIVES													12/4											2/21												
IDENTIFY POSSIBLE ALTERNATIVES [3.3.3]																																				
DEVELOP MATERIAL FOR ON-SITE WORKSHOP																																				
DEVELOP TECHNICAL ANALYSIS [3.4.1]																																				
ENGINEERING STAGE 2: SYSTEMS CONCEPTS																																				
ON-SITE WORKSHOP: POSSIBLE ALTERNATIVES [5]																																				
SELECT VIABLE ALTERNATIVES [3.3.3.1]																																				
DELIVERABLES SUBMITTED TO CLIENT/USER																					1/31															
CLIENT/USER REVIEW AND COMMENT																																				
RESPOND TO AND INCORPORATE CLIENT/USER COMMENTS [3.8.2]																								2/21												
Submission 2 (4+5+6): Viable Alternatives, Preferred Alternative, and Final Report																																				
VIABLE ALTERNATIVES																									2/24				3/27							
DEVELOP VIABLE ALTERNATIVES [3.3.4]																																				
DEVELOP MATERIAL FOR ON-SITE WORKSHOP																																				
DEVELOP TECHNICAL ANALYSIS [3.4.2]																																				
DEVELOP FINANCIAL ANALYSIS [3.5.2]																																				
DEVELOP IMPLEMENTATION SCHEDULE [3.6.2]																																				
ENGINEERING STAGE 3: SYSTEMS DEVELOPMENT																																				
ON-SITE WORKSHOP: VIABLE ALTERNATIVES AND COMPARATIVE ANALYSIS [3.3.4.1] [5]																																				
SELECT PREFERRED ALTERNATIVE																																				
IDENTIFY PREFERRED ALTERNATIVE [3.3.4.2]																																				

	2019																	2020																		
	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	4-Nov	11-Nov	18-Nov	25-Nov	2-Dec	9-Dec	16-Dec	23-Dec	30-Dec	6-Jan	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May
TASKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
DEVELOP TECHNICAL ANALYSIS [3.4.3]																																				
DEVELOP FINANCIAL ANALYSIS [3.5.3]																																				
DEVELOP IMPLEMENTATION SCHEDULE [3.6.3]																													3/27							
PREFERRED ALTERNATIVE, IMPLEMENTATION, BUDGET, AND FINAL REPORT																														3/30						5/15
ON-SITE MEETING [5]																																				
DEVELOP PREFERRED ALTERNATIVE [3.3.5]																																				
SPACE PROGRAM REQUIREMENTS [3.3.5.1]																																				
FINAL REPORT DEVELOPMENT [3.3.6]																																				
DELIVERABLES SUBMITTED TO CLIENT/USER																																	4/24			
CLIENT/USER REVIEW AND COMMENT																																				
RESPOND TO AND INCORPORATE CLIENT/USER COMMENTS [3.8.2]																																				
CREATE PRESENTATION FOR NPS USE [3.1.2]																																				5/15

Prepared by marble fairbanks

in-person meeting / visit [3.1.1] [3]
WebEx or GoTo meeting [3.1.1] [4]
client / user review period
phase / task
deliverables due

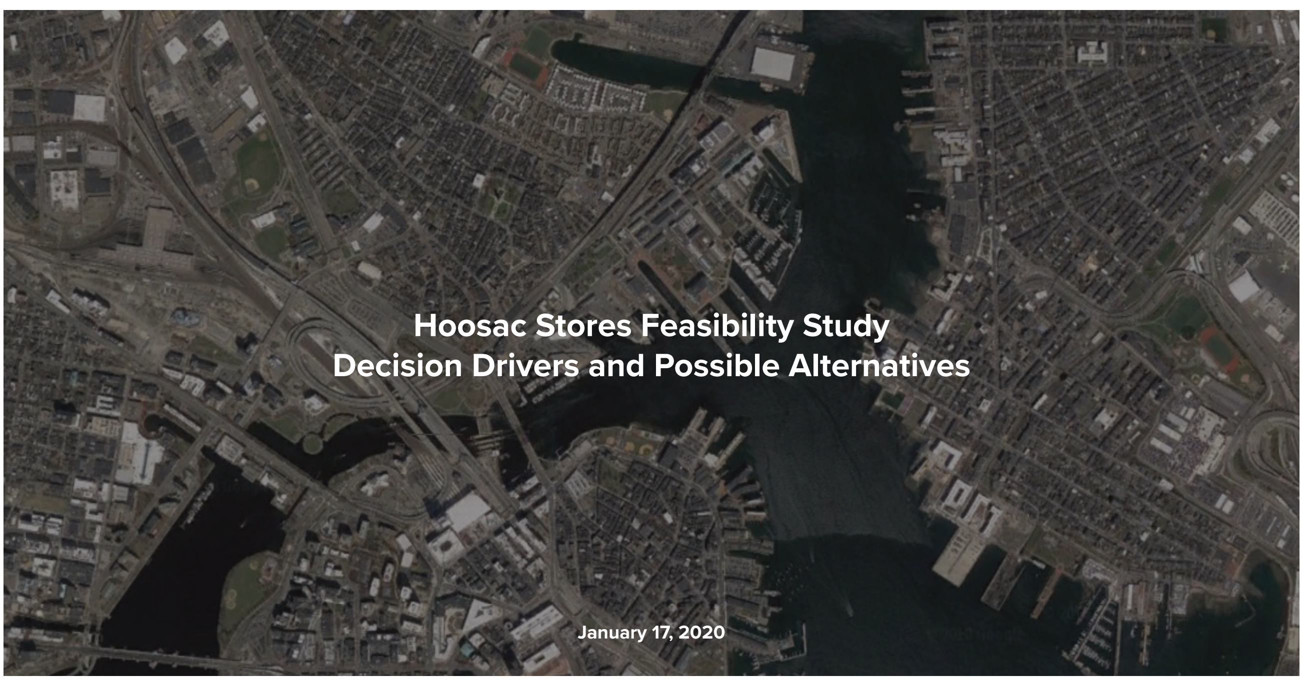
1 Tasks to reference PDS Submission #2
2 Interviews to be in-person or via WebEx or GoTo [TBD]
3 Site visits may be required outside of the ones noted on this schedule depending on the deliverable
4 Bi-weekly progress meetings shall be held via online or phone conference throughout the duration of the project
5 Exact date of on-site meeting / workshop to be confirmed with all parties

NOVEMBER 8, 2019 marble fairbanks | JACOBS HOOSAC STORES, FEASIBILITY STUDY

Decision Drivers and Possible Alternatives Presentation

JANUARY 17, 2020

This presentation and workshop was given by the design team to NPS, GSA, the USSCM, and the Navy in January 2020. The goal of this meeting was to collectively review and evaluate 16 Alternatives to the Hoosac Stores building and site and, using pre-defined Decision Drivers, determine five Possible Alternatives to further develop and get RoM costing.



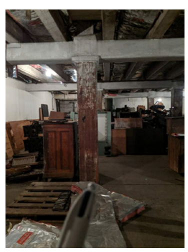
JANUARY 17, 2020 marble fairbanks | JACOBS HOOSAC STORES, FEASIBILITY STUDY

Structural and Material Testing Review

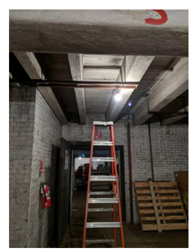
Material Testing Results


1 (E) COND. NO. 3 GRADE TYP


2 LEVEL 3 - BEAM SAMPLE LEVEL 4


3 (E) COND. LEVEL 3 COL. SAMPLE


4 LEVEL 3 COL. SAMPLE

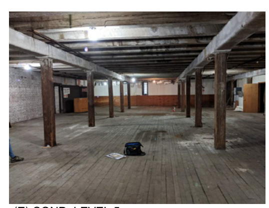

5 LEVEL 4 - DECKING SAMPLE AT LEVEL 5


6 (E) COND. COL. DAMAGE TYP


7 LEVEL 5 AT BEAM SAMPLE ABOVE


8 LEVEL 5 - BEAM SAMPLE LEVEL 6


9 LEVEL 5 COL. SAMPLE


10 (E) COND. LEVEL 5

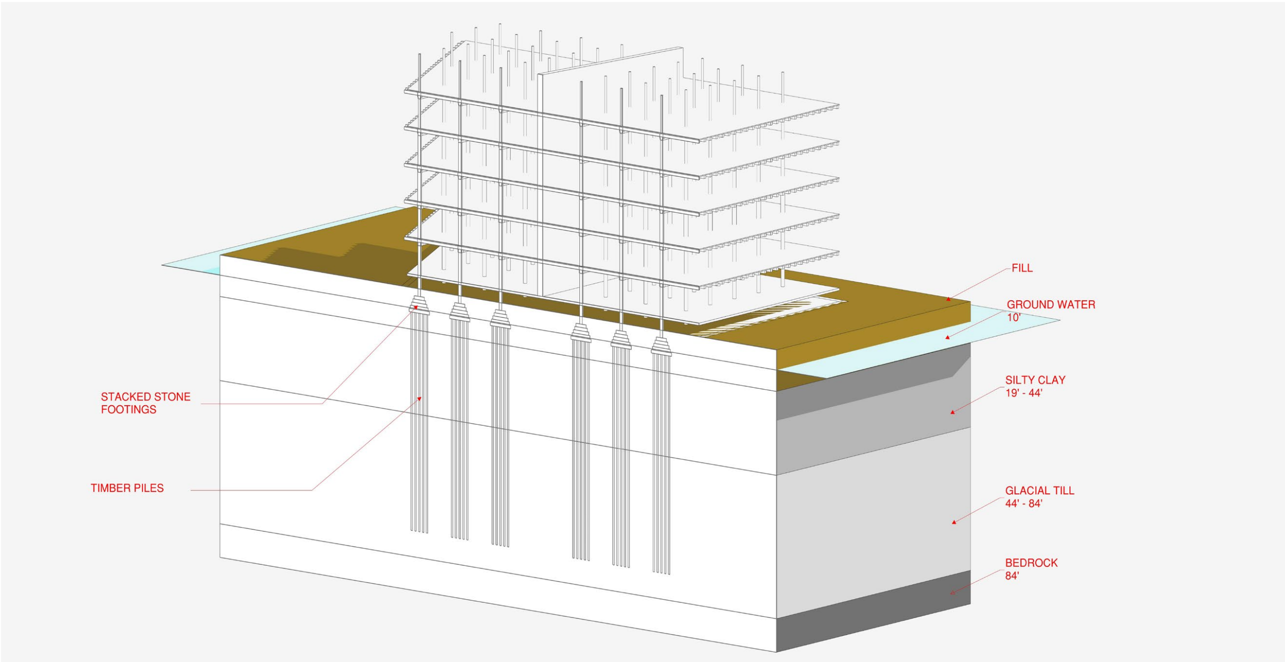
Structural and Material Testing Review

Material Testing Results

- Wood: Wood species of the columns and beams is southern pine based on our visual review. A representative number of columns and beams were graded and most were graded highly.
- Steel: We collected and tested two steel coupons from the top flange of the structural beams on floors 1 and 2 (Specimen IDs 1 and 2, respectively). One sample came in around A36 gr. 36 range, but one came in a little lower, so we may recommend capping the yield strength a little lower than 36ksi to cover any variability.
- Brick and Mortar: Compression testing results indicate that the brick compressive capacity in the good to excellent category according to ASCI41 standards.

Structural and Material Testing Review

Geotech Recommendations



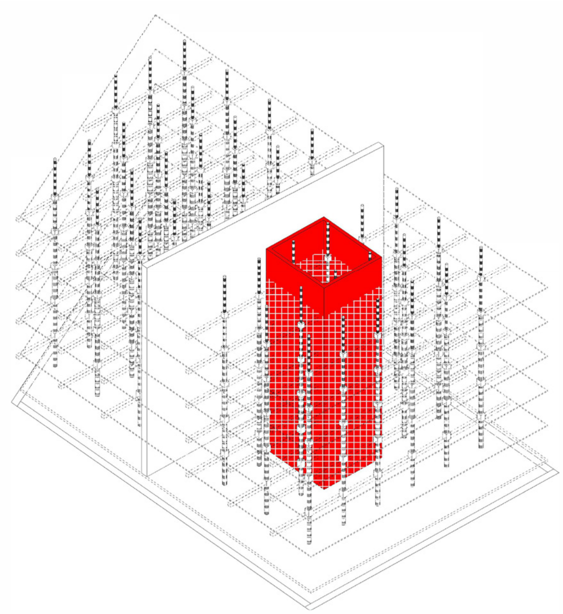
Structural and Material Testing Review

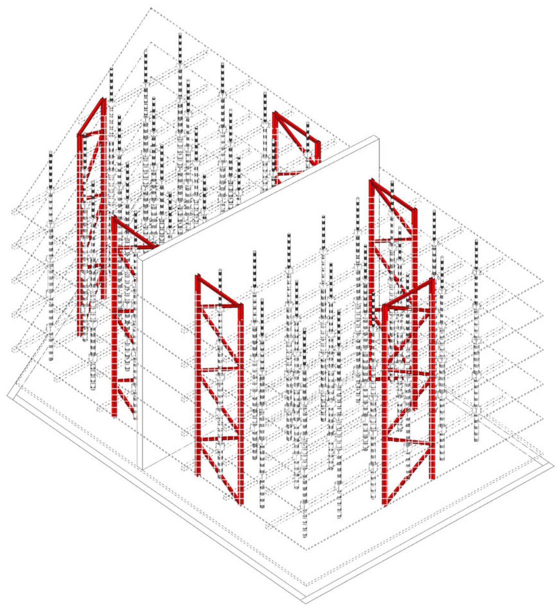
Geotech Recommendations

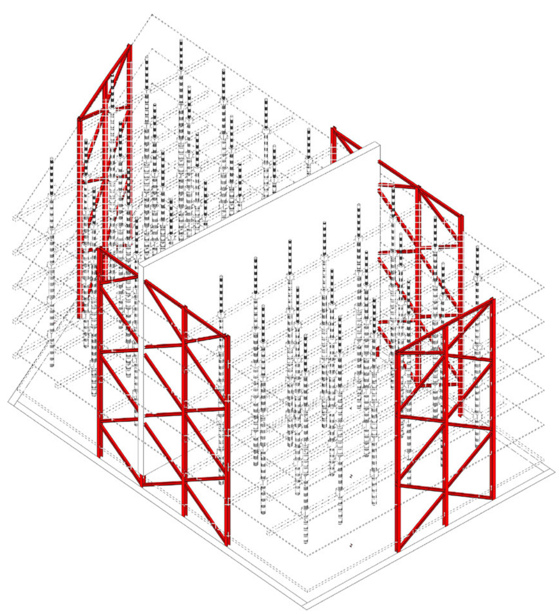
- All the existing timber piles are permanently under the groundwater table. It is generally accepted that foundation timber piles finished below permanent groundwater table will last indefinitely. Therefore, it is expected that the existing footings can still carry the original vertical loads if there is no increase in the vertical loads in the final design.
- However, since the granite stones were simply stacked on top of the piles and on top of each other, the existing footings can not develop much lateral capacity to resist lateral loads (such as wind load and seismic load). Therefore, retrofitting design is required regarding to the lateral loading.

Structural and Material Testing Review

Possible Structural Remediation Strategies





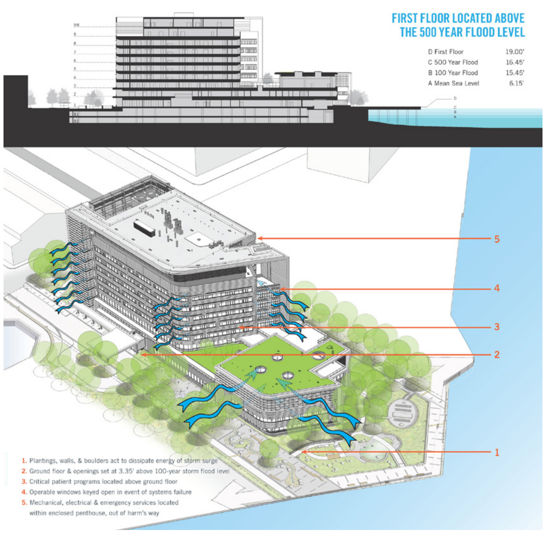


Structural and Material Testing Review

Conclusion

- Overall existing building material seems to be in good to excellent condition (except for the roof).
- Existing piles can remain indefinitely and can carry the building's gravity loads.
- Liquefaction of the soil is not a concern.
- Structure will need to be added to address lateral forces.

Precedent: Spaulding Rehabilitation Hospital, Charlestown Navy Yard



- Spaulding Rehabilitation Hospital in the Charlestown Navy Yard took a very conservative approach to resiliency and located the main floor at 19.0' above BCB which is considered far beyond any city, state or federal requirements. (Source: DGT Associates Surveying & Engineering website)
- Image ©Perkins + Will

Decision Drivers

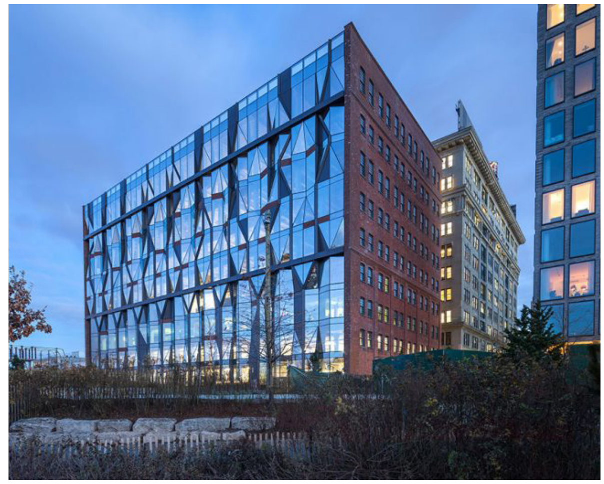
Decision Drivers

“Wow” Factor
User Experience - Exterior to Interior Sequence
Historic Sensitivity / Conservation
Ability to Meet Program
Program Distribution
Flexibility of Use over Time
Ease of Phasing
Design Innovation
Cost [initial, life cycle, proforma]
Constructability
Innovative NPS Public-Private Partnership
Visibility
Workplace Innovation
Security
Phasing [short term and long term]

Decision Drivers

"Wow factor" (Exterior Expression)

- Legibility of program on the exterior
- Memorable first impression (imageability)
- Innovative material use
- Strong relationship to the waterfront and USSC



ODA - 10 JAY ST, BROOKLYN, NY

Decision Drivers

User Experience - Exterior to Interior sequence

- Location of Entry & sequence from exterior to interior
- Variety of scale of interior spaces
- Outdoor spaces
- Quality views

Decision Drivers

Historic Sensitivity/Conservation

- Preserve existing interior
- Preserve existing exterior
- Compelling narrative for preservation
- Maintain community views

Decision Drivers

Ability to Meet Program

- Meets square feet requirements for USSC Museum program
- Meets square feet requirements for orientation program
- Meets square feet requirements for NPS program
- Meets square feet requirements for lease space

192 SHOREHAM STREET, SHEFFIELD, ENGLAND

Decision Drivers

Program Distribution

- Location of program appropriate relative to other programs
- Location of program appropriate relative to site
- Orientation of program appropriate relative to horizontal layout or vertical stack

Decision Drivers

Flexibility of Use Over Time (Adaptability)

- Open floor plates (minimal structural elements)
- Adequate floor to floor heights
- Adequate and evenly distributed natural light

CAIXA FORUM MUSEUM, MADRID, SPAIN

Decision Drivers

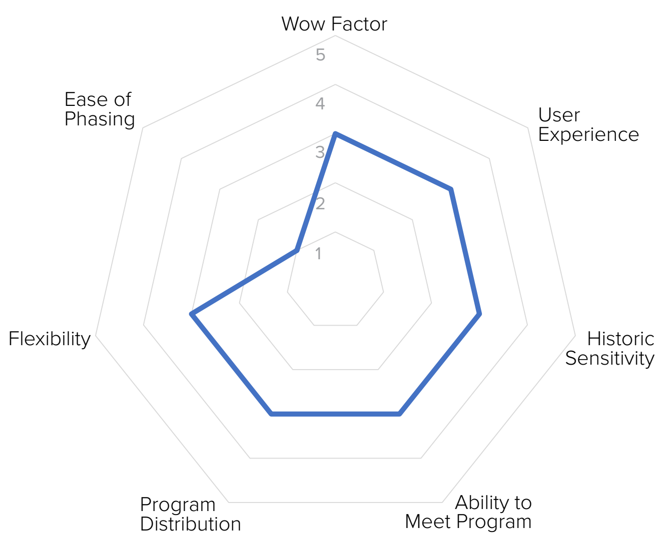
Phasing

- Discrete zones within building
- Discrete massing
- Alignment of building phasing with proforma

TATE MODERN, LONDON, ENGLAND

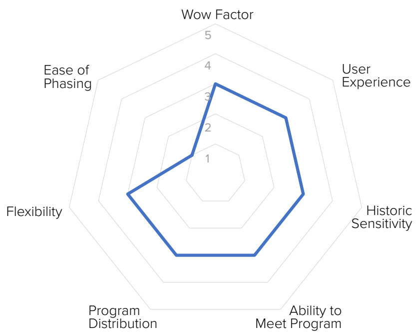
Decision Drivers

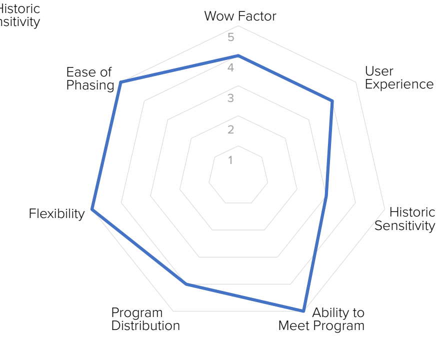
Evaluation

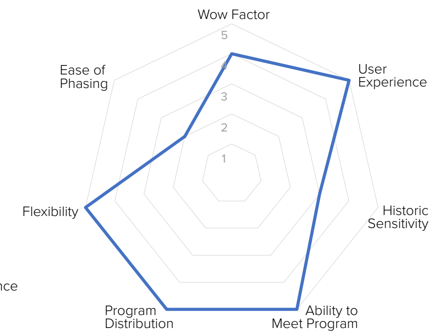


Decision Drivers

Evaluation



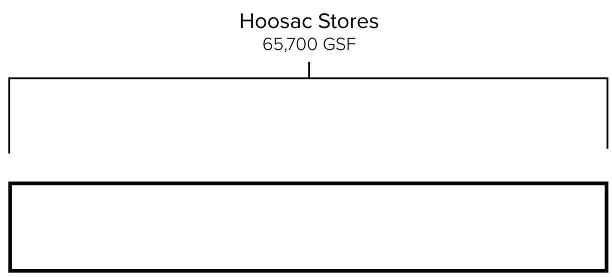




Program Breakdown

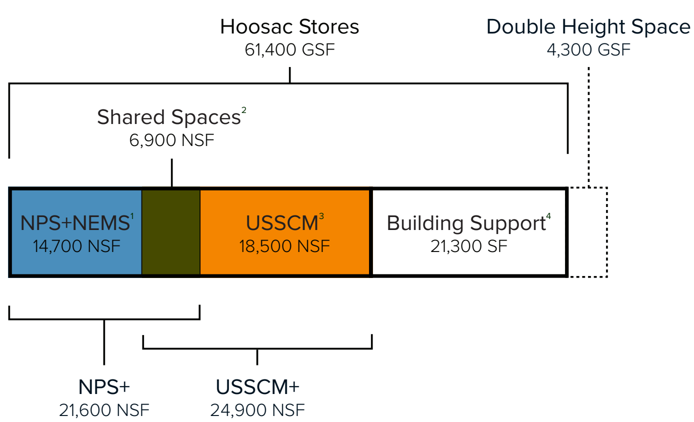
Program Breakdown

Existing Hoosac Stores



Program Breakdown

From Workplace Recommendation Report

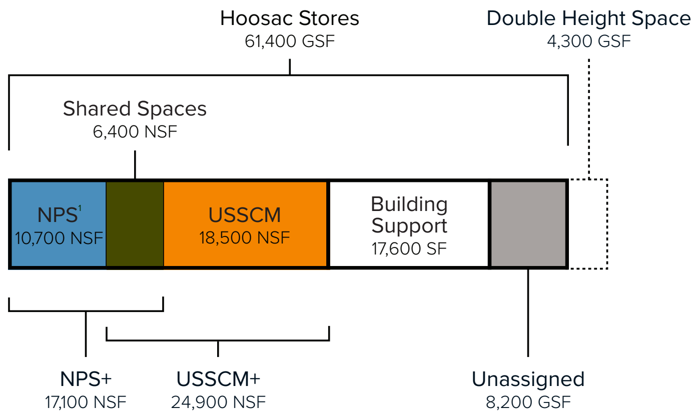


Notes:

1. Includes directorates as indicated in the Workplace Recommendation Report. The Visitor Center remains the same size as the existing.
2. Includes shared meeting spaces and shared resource spaces, including the theater, as indicated in the Workplace Recommendation Report.
3. Based on the existing USSCM as documented by MFA and Jacobs for the Workplace Recommendation Report but using office/workstation standards as provided in the report. Does not reflect any desired future growth.
4. Includes building services that make up gross square footage such as building structure, circulation, restrooms, mechanical space, utility rooms, etc. An efficiency ratio of 70% was used for USSCM space [based on the existing Building 22/28 configuration, excluding basement] and a ratio of 55% was used elsewhere. This will vary as design progresses.

Program Breakdown

Without Northeast Museum Services

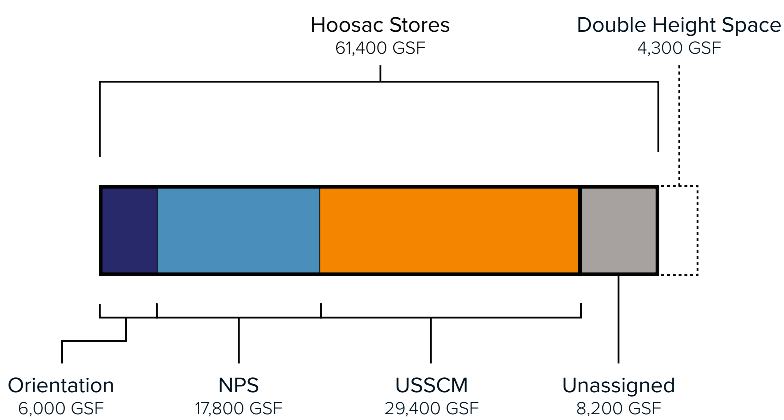


Notes:

1. NEMS is removed from the space as directed by Parks.

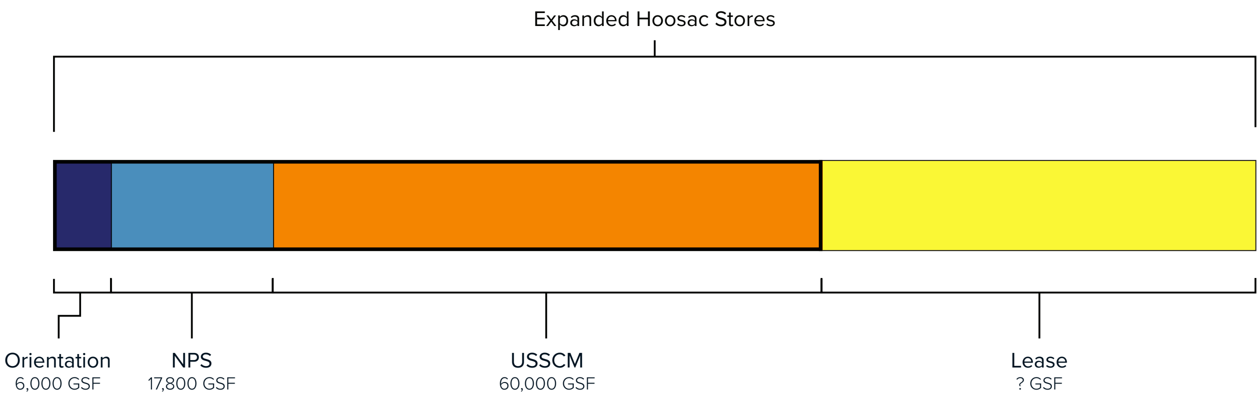
Program Breakdown

GSF



Program Breakdown

Assumed Square Foot Areas for Possible Alternatives (GSF)



Building Precedents and Possible Alternatives

Possible Alternatives

BASELINE: Workplace Recommendation Report

ALTERNATIVE 1: Add Additional Floor

ALTERNATIVE 2: Add Multiple Floors

ALTERNATIVE 3: Partial Removal of Interior, Retain Exterior

ALTERNATIVE 4: Utilize Adjacent Lot - Discrete New Building

ALTERNATIVE 5: Utilize Adjacent Lot - Integrated New Building

ALTERNATIVE 6: Utilize Adjacent Lot - All New Construction

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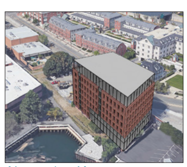
Possible Alternatives


Baseline: Workplace Rec. Report

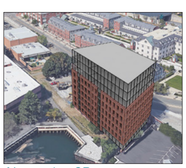

Alternative 1A


Alternative 1B


Alternative 2A


Alternative 2B

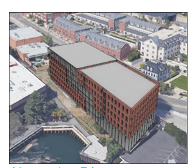

Alternative 3A

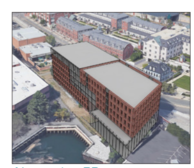

Alternative 3B


Alternative 3C


Alternative 4A


Alternative 4B


Alternative 5A


Alternative 5B


Alternative 5C


Alternative 5D


Alternative 5E


Alternative 6A

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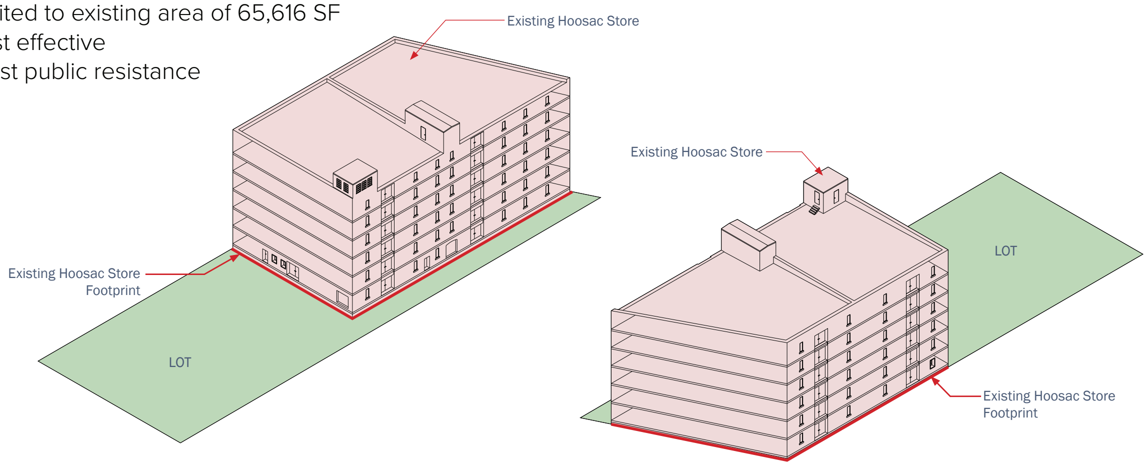
Baseline: Workplace Recommendation Report

Baseline: Workplace Rec. Report

Baseline: Workplace Recommendation Report

- Limited to existing floor to ceiling heights
- Limited to existing area of 65,616 SF
- Cost effective
- Least public resistance



Baseline: Workplace Recommendation Report

The Banknote Building, Bronx, NY

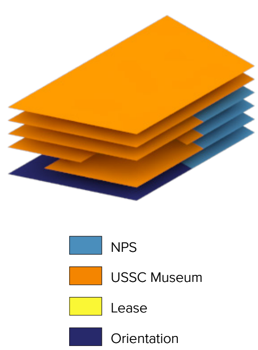
- Built in 1909 / Renovated in 2010
- 420,000 GSF
- Printing Plant -> Mixed-use
- Industrial-scale windows were replaced, flooding expansive interior loft spaces with natural light

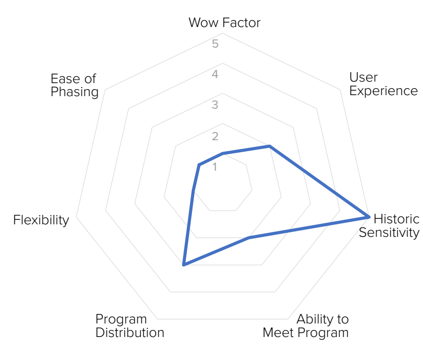
Baseline: Workplace Recommendation Report

Baseline: Workplace Recommendation Report

Baseline: Workplace Recommendation Report

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 37,600 GSF





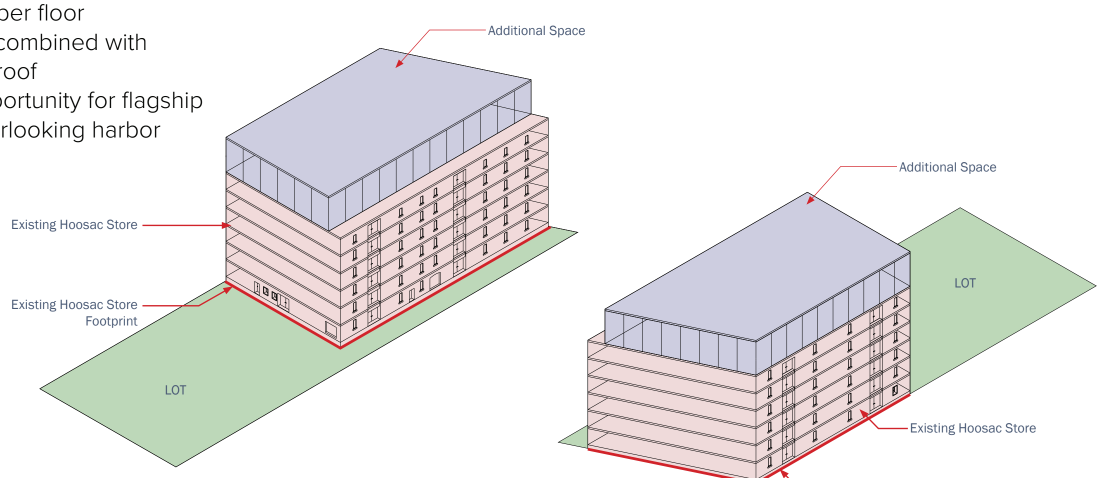
Alternative 1: Add Additional Floor

Alternative 1A

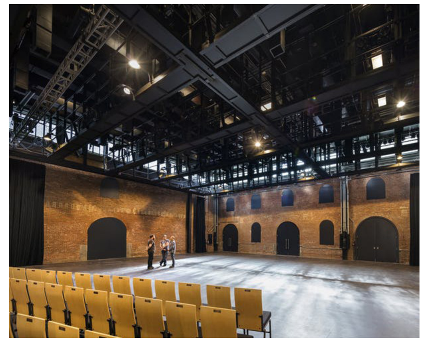
Alternative 1B

Alternative 1: Add Additional Floor

- Increase floor area by approximately 10,000SF per floor
- Could be combined with replacing roof
- Offers opportunity for flagship space overlooking harbor



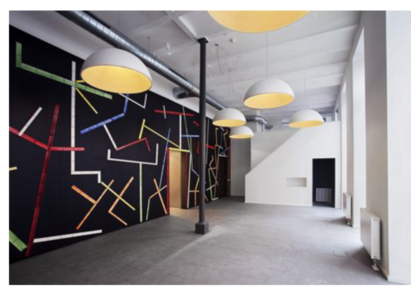
Alternative 1: Add Additional Floor



St. Ann's Warehouse, Brooklyn, NY

- Built in 1860 / Renovated in 2015
- 25,500 GSF
- Tobacco Warehouse -> Art Theater
- An overall discrete volume is inserted snugly into the walls on three sides, allowing the historic arched doors and varied windows to remain untouched

Alternative 1: Add Additional Floor



Kendall Building, Antwerp, Belgium

- Renovated in 2011
- 13,000 GSF
- Warehouse -> Office

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Alternative 1: Add Additional Floor

Alternative 1A

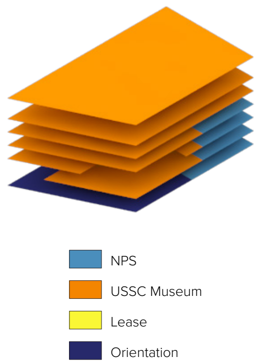
Alternative 1: Add Additional Floor

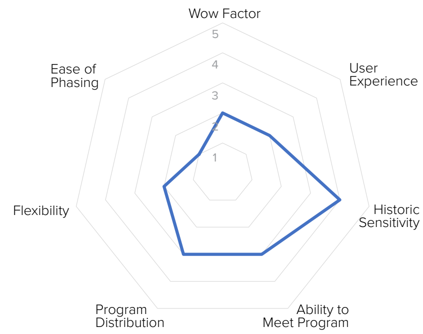
Alternative 1A

Alternative 1: Add Additional Floor

Alternative 1A

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 48,000 GSF





Alternative 1: Add Additional Floor

Alternative 1B

Alternative 1: Add Additional Floor

Alternative 1B

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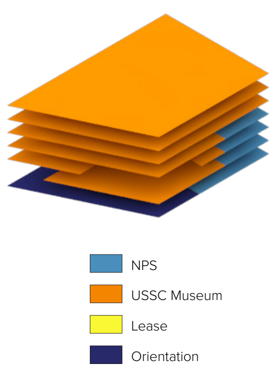
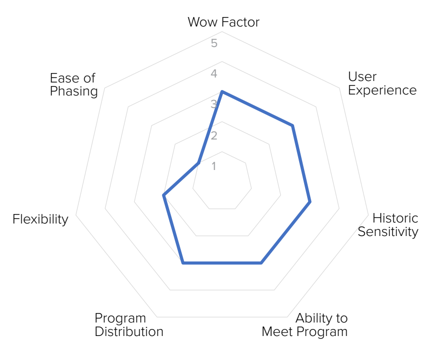
Alternative 1: Add Additional Floor

Alternative 1B

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 57,000 GSF





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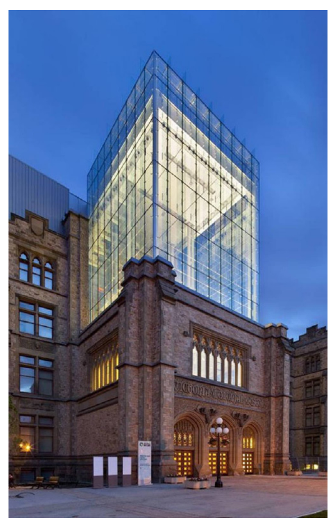
Alternative 2: Add Multiple Floors


Alternative 2A


Alternative 2B

Alternative 2: Add Multiple Floors



Alternative 2: Add Multiple Floors

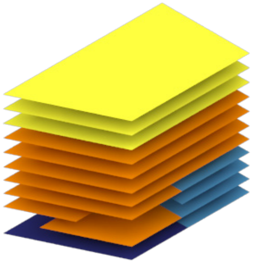
Alternative 2A

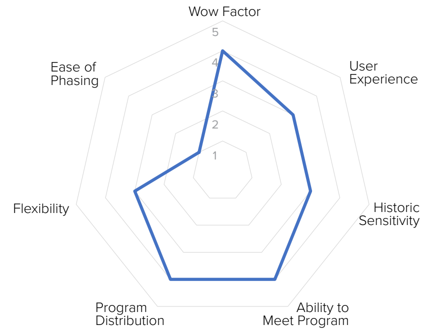
Alternative 2: Add Multiple Floors

Alternative 2A

Alternative 2: Add Multiple Floors

Alternative 2A





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 32,800 GSF

NPS
USSC Museum
Lease
Orientation

Alternative 2: Add Multiple Floors

Alternative 2B

Alternative 2: Add Multiple Floors

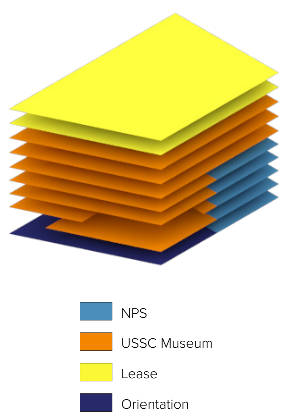
Alternative 2B

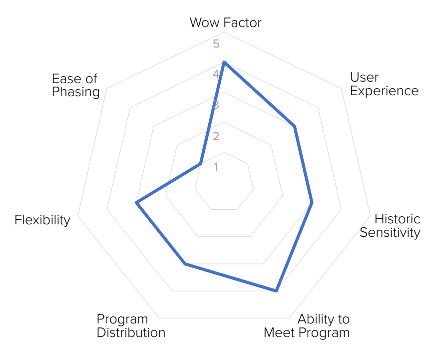
JANUARY 17, 2020 | marble fairbanks | JACOBS | HOOSAC STORES, FEASIBILITY STUDY

Alternative 2: Add Multiple Floors

Alternative 2B

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 38,100 GSF





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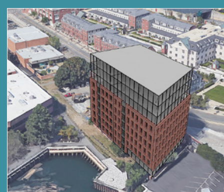
Alternative 3: Partial Removal of Interior, Retain Exterior

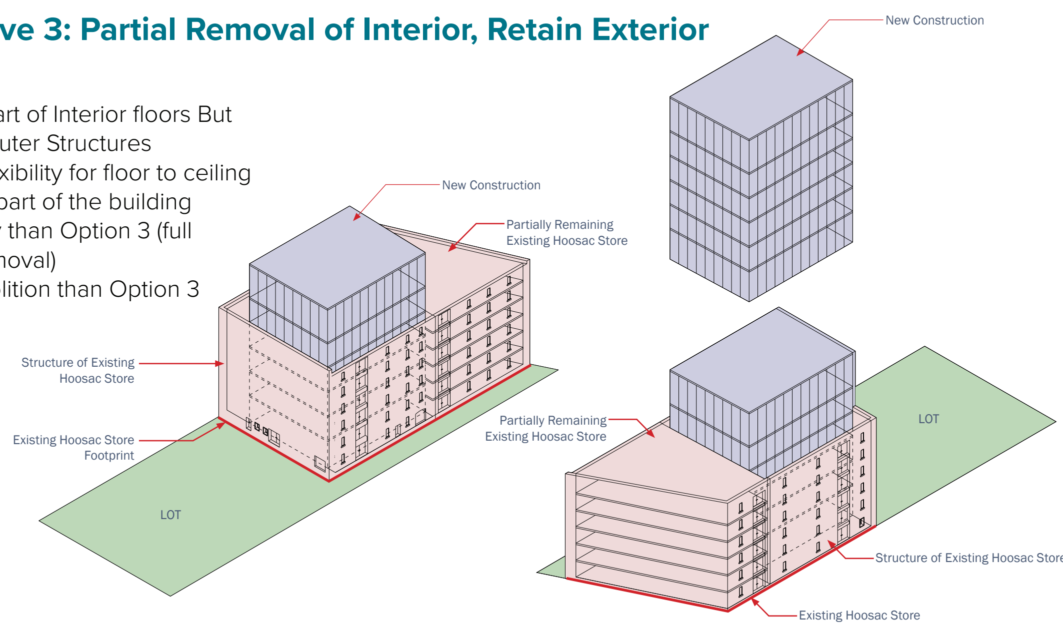

Alternative 3A


Alternative 3B

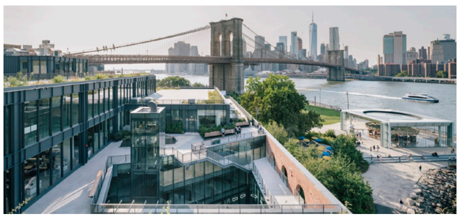

Alternative 3C

Alternative 3: Partial Removal of Interior, Retain Exterior

- Remove part of Interior floors But Keeping Outer Structures
- Provide flexibility for floor to ceiling heights in part of the building
- Less costly than Option 3 (full interior removal)
- Less demolition than Option 3



Alternative 3: Partial Removal of Interior, Retain Exterior



Empire Stores, Brooklyn, NY

- Built in 1869 / Renovated in 2017
- 450,000 GSF.
- Powerhouse -> Mixed-use Complex
- The campaign of adaptive re-use celebrates and preserves the building's monumental presence on the waterfront, while improving circulation between DUMBO's urban fabric and the 85-acre Brooklyn Bridge Park.

Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3A

Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3A

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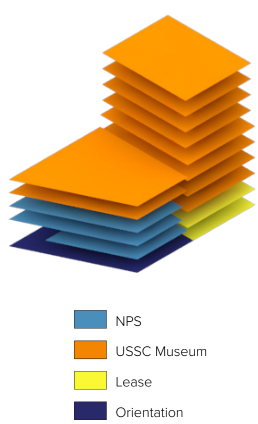
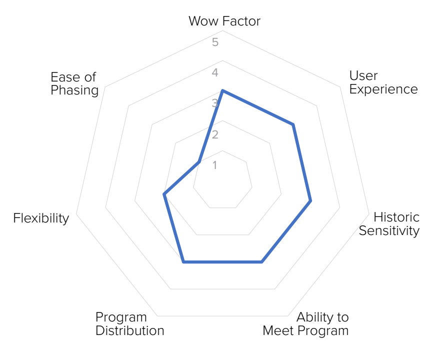
Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3A

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 10,200 GSF





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Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3B

JANUARY 17, 2020 marble fairbanks | JACOBS HOOSAC STORES, FEASIBILITY STUDY

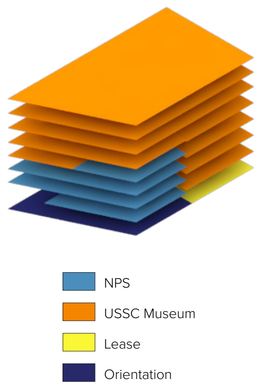
Alternative 3: Partial Removal of Interior, Retain Exterior

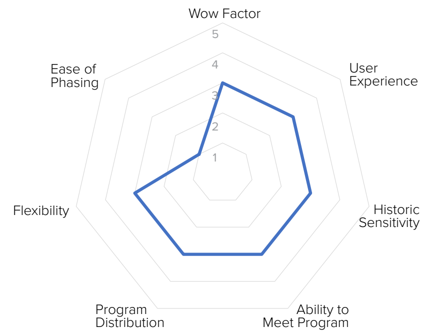
Alternative 3B

JANUARY 17, 2020 marble fairbanks | JACOBS HOOSAC STORES, FEASIBILITY STUDY

Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3B





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 4,800 GSF

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Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3C

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Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3C

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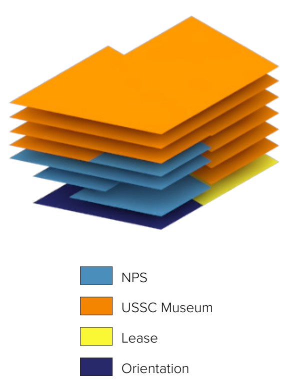
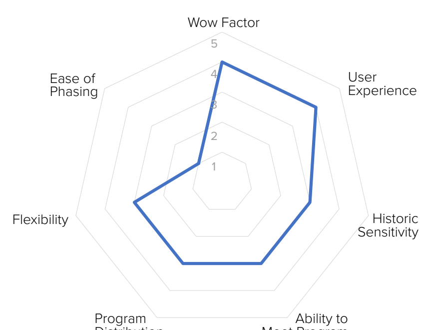
HOOSAC STORES, FEASIBILITY STUDY

Alternative 3: Partial Removal of Interior, Retain Exterior

Alternative 3C

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 5,800 GSF





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HOOSAC STORES, FEASIBILITY STUDY

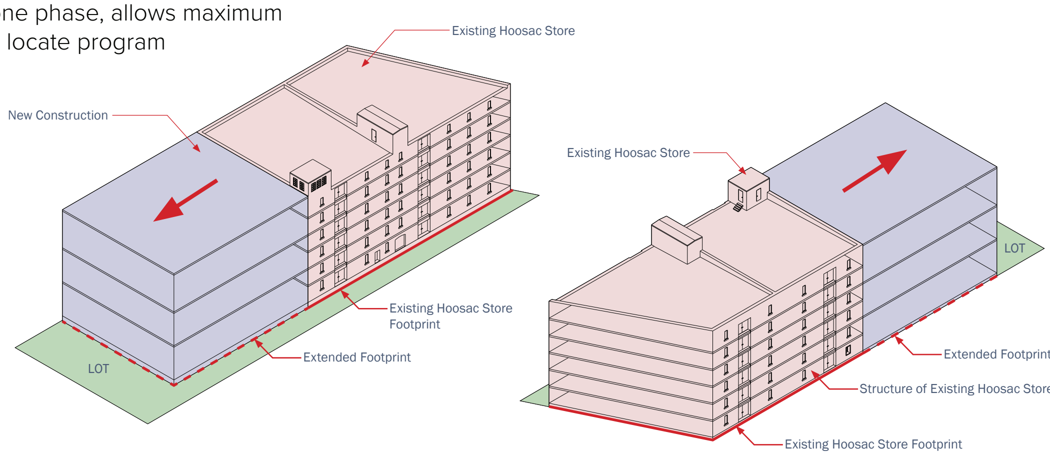
Alternative 4: Utilize Adjacent Lot - Discrete New Building


Alternative 4A

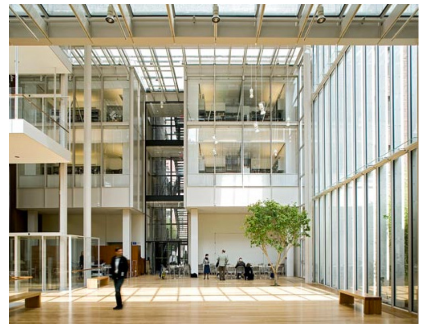

Alternative 4B

Alternative 4: Utilize Adjacent Lot - Separate building

- Maximizes allowable floor area across entire site (requires zoning approval)
- If done in one phase, allows maximum flexibility to locate program



Alternative 4: Utilize Adjacent Lot - Separate building



The Morgan Library & Museum, New York, NY

- Built in 1853 / Renovated in 2012
- 147,000 GSF.
- Library & Museum
- The expansion knits the campus together through the construction of a 72,000 SF modern, skylit atrium, which extends four stories below grade.

Alternative 4: Utilize Adjacent Lot - Separate building

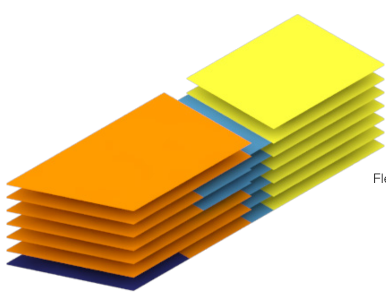
Alternative 4A

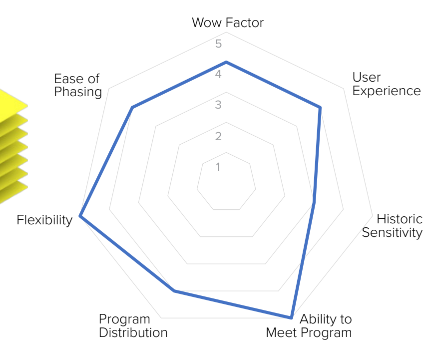
Alternative 4: Utilize Adjacent Lot - Separate building

Alternative 4A

Alternative 4: Utilize Adjacent Lot - Separate building

Alternative 4A





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 61,000 GSF

NPS
USSC Museum
Lease
Orientation

Alternative 4: Utilize Adjacent Lot - Separate building

Alternative 4B

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HOOSAC STORES, FEASIBILITY STUDY

Alternative 4: Utilize Adjacent Lot - Separate building

Alternative 4B

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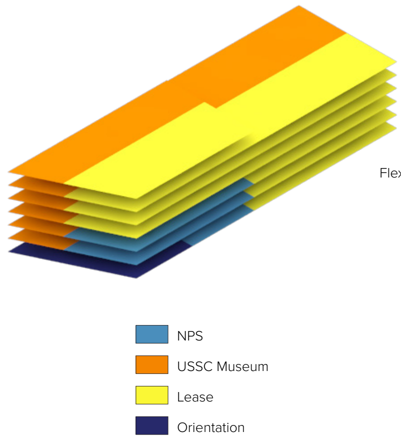
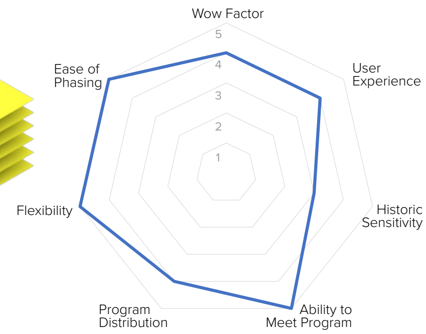
Alternative 4: Utilize Adjacent Lot - Separate building

Alternative 4B





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 61,700 GSF

Alternative 5: Utilize Adjacent Lot - Integrated New Building


Alternative 5A


Alternative 5B


Alternative 5C


Alternative 5D


Alternative 5E

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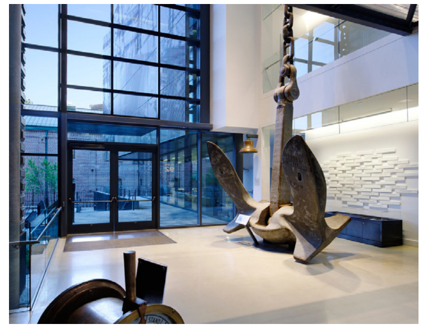
Alternative 5: Utilize Adjacent Lot - Integrated New Building



Building 92, Brooklyn, NY
- Part of Brooklyn Navy Yard
- Built in 1857 / Renovated in 2011
- 32,000 GSF
- Commendant's House -> Museum

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5A

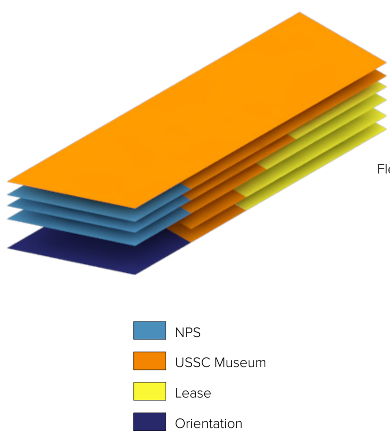
Alternative 5: Utilize Adjacent Lot - Integrated New Building

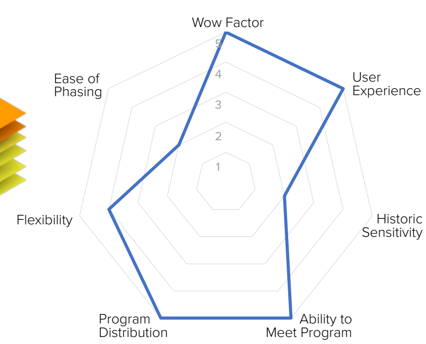
Alternative 5A

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5A

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 38,900 GSF





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HOOSAC STORES, FEASIBILITY STUDY

Alternative 5: Utilize Adjacent Lot - Integrated New Building

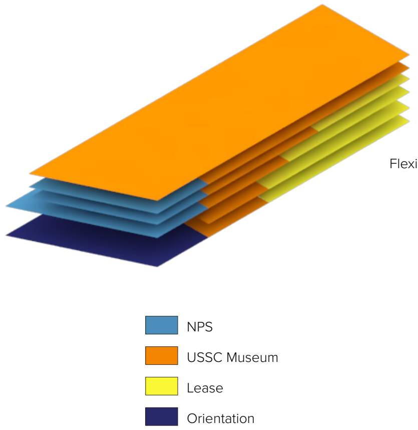
Alternative 5B

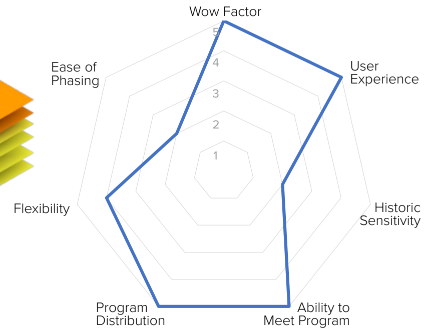
Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5B

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5B





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 38,900 GSF

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5C

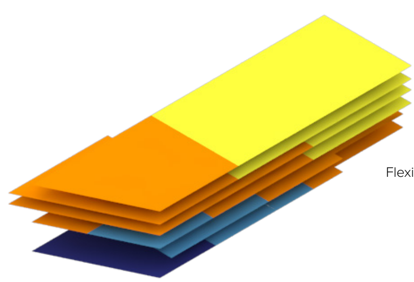
Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5C

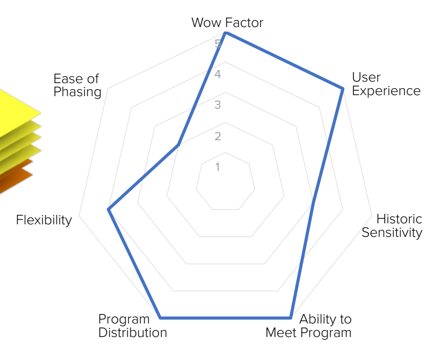
Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5C

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 42,900 GSF



NPS
USSC Museum
Lease
Orientation



Alternative 5: Utilize Adjacent Lot - Integrated New Building

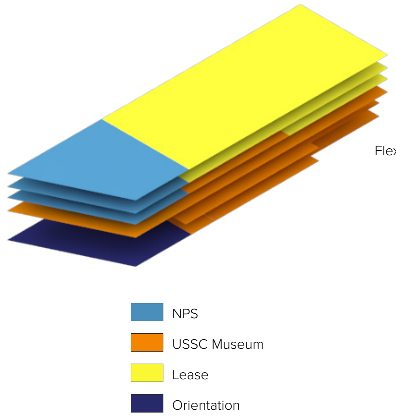
Alternative 5D

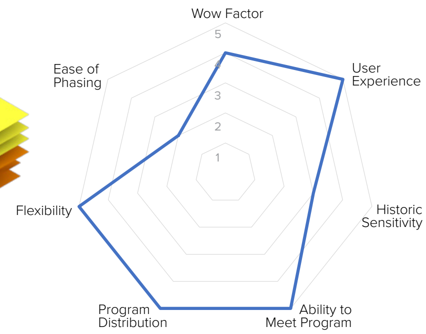
Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5D

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5D





Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 39,200 GSF

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Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5E

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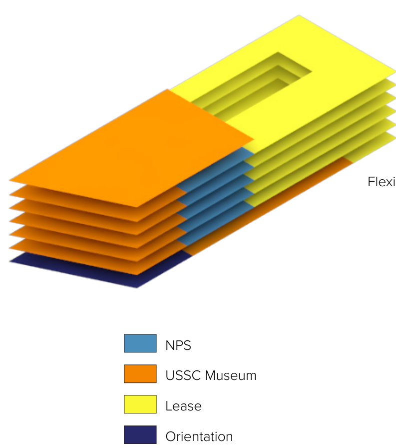
Alternative 5: Utilize Adjacent Lot - Integrated New Building

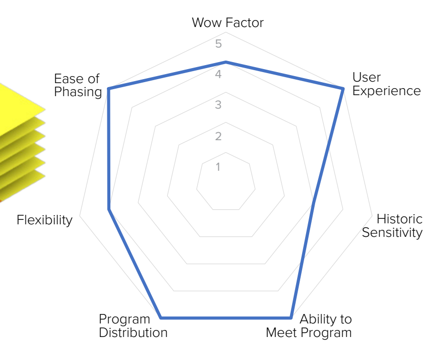
Alternative 5E

Alternative 5: Utilize Adjacent Lot - Integrated New Building

Alternative 5E

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 57,400 GSF





Alternative 6: Utilize Adjacent Lot - All New Construction

Alternative 6A

Alternative 6: Utilize Adjacent Lot - All New Construction

Alternative 6A

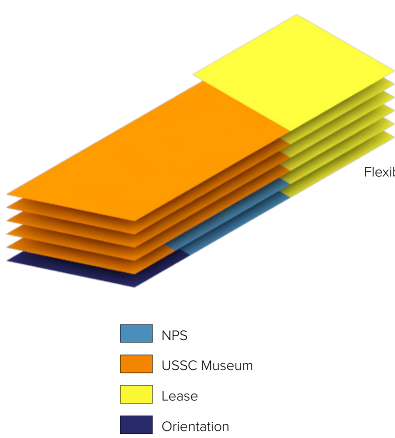
Alternative 6: Utilize Adjacent Lot - All New Construction

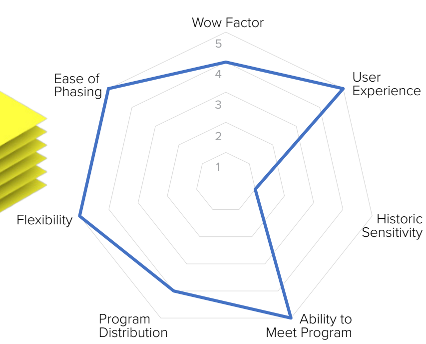
Alternative 6A

Alternative 6: Utilize Adjacent Lot - All New Construction

Alternative 6A

Orientation 6,000 GSF
NPS 17,800 GSF
USSCM 60,000 GSF
Lease 55,300 GSF





Additional Environmental Assessment Work Report

In October through December 2019, BETA performed an environmental site assessment relating to the Hoosac Stores Program Development Study (PDS) and Design-Build Bridging Documents. The Hoosac Stores Building property (the site) is located at 115 Constitution Road in the Charlestown Navy Yard (CNY) in Charlestown, MA and is part of the CNY National Park that is owned and operated by the National Park Service (NPS) Northeast Regional Office. This assessment was performed in accordance with customary principles and practices in the field of environmental science and engineering.

January 2020

Jason Roberts, AIA
Organization Director
Marble Fairbanks
20 Jay Street
Brooklyn, NY 11201

RE: Additional Environmental Assessment Work relating to Hoosac Stores Program Development Study (PDS) and Design-Build Bridging Documents
Hoosac Stores Building
115 Constitution Road
Charlestown Navy Yard
Charlestown, Massachusetts

Dear Mr. Roberts:

BETA Group Inc. is pleased to submit this Environmental Site Assessment for the Hoosac Stores Building property located at 115 Constitution Road in Charlestown, Massachusetts (the site). For a summary of findings, please review the Executive Summary. The Executive Summary should be reviewed in conjunction with the entire report.

Sincerely,

BETA Group, Inc.

Mykel Mendes
Environmental Engineer

Marylou Armstrong, LSP
Vice President

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FIGURES

APPENDICES

1.0 EXECUTIVE SUMMARY

In October through December 2019, BETA performed an environmental site assessment relating to the Hoosac Stores Program Development Study (PDS) and Design-Build Bridging Documents. The Hoosac Stores Building property (the site) is located at 115 Constitution Road in the Charlestown Navy Yard (CNY) in Charlestown, MA and is part of the CNY National Park that is owned and operated by the National Park Service (NPS) Northeast Regional Office. This assessment was performed in accordance with customary principles and practices in the field of environmental science and engineering.

Findings:

The six-story, approximate 60,000 square foot historic Hoosac Stores structure was constructed in 1885 and is part of the Charlestown Navy Yard (CNY) National Park. The structure consists of warehouse / storage space and has a flat roof and two cable-style elevators which are not in service. The exterior of the structure is brick with wood-framed windows and vents. The western portion of the site is improved with a paved parking area, driveway, and small utility shed-like structure. The Hoosac Stores structure was historically utilized as a warehouse for the storage of various goods for freight trade along the Fitchburg Railroad from 1885 until 1981. Since 1981, the NPS has utilized the site for inactive storage for the NPS and USS Constitution Museum.

In October 2019, ageotechnical assessment of the site was conducted as a precursor to the potential redevelopment of the site. Six soil borings were advanced and are identified as B-1, B-2/B-2A, B-3, B-4, and B-6. Three borings (B-1, B-2/B-2A, and B-3) were advanced within the lower level of the Hoosac Stores Building and two borings (B-4 and B-5) were advanced in the western abutting paved parking area.

The geology at the site can be described as variable with fine to coarse sands from depths of 10 to 19 feet below grade surface (bgs), silty clay was observed at depths from 19 to approximately 50 feet bgs. Shallow bedrock and/or tight glacial till was encountered from approximate depths of 30 feet to 49 feet bgs and bedrock was encountered at depths from 79 feet to 84 feet bgs. Groundwater was encountered between 9 and 10 feet bgs.

Composite soil samples were obtained from the six boring locations, noting geologic descriptions, field screening observations, and laboratory analysis. Soil samples were collected for Disposal Qualification (DQ) criteria in accordance with MassDEP Policy COMM-97-01. Soil samples were analyzed for Volatile Organic Compounds (VOCs), Semi-VOCs (SVOCs), Total Petroleum Hydrocarbons (TPH), Polychlorinated Biphenyls, RCRA 5 Metals and Conductivity.

Soil analytical results revealed analyte concentrations below laboratory detection limits or below applicable MassDEP Reportable Concentration for Soil Category 1 (RCS-1) standards, with the exception of Arsenic. Arsenic concentrations were detected above applicable RCS-1 standards from boring location B-6 at 14 to 16 feet bgs.

In accordance with 310 CMR 40.0317(22), the concentrations are considered exempt from notification to MassDEP because they are considered naturally occurring due to the presence of Boston Blue Clay.

On November 22, 2019 BETA supervised a geophysical survey at the site. The survey included ground penetrating radar (GPR), electromagnetic metal (EM) detection, radio frequency and magnetic technologies conducted by TPI Environmental (TPI). Based on the EM/GPR survey, TPI identified a significant metallic anomaly in the northwest corner of the site. GPR transects indicate the anomaly is a steel reinforced concrete slab approximately 1.5 ft. below ground surface. TPI also identified at least three pipe-style anomalies that appeared to be underground utilities. TPI noted there was no evidence of underground storage tanks (USTs).

At the time of BETA's visual inspection in November 2019, BETA observed two vent-like pipes extending from the ground at the eastern exterior portion of the site building and from the roof of the smaller utility shed (located in the paved parking area). Upon closer inspection during the geophysical survey, it was determined that these were either associated with roof drainage and/or with an underground utility.

Recommendations:

BETA is not recommending further investigation at the site at this time. However, if future redevelopment activities require the off-site disposal of soils, appropriate management and disposal practices would be required in accordance with applicable MassDEP regulations and policies.

2.0 HISTORICALLY COMPLETED ENVIRONMENTAL DOCUMENTATION

From March to May 2019, Marble Fairbanks completed a Program Development Study (PDS) with contributions from Jacobs, Public Archaeology Laboratory (PAL), and BETA Group Inc. for the Hoosac Stores Modernization. BETA reviewed this report and historic record sources (Sanborn Fire Insurance Maps and Aerial Photographs) for the presence of potential environmental conditions at the site. Historically completed reports are considered readily available and are not included as attachments to this report, however copies of the Sanborn Fire Insurance Maps and Historic Aerial Photographs are included at attachments in **Appendix A.** The site is outlined and/or highlighted in red on each of the Maps and Photographs attached herein.

2.1 *Hoosac Stores Modernization – PDS Submssion*, dated May 10, 2019 for Submittal 2

Marble Fairbanks completed the PDS Submission for the modernization of the Hoosac Stores Building in March 2019 and later submitted a revision in May 2019. Public Archaeology Laboratory (PAL) prepared the Historic Research and Documentation Memorandum as part of the PDS report.

In summation, PAL identified that the Hoosac Stores No. 1 and No. 2 building was constructed in 1885. In 1985, Hoosac Stores No. 1 and No. 2 and Hoosac Stores 3 were listed in the National Register as historic resources (although Hoosac Stores 3 has since been razed).

The building complex was initially constructed for and utilized for active warehouse storage for the Fitchburg Railroad. The Fitchburg Railroad was incorporated in 1842 and extended the line into the CNY in 1863 for munitions delivery during the Civil War. In 1870, the Fitchburg Railroad purchased the wharves near the CNY, which at the time were utilized for ice trade. In 1879, the Hoosac Tunnel Dock and Elevator Company built a wharf between the CNY to the east for the storage and shipment of goods transported to Boston via the Hoosac Tunnel (the Hoosac Tunnel was located in North Adams, MA). This allowed for the shipment of grain, livestock, sugar and various other goods. As freight along the Railroad increased, the Hoosac Tunnel Dock and Elevator Company constructed Hoosac Stores No.1 and No.2 in 1895. In the 1930s, goods such as wood pulp, cotton, canned goods, liquor, coffee, tea, and rubber were stored in the Hoosac Stores No.1 and No.2. As the Navy expanded, Hoosac Stores 3 was razed for a parking lot for visitors of the USS Constitution. As rail trade declined, W.F. Schrafft & Sons Company purchased the Hoosac Stores building and the building was utilized as warehouse storage of confectionary goods until 1981 when NPS acquired the property by eminent domain. Since the acquisition, the NPS has continued to utilize the building for inactive storage for several organizations and the USS Constitution Museum and the surrounding area has been largely redeveloped since the decommissioning of the CNY.

2.2 Historic Sanborn Fire Insurance Maps

BETA reviewed Historic Sanborn Fire Insurance Maps of the site dated 1888, 1900, 1927, 1950, 1964, 1989, 1990, 1993, 1994, 1995, 1996, 1998, and 2002.

The 1888 map depicts an additional building identified as "Store 3 – Corrugated Iron Sides" that appeared to share the site building's western facing wall. The site building complex is identified as being occupied by Gage's Stores No.1 and No.2 and listed as "U.S. Bonded Ware Houses".

The 1900 map depicts the site as occupied as "Hoosac No. 2" and the former "Store 3" as no longer extant.

The 1927 map depicts the site as "Hoosac Stores No. 1 and No.2" and an additional building identified as a "Battery Charging Station" is depicted immediately west of the Hoosac building complex.

The 1950 map depicts the site similarly to current/existing conditions with one exception, there appears to be a smaller additional building abutting the (current) small utility shed located in the paved parking area of the site.

The 1964 map no longer depicts this additional building.

The 1989 to 1996 maps depict the site as it presently appears, however a steel and concrete viaduct is depicted immediately north of the site. The site vicinity (as depicted) in the map dated 1998 would indicate that this viaduct was razed between 1996 and 1998 and/or relocated to the present-day steel and concrete viaduct that connects motor vehicle traffic to the presently named Tobin Bridge.

The 2002 map depicts the site and the site vicinity similarly to present/current conditions; however, the area immediately north of the site shows minimal development in comparison to present/existing conditions.

Each of the Sanborn Maps reviewed identified unique building construction characteristics, including an automatic fire alarm system, wall openings equipped with a standard fire door and/or iron clad door, 20 inch thick sidewalls, windows with wired glass on each floor, wood post beams, and an open elevator on the southern portion of the building.

BETA's review of the Sanborn Fire Insurance Maps did not reveal evidence of potential environmental conditions.

2.3 Historic Aerial Photographs

BETA reviewed historic aerial photographs dated 1938, 1946, 1952, 1955, 1960, 1969, 1970, 1978, 1980, 1985, 1995, 2008, 2012 and 2016. The photographs dated 2016, 2012, and 2008 depict the site with similar conditions to those observed during BETA's November 2019 visual assessment with one exception. The USS Constitution (usually located immediately south of the site) is pictured as being in dry-dock in 2012.

Photographs dated 1938 through 1970 depict the site as it is presently observed, however the site vicinity is significantly developed with US Navy improvements following World War II. Photographs dated from 1978 through 1995 depict the site vicinity with additional development over time following the decommissioning of the of the CNY in 1974 and the acquisition of the CNY by NPS in 1981.

3.0 SITE DESCRIPTION

The six-story, approximate 60,000 square foot historic Hoosac Stores structure was constructed in 1895 and consists of warehouse / storage space. The structure which is part of the Charlestown Navy Yard National Park, has a flat roof and two cable-style elevators which are not in service. The exterior of the structure is brick with wood-framed windows and vents.

The western portion of the site is improved by a paved parking area, driveway, and small utility shed-like structure. A restricted parking area for the USS Constitution abuts the site immediately to the east. The historic Freedom Trail along Constitution Avenue abuts the site to the north and portions of the former Fitchburg Freight Railroad tracks (buried in grass) and the Charlestown Navy Yard Harborwalk abuts the site to the south and southeast. The site offers scenic views of the USS Constitution and Boston Harbor. Refer to **Appendix B** for site photographs documented in November 2019.

At the time of BETA's November 2019 inspection, the structure and site were vacant, however significant pedestrian traffic within the site vicinity was observed. BETA was escorted by NPS personnel at the time of the visual inspection. BETA observed two vent-like pipes extending from the ground at the eastern exterior portion of the site building and from the roof of the smaller utility shed (located in the paved parking area). Upon closer inspection during the geophysical survey, it was determined that these were either associated with roof drainage and/or with an underground utility.

The site appears on the United States Geological Survey (USGS) Topographic Quadrangle – Boston-South. See **Figure 1** - Site Location and **Figure 2** – Site Plan for details.

4.0 SUBSURFACE EXPLORATION

4.1 Geophysical Survey

On November 22, 2019 BETA supervised a geophysical survey via ground penetrating radar (GPR) and electromagnetic metal (EM) detection, radio frequency and magnetic technologies conducted by TPI Environmental (TPI). The survey was conducted to identify underground utilities and other structures (if any) that could potentially pose a risk or concern to the environment. A representative from the National Park Service (NPS) was on-site to escort TPI and BETA to restricted portions of the site.

Based on the EM/GPR survey, TPI identified one 50 ft. by 16 ft. significant metallic anomaly in the northwest corner of the site, however GPR transects indicated the anomaly was a steel reinforced concrete slab at approximately 1.5 ft. below ground surface. At least three pipe-style anomalies that appeared to be underground utilities were also identified, two of which were associated with existing and/or former water lines. TPI noted there was no evidence of underground storage tanks (USTs).

There were no additional anomalies observed within the site area that indicated potential underground structures. TPI conducted a utility scan of the southern portion of the site, however there was significant interference as a result of the steel rails from the former Fitchburg Rail Road. However, underground structures, such as a USTs, would not typically be located under a rail line and the rail tracks were constructed circa 1835. The potential presence of subsurface structures remains, and care should be taken during all future excavation and/or renovation activities.

Refer to the Geophysical Survey Report for additional details included in **Appendix C**.

4.2 Geotechnical Assessment / Exploration

In October 2019, Jacobs Engineering Group (Jacobs) conducted a geotechnical assessment of the site as a precursor to the potential redevelopment of the site. Jacobs supervised the advancement of six soil borings identified as B-1, B-2/B-2A, B-3, B-4, and B-6. Three borings (B-1, B-2/B-2A, and B-3) were advanced within the lower level of the Hoosac Stores Building and two borings (B-4, and B-5) were advanced within the western paved parking area. Refer to Figure 2 – Site Plan. Drilling activities were conducted by New England Boring Contractors Inc. via hollow-stem rotary auger and rotary-wash and standard rock-coring drilling methods with casing. It is BETA’s understanding that Jacobs preselected the six boring locations based on areas of proposed development and known underground utility location. However, only five were advanced due to encountering refusal.

Soil borings were advanced to a maximum depth of 94 feet below ground surface (bgs). Several boring locations were only advanced to depths ranging from 40 feet to 83 feet bgs. Monitoring wells were not installed. Refer to **Appendix D** for the boring logs completed by Jacobs for their Hoosac Structural Rehabilitation Strategies Report.

Soil Borings B-2, B-2A and B-3 were advanced within the lower floor of the Site building and soil borings B-4 and B-6 were advanced within the western paved parking area. Refer to Figure 2 for the soil boring locations and additional site details.

The geology at the site can be described as variable with fine to coarse sands from depths of 10 to 19 feet bgs, silty clay was observed at depths from 19 to approximately 50 feet bgs. Shallow bedrock and/or tight glacial till was encountered from approximate depths of 30 feet to 49 feet bgs and bedrock was encountered at depths from 79 feet to 84 feet bgs. Groundwater was encountered between 9 and 10 feet bgs as observed during the boring advancement. Refer to **Appendix D** –Boring Logs for additional details regarding the site’s geology.

5.0 HYDROGEOLOGICAL SETTING

According to the USGS Topographic Quadrangle – Boston- South, elevation at the site has a range of approximately 6 - 15 feet above mean sea level (MSL). The highest areas of elevation are on the north-northwestern portions of the site near Constitution Road. The topography of the site can be categorized as flat. The lowest area of elevation of the site is in the vicinity of the southeastern corner of the building – closest to Boston Harbor. See **Figure 2** – Site Plan for details. Determination of empirical ground water flow direction was beyond the scope of this assessment; however it can be inferred that groundwater may flow to the south-southeast towards Boston Harbor.

BETA's review of the Massachusetts 21E Resources Map revealed the site is not located in a USEPA-designated or MassDEP-designated Water Resource Area, however the site is located within a 100-year FEMA designated Floodplain. Please refer to **Figure 3**.

6.0 MCP REPORTING CATEGORIES

As noted, BETA's review of the Massachusetts GIS Priority Resources (21E) Map revealed that the site is not located within a USEPA or MassDEP-designated water resource area. Therefore, groundwater at the site is classified as the MCP Method 1 Groundwater Category 2 (GW-2). Applicable groundwater standards are MCP Reportable Concentration for Groundwater Category 2 (RCGW-2) standards.

The Hoosac Stores Building is not occupied however, it is located within 500 feet of residential dwellings and a child day-care facility, therefore, the MCP Reportable Concentration for Soil Category 1 (RCS-1) is applicable to the site and for any future use/redevelopment the MCP Method 1 Soil Standard (S-1) should be applied.

7.0 SAMPLING & SCREENING

7.1 Soil Sampling

Soil sampling was conducted with a split spoon sampler at five-foot intervals until glacial till was encountered. Soil samples were obtained from the six boring locations, (B-1, B-2/B-2B, B-3, B-4, and B-6) noting geologic descriptions, field screening observations, and laboratory analysis. Composite soil samples collected from B-3 (4'-6') and (14'-16'), B-4 (4'-6') and (14'-16'), and B-6 (4'-6') and (14'-16'), were submitted for laboratory analysis. Soil samples from each boring were field screened for evidence of potential contamination utilizing olfactory, and visual techniques.

The composite soil samples were collected for soil disposal qualification (DQ) criteria following MassDEP Policy # COMM-97-001 which included laboratory analysis for Volatile Organic Compounds (VOCs), Semi-VOCs, Total Petroleum Hydrocarbons (TPH), Polychlorinated Biphenyls (PCBs), RCRA 5 Metals and Conductivity.

These samples were collected specifically for disposal criteria analysis to document soil conditions in the event that future redevelopment activities require the off-site disposal of soils. Refer to **Appendix E** for the complete laboratory analytical report.

8.0 SAMPLE ANALYSIS

Soil samples were analyzed for VOCs, SVOCs, TPH, RCRA 5 Metals, PCBs, and soil chemistry parameters (following the MassDEP Policy #COMM-97-001).

8.1 Soil Analysis

Soil analytical results did not reveal PCB concentrations above laboratory reporting limits from the three soil sampling locations, however the analytical results did reveal detectable concentrations of select VOCs, SVOCs, TPH, and Metals; these concentrations were below the applicable RCS-1 Soil Standards with one exception. Arsenic concentrations exceeded the applicable MassDEP RCS-1 standard from soil boring location B-6 at depths 14 feet to 16 feet bgs. However, this exceedance is exempt from notification to MassDEP pursuant to MassDEP *"Historic Fill/Anthropogenic Background Public Comment DRAFT Technical Update*, dated May 24, 2016"

> *"Elevated arsenic concentrations may be due to naturally occurring in the soil (central Massachusetts), from sediment fill (Boston blue clay), due to the application of pesticides or from coal ash. Beryllium, cadmium, copper, nickel and zinc are not likely to trigger risk thresholds at levels typically found in fill. While the Boston Blue clay can contain arsenic up to 75 mg/kg, (Swanson & Lamie, 2007), higher concentrations outside of central and northeastern Massachusetts "arsenic belt", could indicate pesticide and/or coal ash as the source."*

310 CMR 40.0317(22) provides:

40.0317: Releases and Threats of Release Which Do Not Require Notification
Notwithstanding the provisions of 310 CMR 40.0311 through 40.0315, the following releases and threats of release of oil and/or hazardous material are exempt from the notification requirements set forth in 310 CMR 40.0300:

(22) arsenic, beryllium or nickel in Boston Blue Clay or arsenic in an area documented by the U.S. Geological Survey or in other scientific literature as an area of elevated arsenic measured in soil or groundwater that
(a) is consistently present in the environment at and in the vicinity of the sampling location;
(b) is solely attributable to natural geologic or ecologic conditions; and
(c) has not been mobilized or transferred to another environmental medium or increased in concentration in an environmental medium as a result of anthropogenic activities.

BETA's records research efforts have revealed that the site had been occupied by the former Fitchburg rail line and utilized as active warehouse storage until 1981 when it was acquired by the NPS and utilized for inactive storage.

As previously mentioned, the Hoosac Stores 1 & 2 buildings stored canned goods, liquor, coffee, tea, rubber, and grain. There are no known on-site sources of arsenic or known evidence of historical on-site uses or generation of arsenic or arsenic products. Additionally, the soil borings document the significant presence of Boston Blue Clay from each of the six borings. The thickness of the Boston Blue Clay varied from 15 to 30 feet and increased at locations further away from the building, specifically Boring B-6. Per USGS geochemical and mineralogical data published in 2014, arsenic is commonly present within the soil C horizon; the soil C horizon is the layer of soil that lies just above the bedrock and as previously mentioned Jacobs boring logs document the presence of shallow bedrock/glacial till at approximately 30 to 49 feet bgs.

Based upon the above referenced citation from MassDEP's Technical Update, 310 CMR 40.0317(22), the arsenic exceedance is exempt from notification to MassDEP.

Response actions are not warranted because the elevated Arsenic does not pose a significant risk to health, safety, public welfare, or the environment, given the depth from which the soil data was collected (14 to 16 feet below the ground surface). However, appropriate soil management and disposal practices should be implemented during future redevelopment activities that would require disposal of soil off-site.

Refer to **Table 1** for the soil analytical data and **Appendix C** for the laboratory analytical reports.

9.0 REPORT LIMITATIONS

This project was performed in accordance with customary principles and practices in the field of environmental science.

This environmental assessment was commissioned to establish if concentrations of oil or hazardous material are present at the site as part of an ongoing redevelopment feasibility study. This statement is in lieu of all other statements either expressed or implied.

This environmental assessment is inherently limited in the sense that conclusions are drawn, and recommendations are developed from sampling and analysis operating procedures which are inherently limited with respect to accuracy, representativeness and repeatability.

In addition, the completion of further subsurface exploration through renovation activities could reveal conditions not revealed in this assessment. This report does not warrant against conditions present of a type, or at a location not investigated.

10.0 REFERENCES

Massachusetts Department of Environmental Protection. *Historic Fill/Anthropogenic Background Public Comment DRAFT Technical Update*. Technical Draft. Version 1.0, May 24, 2016.

Massachusetts Department of Environmental Protection. *The Massachusetts Contingency Plan (MCP) – 310 CMR 40.0000.* April 25, 2014.

Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, and Ellefsen, K.J., 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014–1082, 386 p., *https://dx.doi.org/10.3133/ofr20141082*.

United States Geological Survey (USGS). National Water-Quality Assessment (NAWQA) Project.

TABLES

Table 1 - Soil Analytical Data Summary - October 2019
Hoosac Stores Building
Charlestown Navy Yard
115 Constitution Road, Charlestown, MA

SAMPLE ID	**B-3**	**B-4**	**B-6**	**MCP Method 1 RCS-1 Soil Standards**
LAB SAMPLE ID	19J1001-01	19J1001-02	19J1001-03	
SAMPLE DATE	10/17/2019	10/17/2019	10/17/2019	
SAMPLE DEPTH (FEET)	4-6 / 14-16	4-6 / 14-16	4-6 / 14-16	
UNITS	mg/kg	mg/kg	mg/kg	mg/kg
Volatile Organic Compounds (VOCs)				
1,1-Dichloroethane	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	0.4
1,4-Dioxane	BRL (<0.119)	BRL (<0.164)	BRL (<0.0867)	0.2
Acetone	BRL (<0.119)	0.0998	BRL (<0.0867)	6
Benzene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	2
Diethyl Ether	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	100
Di-isopropyl ether	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	100
Ethyl tertiary-butyl ether	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	NE
Ethylbenzene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	40
Isopropylbenzene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	1000
Methyl tert-Butyl Ether	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	0.1
Methylene Chloride	BRL (<0.119)	BRL (<0.164)	BRL (<0.0087)	0.1
Naphthalene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	4
Tertiary-amyl methyl ether	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	NE
Tetrachloroethene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	1
Trichloroethene	BRL (<0.0059)	BRL (<0.0082)	BRL (<0.0043)	0.3
Vinyl Chloride	BRL (<0.119)	BRL (<0.164)	BRL (<0.0087)	0.7
Xylenes (Total)	BRL (<0.119)	BRL (<0.164)	BRL (<0.00867)	100
Semi-Volatile Organic Compounds (SVOCs)				
Acenaphthene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	4
Acenaphthylene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	1
Acetophenone	BRL (<0.799)	BRL (<0.892)	BRl (<0.837)	1000
Anthracene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	1000
Benzo(a)anthracene	BRL (<0.399)	BRL (<0.445)	0.53	7
Benzo(a)pyrene	BRL (<0.2)	BRL (<0.223)	0.445	2
Benzo(b)fluoranthene	BRL (<0.399)	BRL (<0.445)	0.459	7
Benzo(g,h,i)perylene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	1000
Benzo(k)fluoranthene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	70
Chrysene	BRL (<0.2)	BRL (<0.223)	0.507	70
Dibenzo(a,h)Anthracene	BRL (<0.2)	BRL (<0.223)	BRL (<0.21)	0.7
Fluoranthene	BRL (<0.399)	BRL (<0.445)	1.17	1000
Fluorene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	1000
Hexachloroethane	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	0.7
Indeno(1,2,3-cd)Pyrene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	7
Naphthalene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	4
Nitrobenzene	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	500
N-Nitrosodimethylamine	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	50
Phenanthrene	BRL (<0.399)	BRL (<0.445)	0.912	10
Phenol	BRL (<0.399)	BRL (<0.445)	BRL (<0.418)	1
Pyrene	BRL (<0.399)	BRL (<0.445)	1.03	1000
Total Petroleum Hydrocarbons - (TPH)				
Total Petroleum Hydrocarbons	31.4	16.8	148	1000

1 of 2

Table 1 - Soil Analytical Data Summary - October 2019
Hoosac Stores Building
Charlestown Navy Yard
115 Constitution Road, Charlestown, MA

SAMPLE ID	B-3	B-4	B-6	MCP Method 1 RCS-1 Soil Standards
LAB SAMPLE ID	19J1001-01	19J1001-02	19J1001-03	
SAMPLE DATE	10/17/2019	10/17/2019	10/17/2019	
SAMPLE DEPTH (FEET)	4-6 / 14-16	4-6 / 14-16	4-6 / 14-16	
UNITS	mg/kg	mg/kg	mg/kg	mg/kg
Total Metals				
Arsenic	3.46	9.22	**21**	**20**
Cadmium	BRL (<0.39)	BRL (<0.39)	BRL (<0.57)	70
Chromium	10.9	37.5	36.7	100
Lead	80.9	9.03	8.98	200
Mercury	1.73	BRL (<0.027)	BRL (<0.015)	20
Polychlorinated Biphenyls (PCBs)				
Aroclor 1016	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1221	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1232	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1242	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1248	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1254	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1260	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1262	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Aroclor 1268	BRL (<0.06)	BRL (<0.07)	BRL (<0.06)	1
Classical Chemistry (umhos/cm)				
Conductivity	1940	4380	3480	NE

Notes:
1. BRL : Below Laboratory Reporting Limits
2. Concentrations are in miligrams per kilogram (mg/kg) with the exception of units of conductivity, which are measured in micromho per centimeter.
3. Concentrations of VOCs are a representative of the soil sample collected from four to six feet below ground surface (bgs).
4. Concentrations of SVOCs, TPH, PCBs, Total Metals, and Soil Chemistry parameters are a representative of the soil sample collected from 14 to 16 feet bgs.

2 of 2

FIGURES

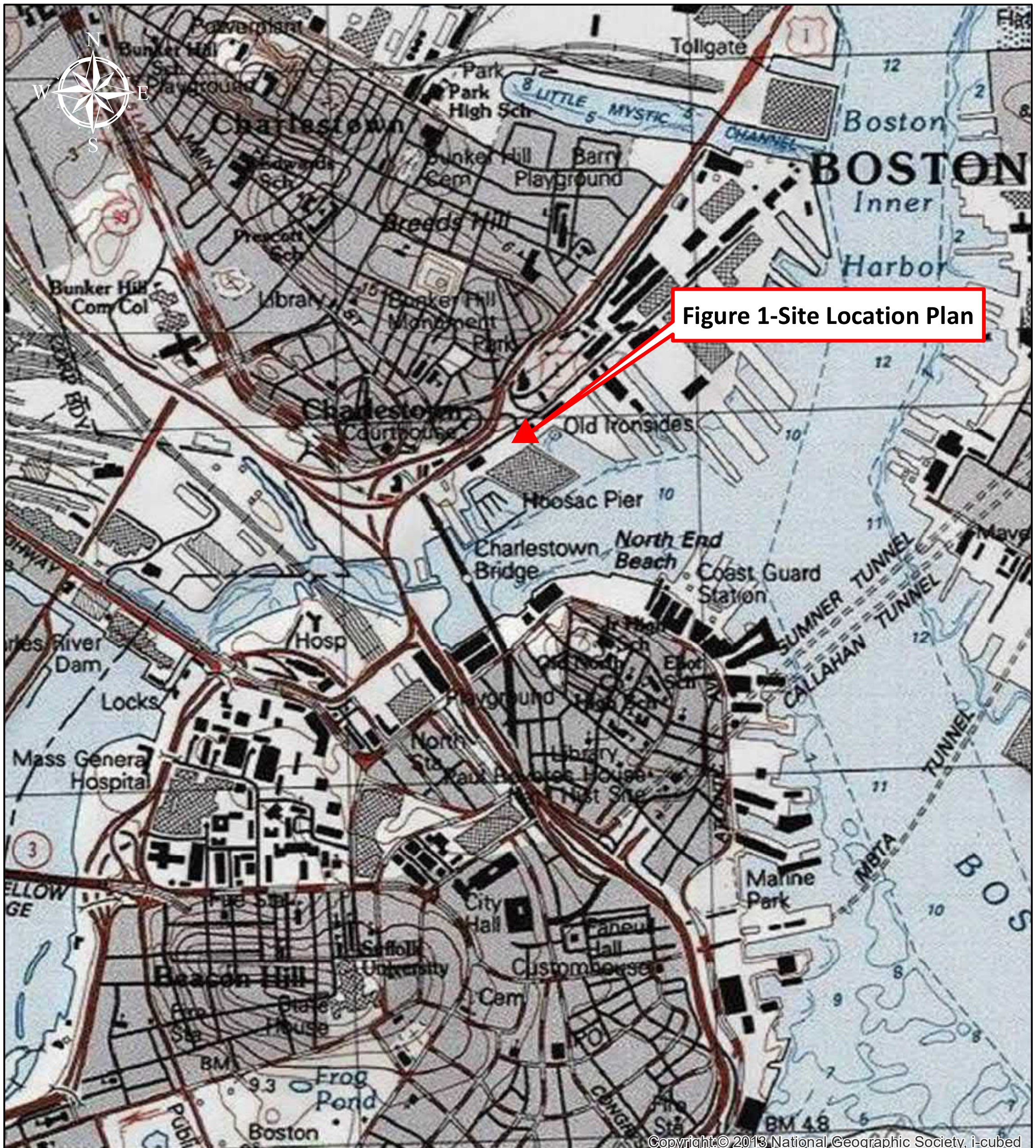


Figure 1-Site Location Plan

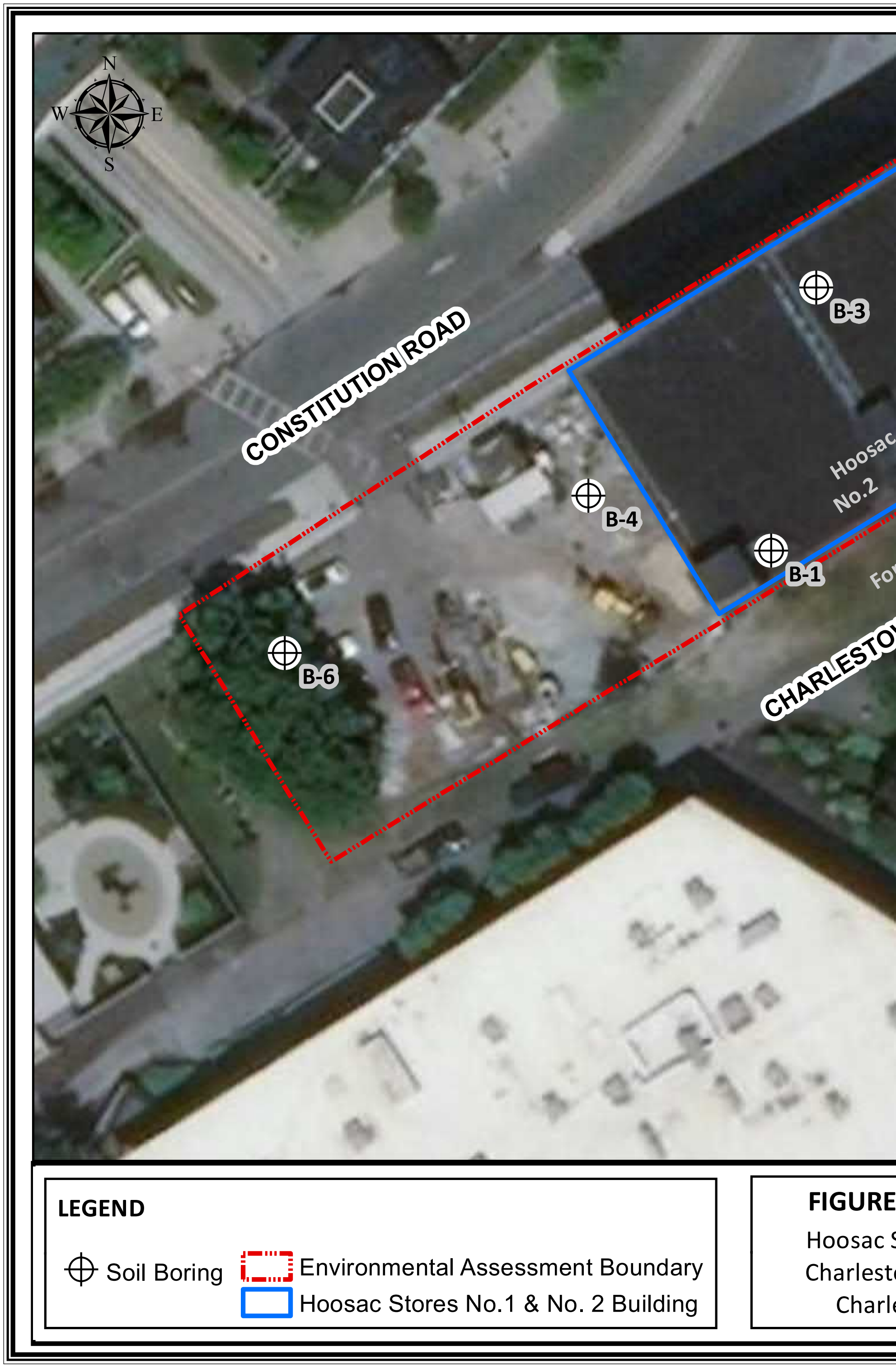
Hoosac Stores No.1 and No.2
Charlestown Navy Yard
115 Constitution Road
Charlestown, MA

Longitude: 42° 22' 21.212"
Latitude: 71° 3' 28.244"

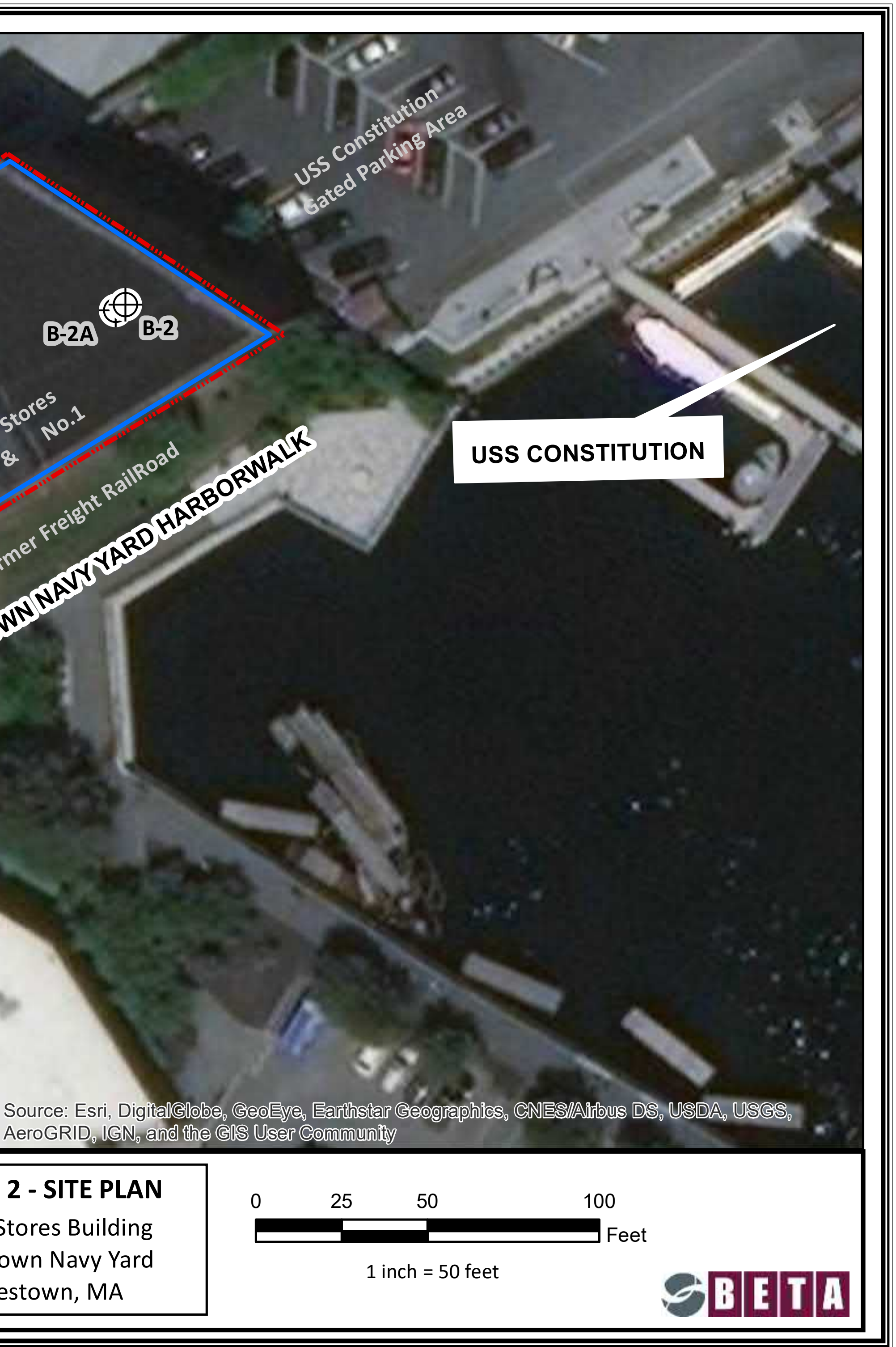
0 750 1,500 3,000 Feet

BETA

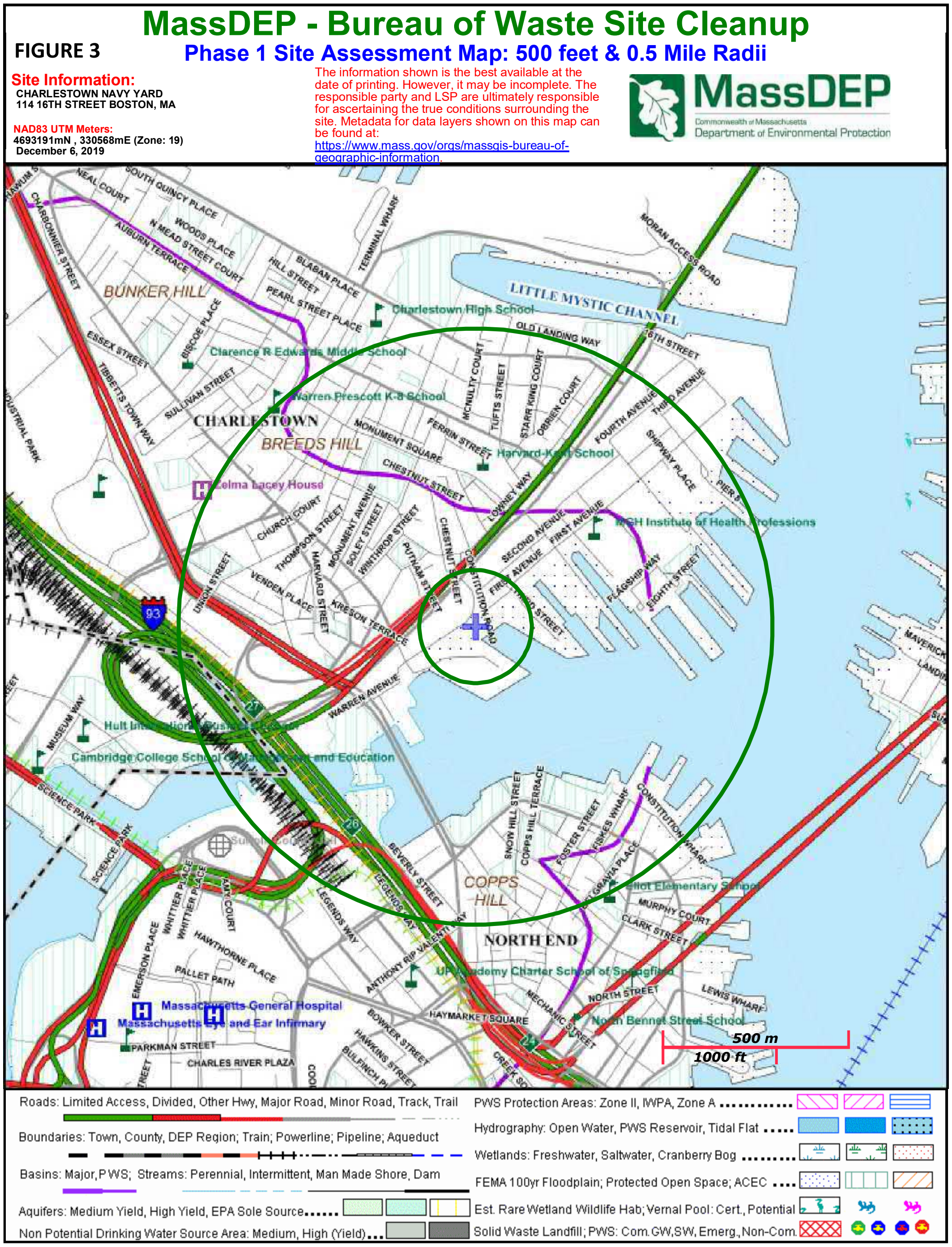
Prepared 12/18/19 By: MDM



Note: The Basemap Imagery is provided by ESRI-ArcGIS. The imagery displayed shows the site prior to



to the repaving of the western abutting parking area. Prepared Date: 12/19/19 By: MDM


MassDEP - Bureau of Waste Site Cleanup
FIGURE 3
Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii
Site Information:
CHARLESTOWN NAVY YARD
114 16TH STREET BOSTON, MA
NAD83 UTM Meters:
4693191mN , 330568mE (Zone: 19)
December 6, 2019
The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at:
https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.
MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection
BUNKER HILL
CHARLESTOWN
BREEDS HILL
LITTLE MYSTIC CHANNEL
Charlestown High School
Clarence R Edwards Middle School
Warren Prescott K-8 School
Harvard-Kent School
MGH Institute of Health Professions
COPPS HILL
NORTH END
Eliot Elementary School
Massachusetts General Hospital
Massachusetts Eye and Ear Infirmary
North Bennet Street School
Cambridge College School of Management and Education
500 m
1000 ft
Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail
Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct
Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam
Aquifers: Medium Yield, High Yield, EPA Sole Source
Non Potential Drinking Water Source Area: Medium, High (Yield)
PWS Protection Areas: Zone II, IWPA, Zone A
Hydrography: Open Water, PWS Reservoir, Tidal Flat
Wetlands: Freshwater, Saltwater, Cranberry Bog
FEMA 100yr Floodplain; Protected Open Space; ACEC
Est. Rare Wetland Wildlife Hab; Vernal Pool: Cert., Potential
Solid Waste Landfill; PWS: Com.GW,SW, Emerg., Non-Com.

APPENDIX A

Historic Sanborn Fire Insurance Maps and Aerial Photographs

Charlestown Navy Yard
115 Constitution Road
Charlestown, MA 02129

Inquiry Number: 5845026.1
November 14, 2019

Certified Sanborn® Map Report

EDR®
6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

Certified Sanborn® Map Report

11/14/19

Site Name:	**Client Name:**
Charlestown Navy Yard	Nover-Armstrong,INC.
115 Constitution Road	124 Main Street
Charlestown, MA 02129	CARVER, MA 02330
EDR Inquiry # 5845026.1	Contact: Mykel Mendes

The Sanborn Library has been searched by EDR and maps covering the target property location as provided by Nover-Armstrong,INC. were identified for the years listed below. The Sanborn Library is the largest, most complete collection of fire insurance maps. The collection includes maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow, and others. Only Environmental Data Resources Inc. (EDR) is authorized to grant rights for commercial reproduction of maps by the Sanborn Library LLC, the copyright holder for the collection. Results can be authenticated by visiting www.edrnet.com/sanborn.

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Certified Sanborn Results:

Certification # AD0E-42AD-A1E4

PO # 6283

Project Marble Fairbanks - Charlestown

Maps Provided:

2002	1964
1998	1950
1996	1927
1995	1900
1994	1888
1993	
1990	
1989	

Sanborn® Library search results

Certification #: AD0E-42AD-A1E4

The Sanborn Library includes more than 1.2 million fire insurance maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow and others which track historical property usage in approximately 12,000 American cities and towns. Collections searched:

- ✔ Library of Congress
- ✔ University Publications of America
- ✔ EDR Private Collection

The Sanborn Library LLC Since 1866™

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Sanborn Sheet Key

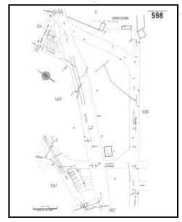
This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

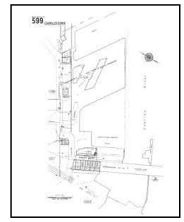
2002 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 594


Volume 5W, Sheet 597


Volume 5W, Sheet 598

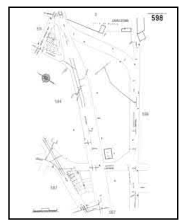

Volume 5W, Sheet 599

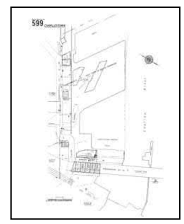
1998 Source Sheets


Volume 5W, Sheet 591

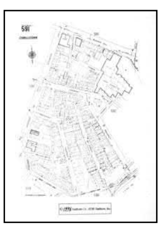

Volume 5W, Sheet 594


Volume 5W, Sheet 597


Volume 5W, Sheet 598

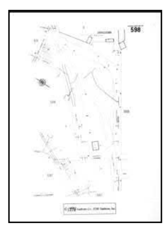

Volume 5W, Sheet 599

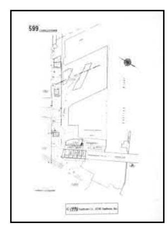
1996 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 594

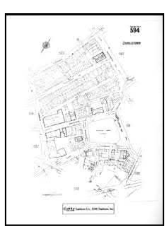

Volume 5W, Sheet 597

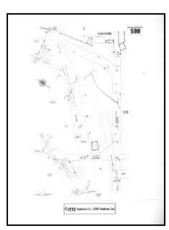

Volume 5W, Sheet 598


Volume 5W, Sheet 599

1995 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 594


Volume 5W, Sheet 598


Volume 5W, Sheet 599


Volume 5W, Sheet 597

Sanborn Sheet Key

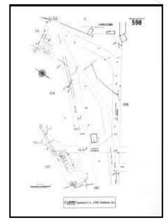
This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

1994 Source Sheets


Volume 5W, Sheet 594

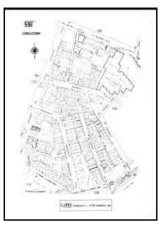

Volume 5W, Sheet 591


Volume 5W, Sheet 597

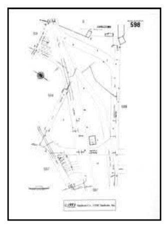

Volume 5W, Sheet 598


Volume 5W, Sheet 599

1993 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 597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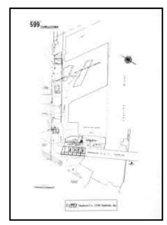
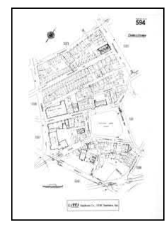
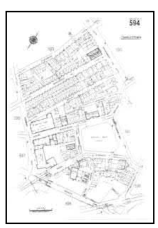

Volume 5W, Sheet 599


Volume 5W, Sheet 594

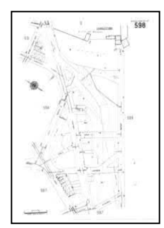
1990 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 594


Volume 5W, Sheet 596


Volume 5W, Sheet 597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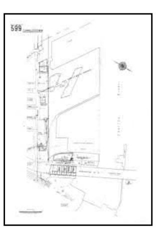

Volume 5W, Sheet 599

Sanborn Sheet Key

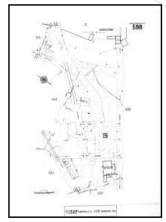
This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

1989 Source Sheets


Volume 5W, Sheet 591


Volume 5W, Sheet 594


Volume 5W, Sheet 597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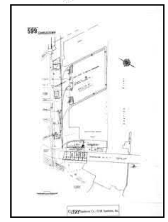
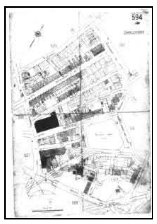

Volume 5W, Sheet 599

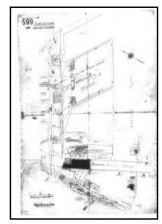
1964 Source Sheets


Volume 5W, Sheet 591

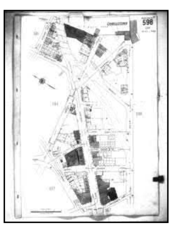

Volume 5W, Sheet 594

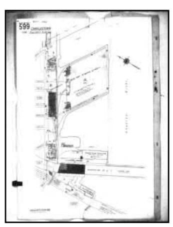

Volume 5W, Sheet 597


Volume 5W, Sheet 598

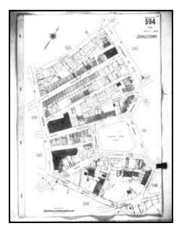

Volume 5W, Sheet 599

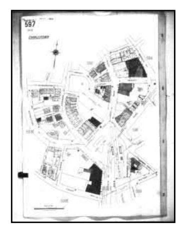
1950 Source Sheets


Volume 5, Sheet 598


Volume 5, Sheet 599


Volume 5, Sheet 591

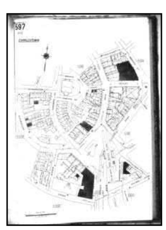

Volume 5, Sheet 594


Volume 5, Sheet 597

1927 Source Sheets


Volume 5, Sheet 591


Volume 5, Sheet 594


Volume 5, Sheet 597


Volume 5, Sheet 598


Volume 5, Sheet 599

Sanborn Sheet Key

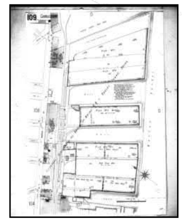
This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

1900 Source Sheets


Volume 5, Sheet 97


Volume 5, Sheet 104


Volume 5, Sheet 108

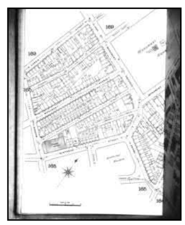

Volume 5, Sheet 109


Volume 5, Sheet 102

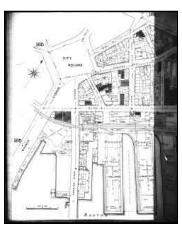
1888 Source Sheets


Volume 5, Sheet 165

Volume 5, Sheet 165


Volume 5, Sheet 166

Volume 5, Sheet 166


Volume 5, Sheet 164

Volume 5, Sheet 164

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EDR

Certified Sanborn® Map

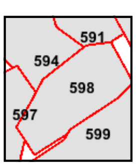
2002

Site Name:	Charlestown Navy Yard
Address:	115 Constitution Road
City, ST, ZIP:	Charlestown, MA 02129
Client:	Nover-Armstrong,INC.
EDR Inquiry:	5845026.1
Order Date:	11/14/2019
Certification #	AD0E-42AD-A1E4
Copyright	2002

Certification # AD0E-42AD-A1E4

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

0 Feet 150 300 600



Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 594
Volume 5W, Sheet 591

N

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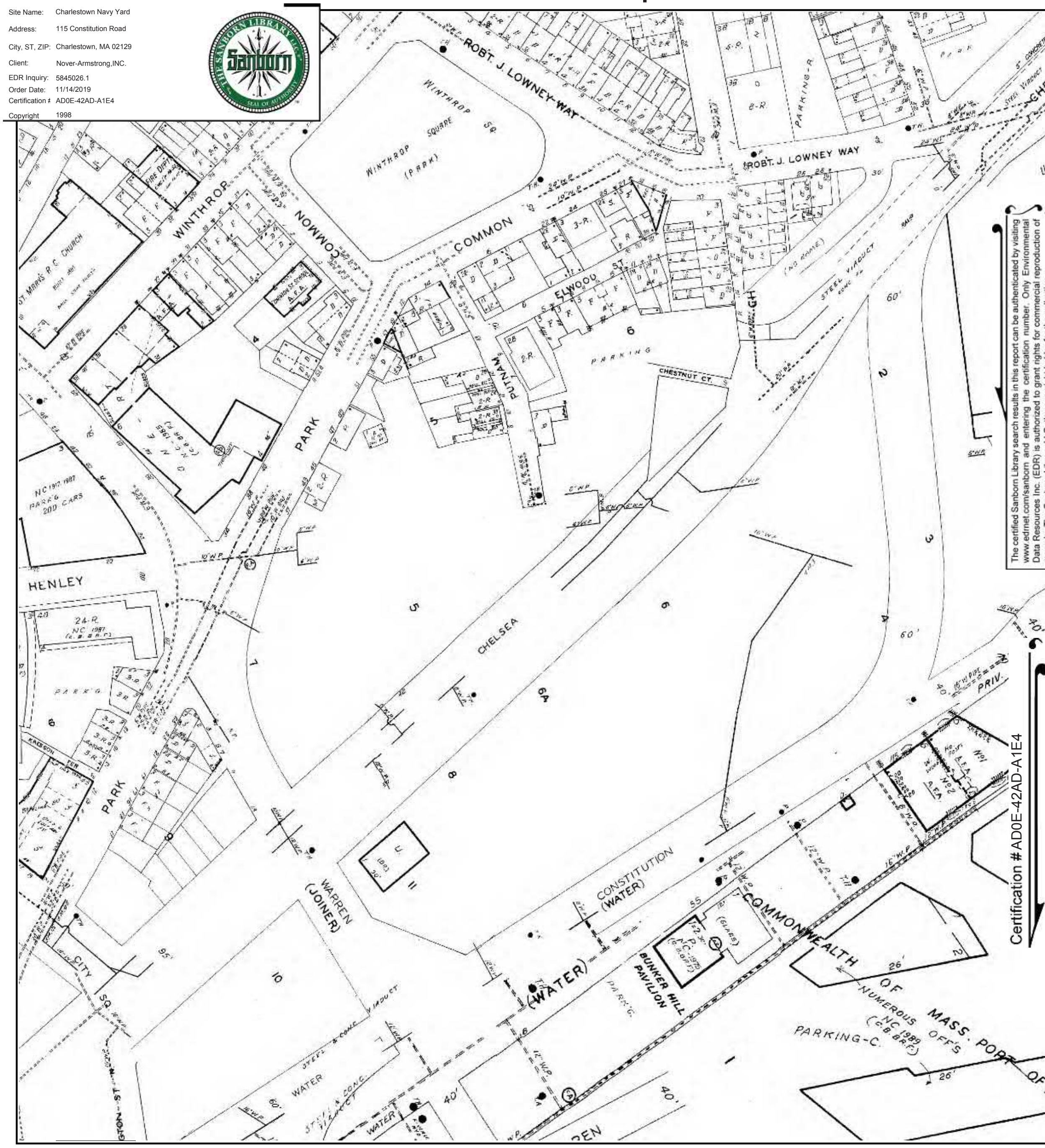
EDR

Certified Sanborn® Map

1998

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1998



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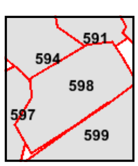
Outlined areas indicate map sheets within the collection.



Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 594
Volume 5W, Sheet 591

0 Feet 150 300 600

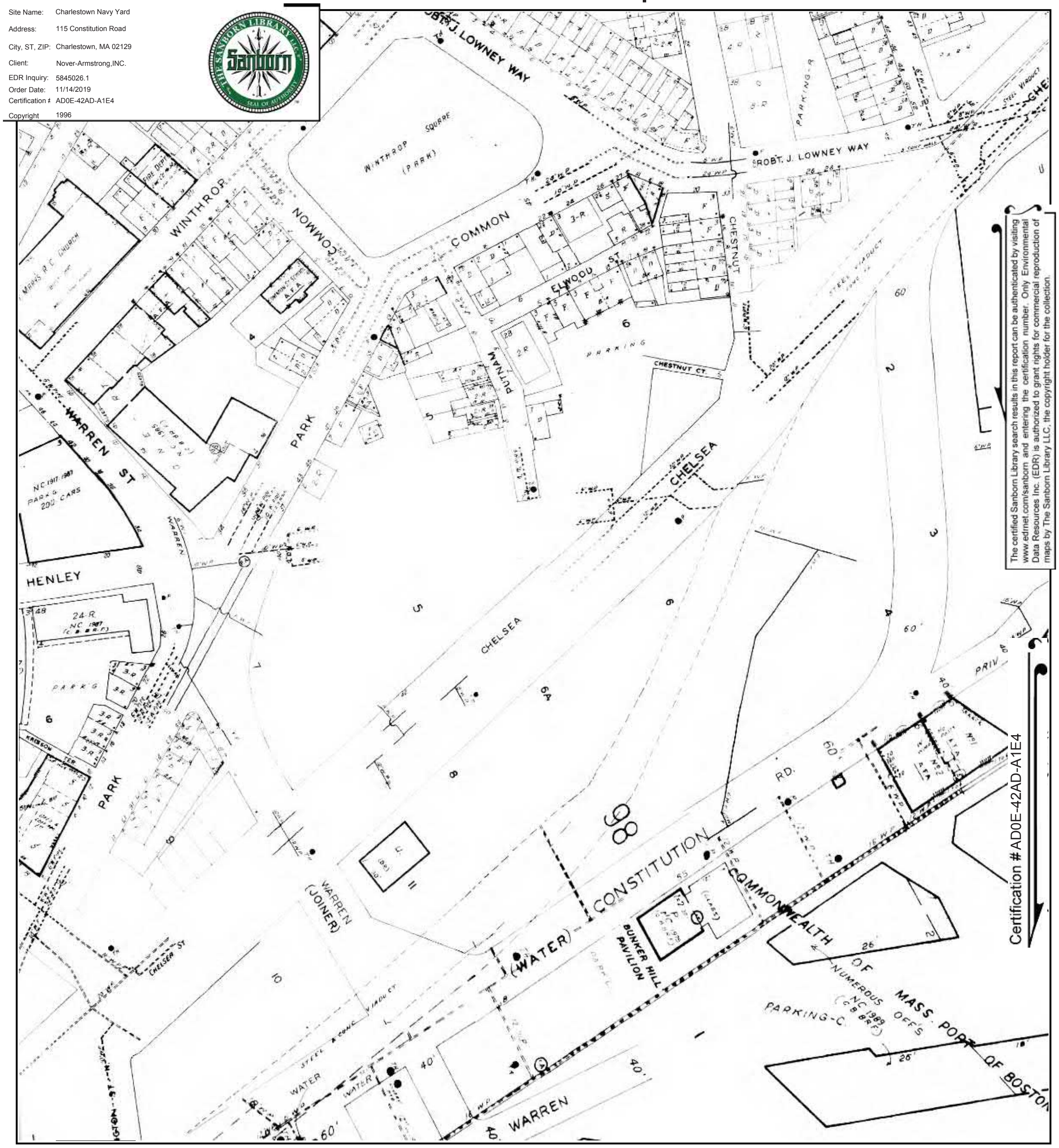
N

5845026 - 1 page 8

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1996

Certified Sanborn® Map

1996



Certification # AD0E-42AD-A1E4

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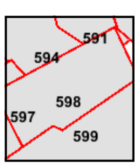

Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 594
Volume 5W, Sheet 591

N

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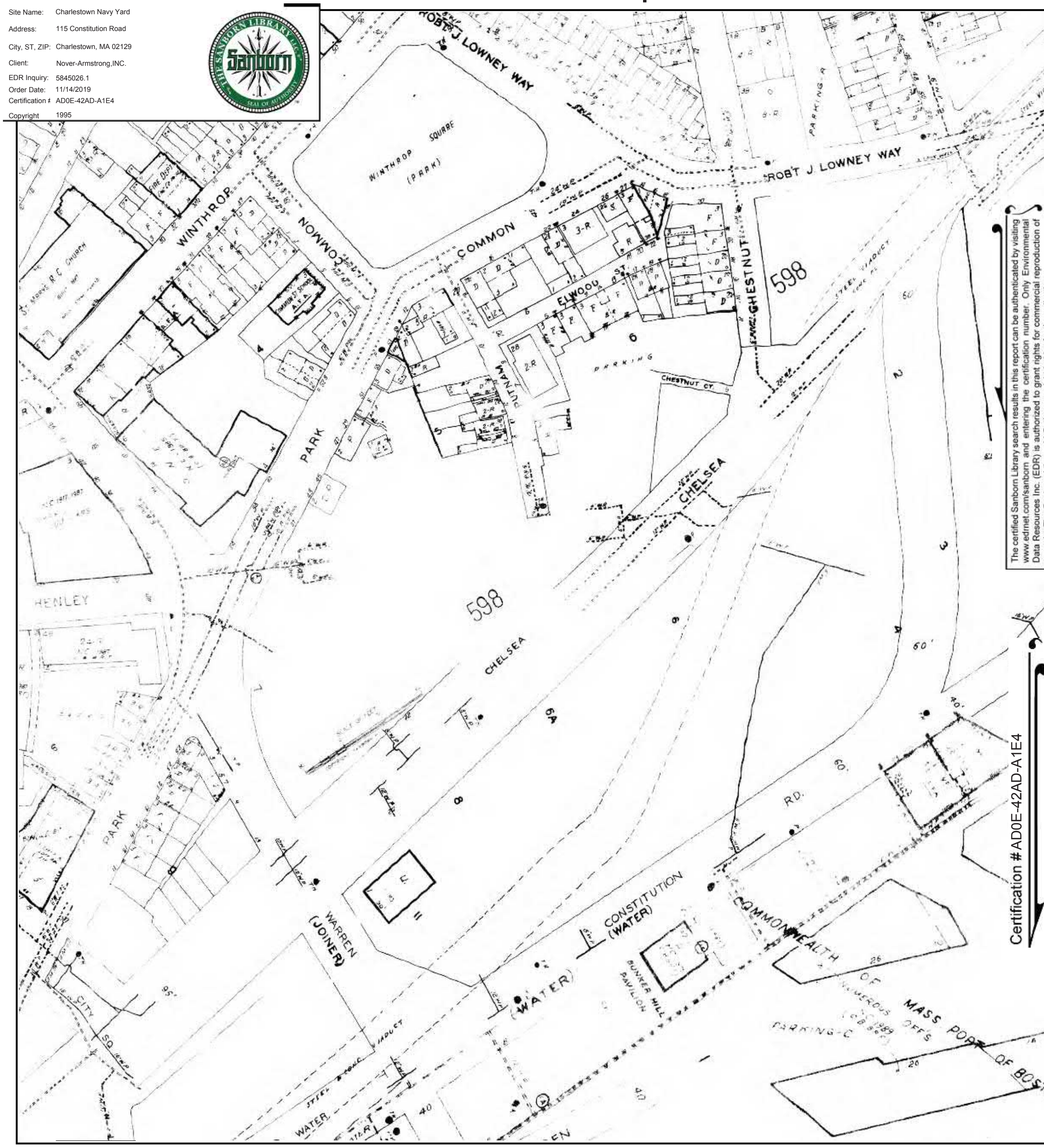
EDR®

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1995

Certified Sanborn® Map

1995



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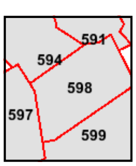

Volume 5W, Sheet 597
Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 594
Volume 5W, Sheet 591

0 Feet 150 300 600

N

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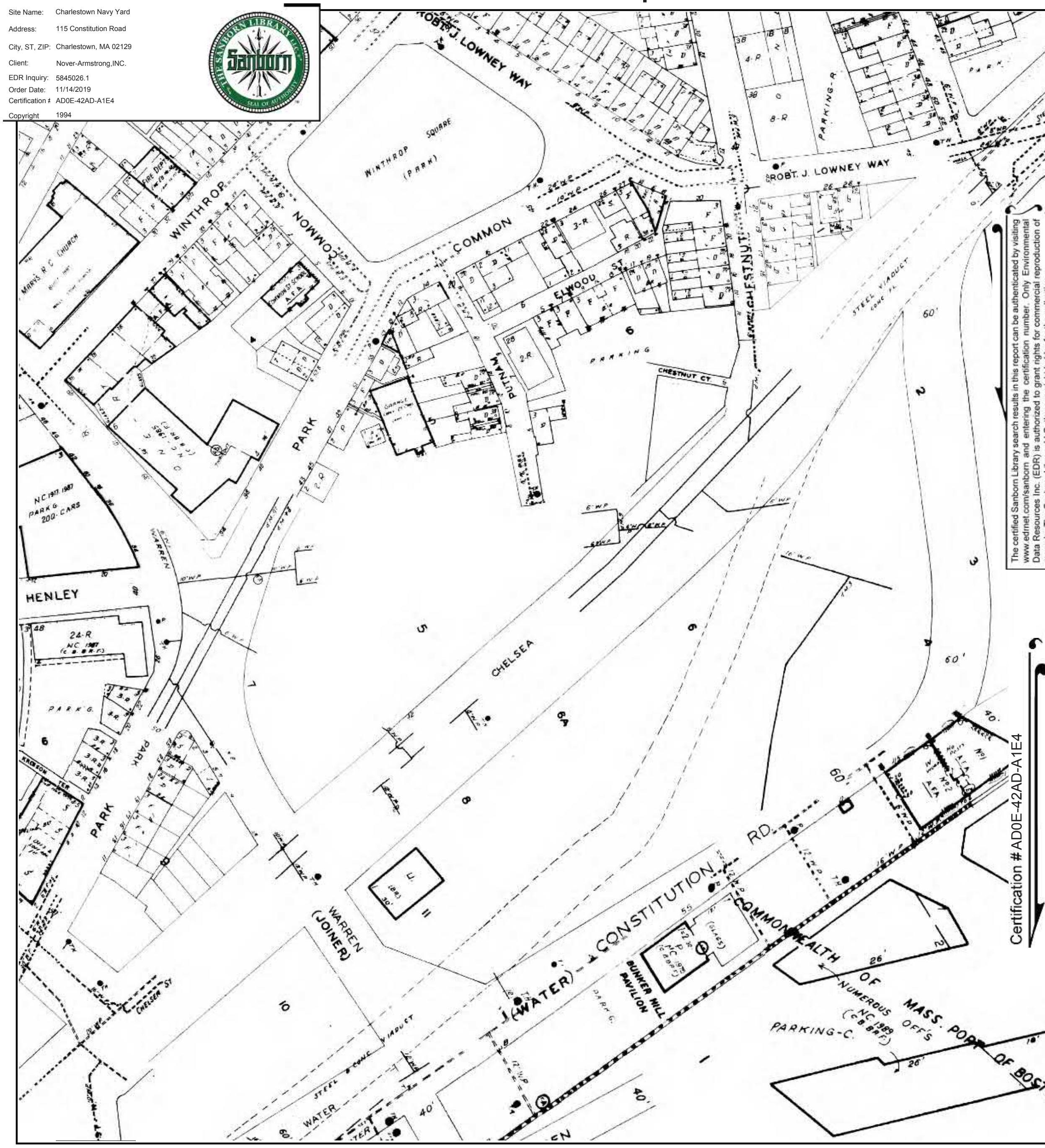
EDR®

Certified Sanborn® Map

1994

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1994



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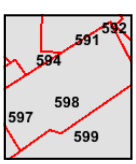

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Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 591
Volume 5W, Sheet 594

0 Feet 150 300 600

N

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EDR

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1993

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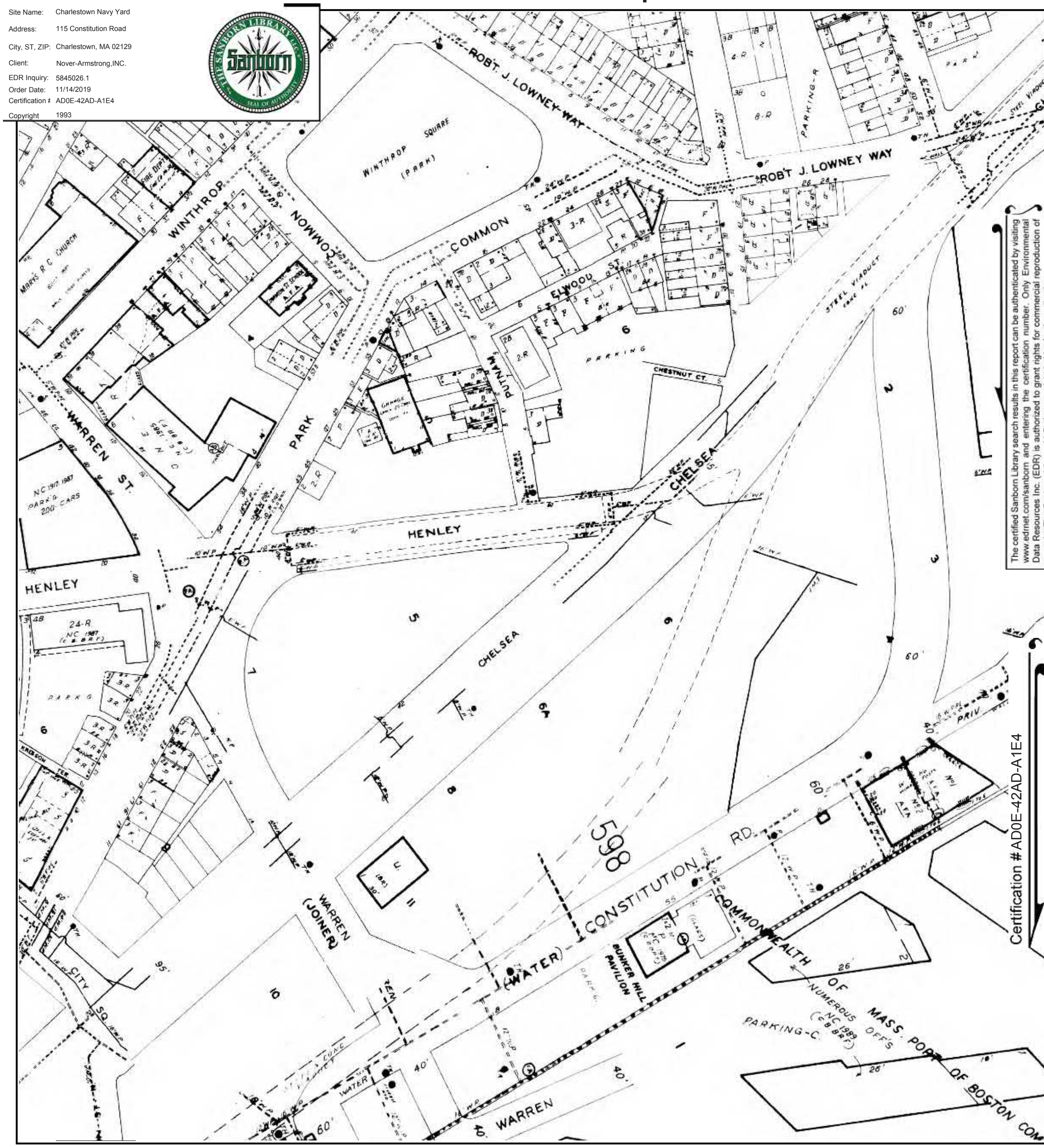
1993



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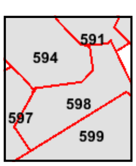

Volume 5W, Sheet 594
Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 591

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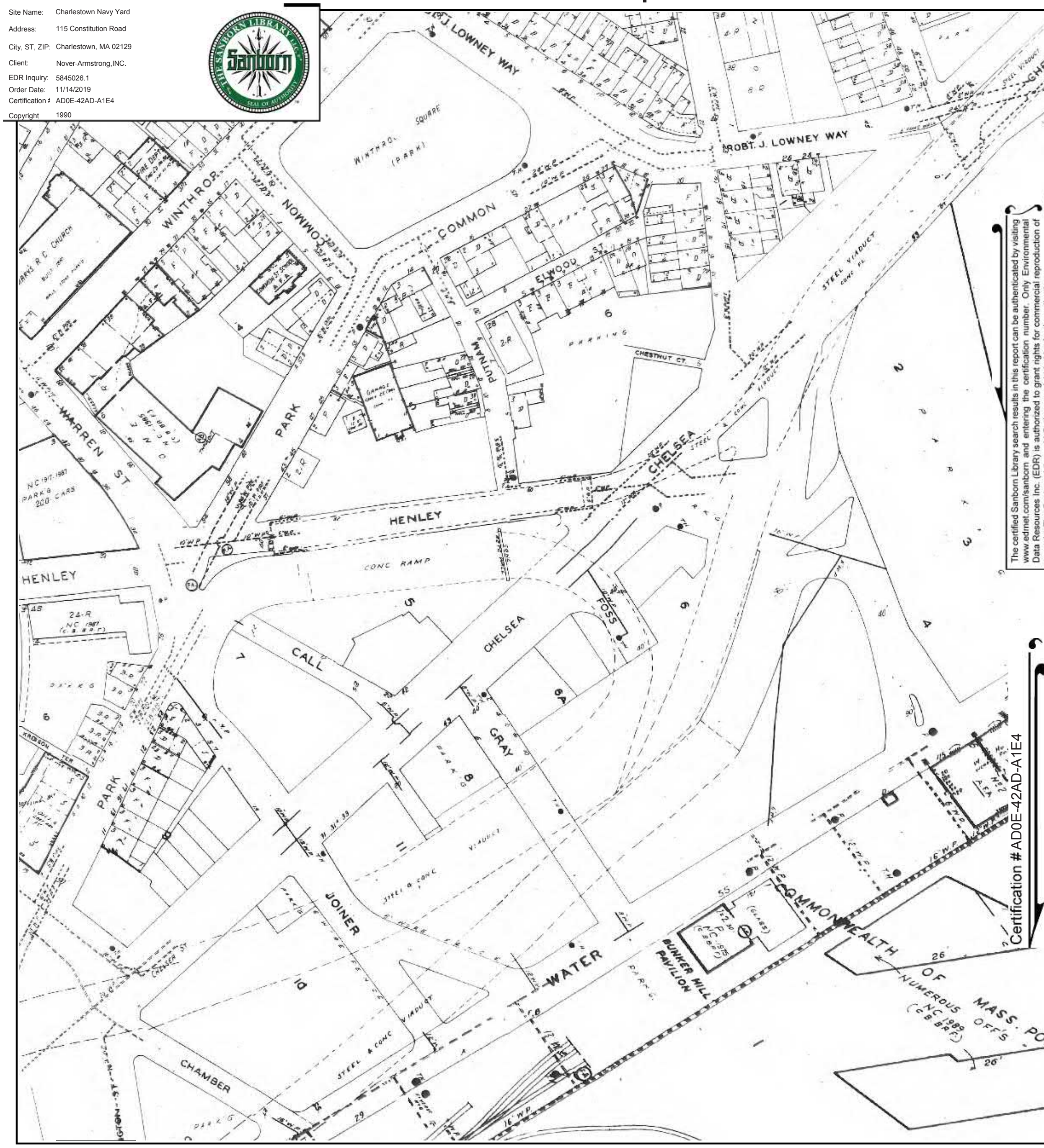
EDR®

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1990

Certified Sanborn® Map

1990



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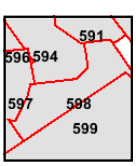

Volume 5W, Sheet 599
Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 596
Volume 5W, Sheet 594
Volume 5W, Sheet 591

0 Feet 150 300 600

N

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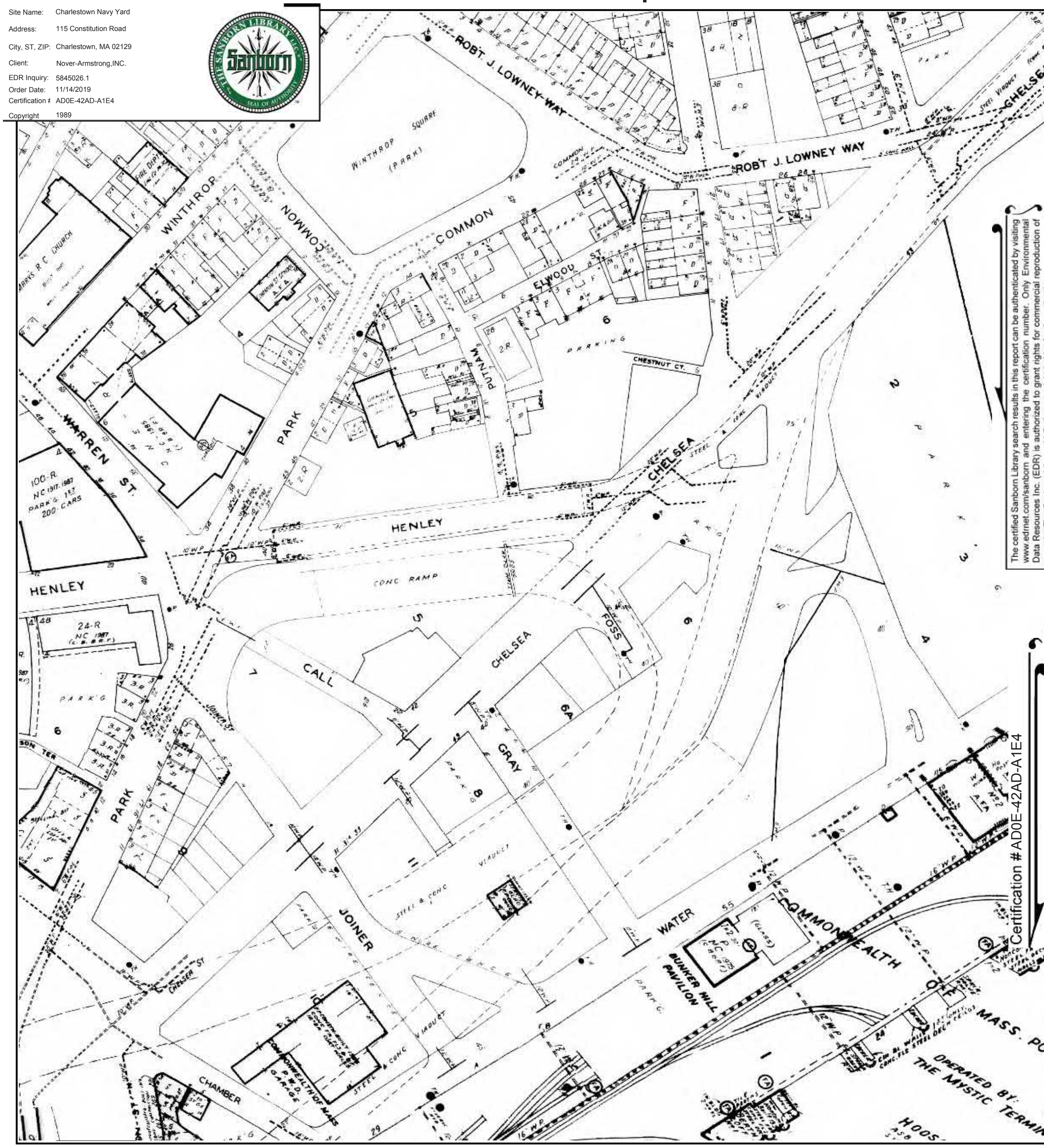
EDR®

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1989

Certified Sanborn® Map

1989



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Outlined areas indicate map sheets within the collection.

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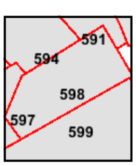

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Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 594
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EDR®

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1964

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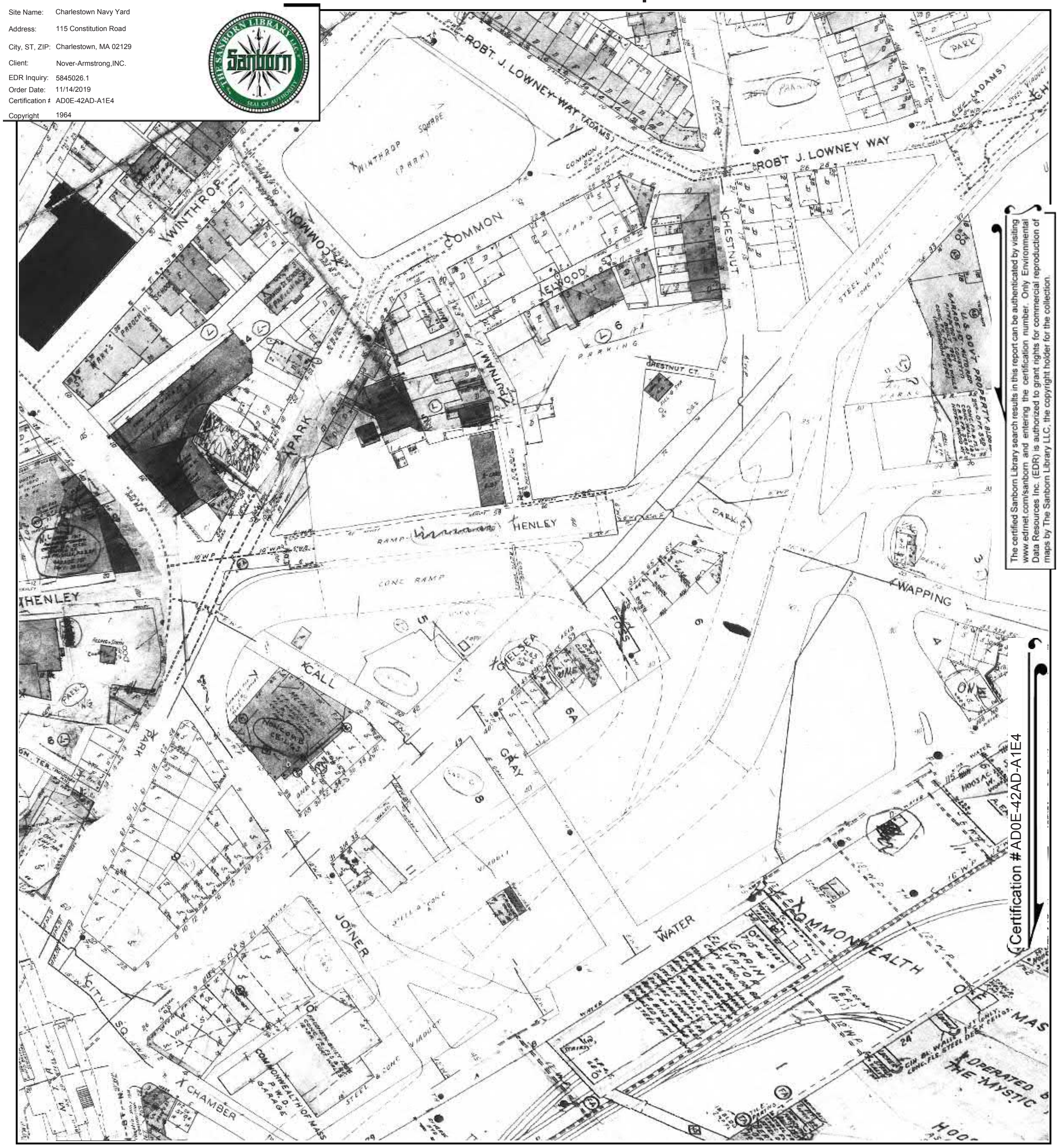
1964



Certification # AD0E-42AD-A1E4

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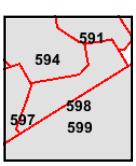

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Volume 5W, Sheet 598
Volume 5W, Sheet 597
Volume 5W, Sheet 594
Volume 5W, Sheet 591

0 Feet 150 300 600

N

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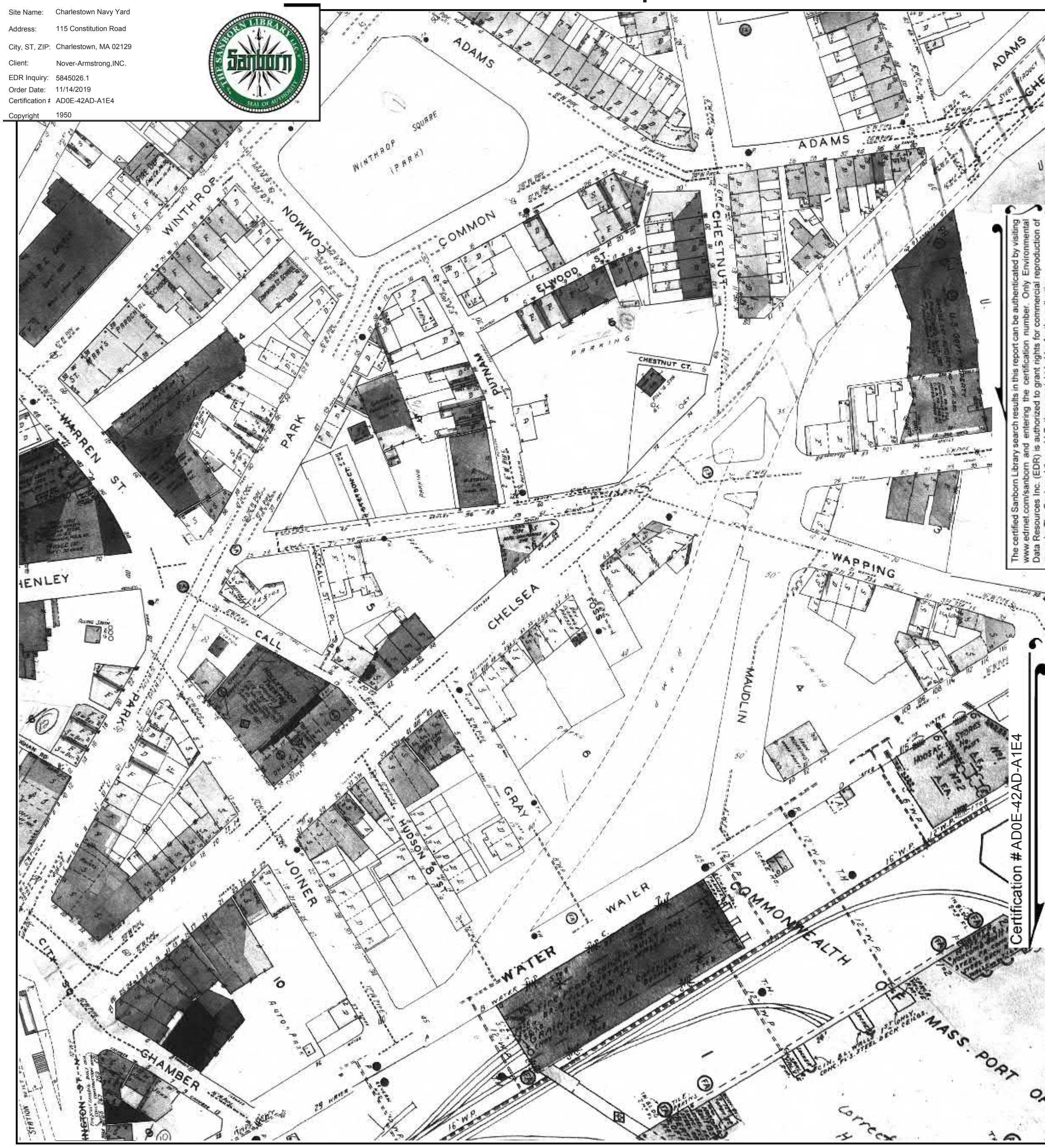
EDR®

Site Name: Charlestown Navy Yard
Address: 115 Constitution Road
City, ST, ZIP: Charlestown, MA 02129
Client: Nover-Armstrong,INC.
EDR Inquiry: 5845026.1
Order Date: 11/14/2019
Certification # AD0E-42AD-A1E4
Copyright 1950

Certified Sanborn® Map

1950



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Outlined areas indicate map sheets within the collection.

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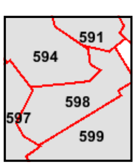

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Volume 5, Sheet 591
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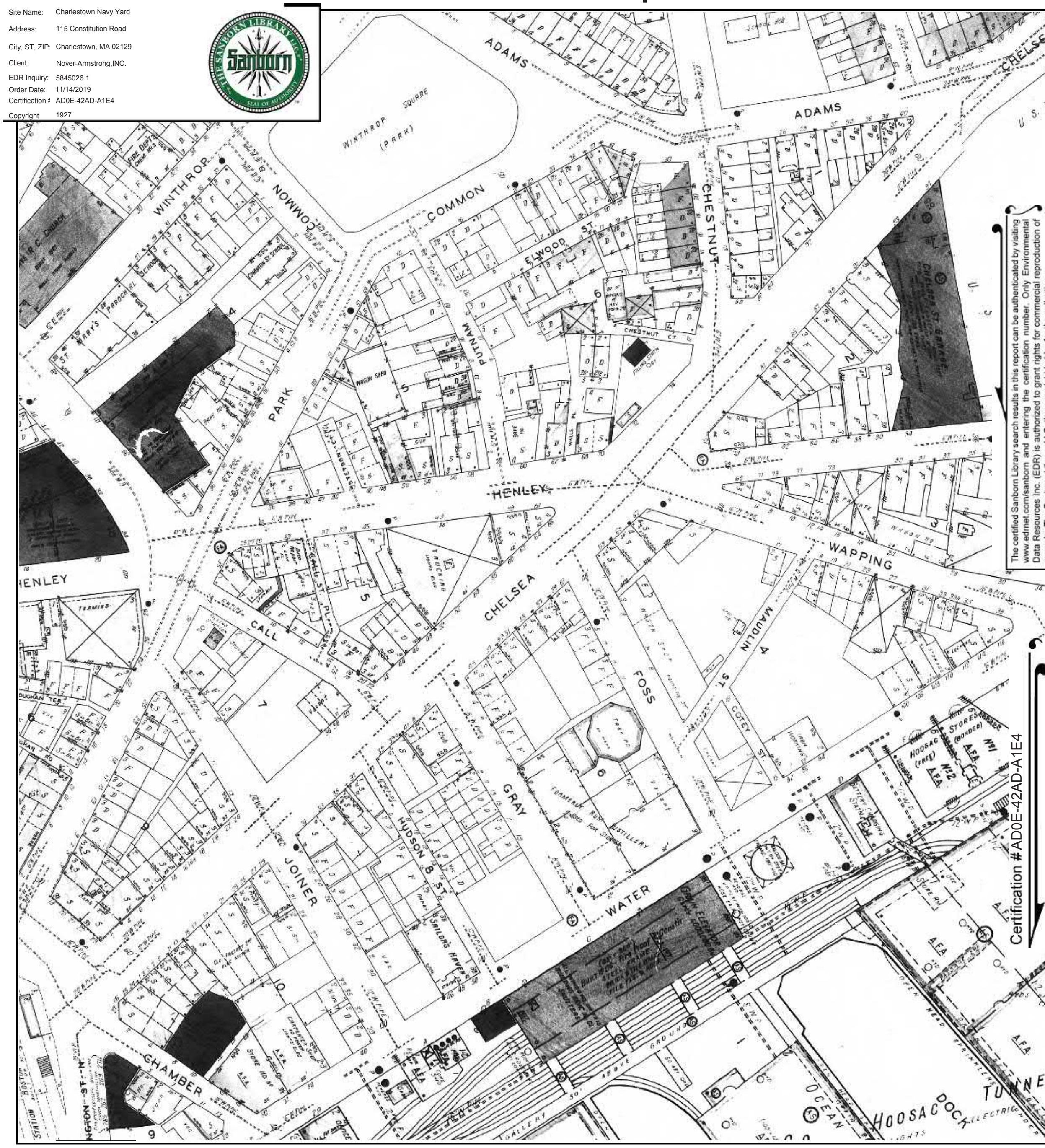
EDR®

Certified Sanborn® Map

1927

Site Name:	Charlestown Navy Yard
Address:	115 Constitution Road
City, ST, ZIP:	Charlestown, MA 02129
Client:	Nover-Armstrong,INC.
EDR Inquiry:	5845026.1
Order Date:	11/14/2019
Certification #	AD0E-42AD-A1E4
Copyright	1927



This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

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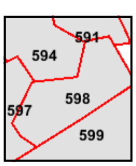

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Volume 5, Sheet 597
Volume 5, Sheet 594
Volume 5, Sheet 591

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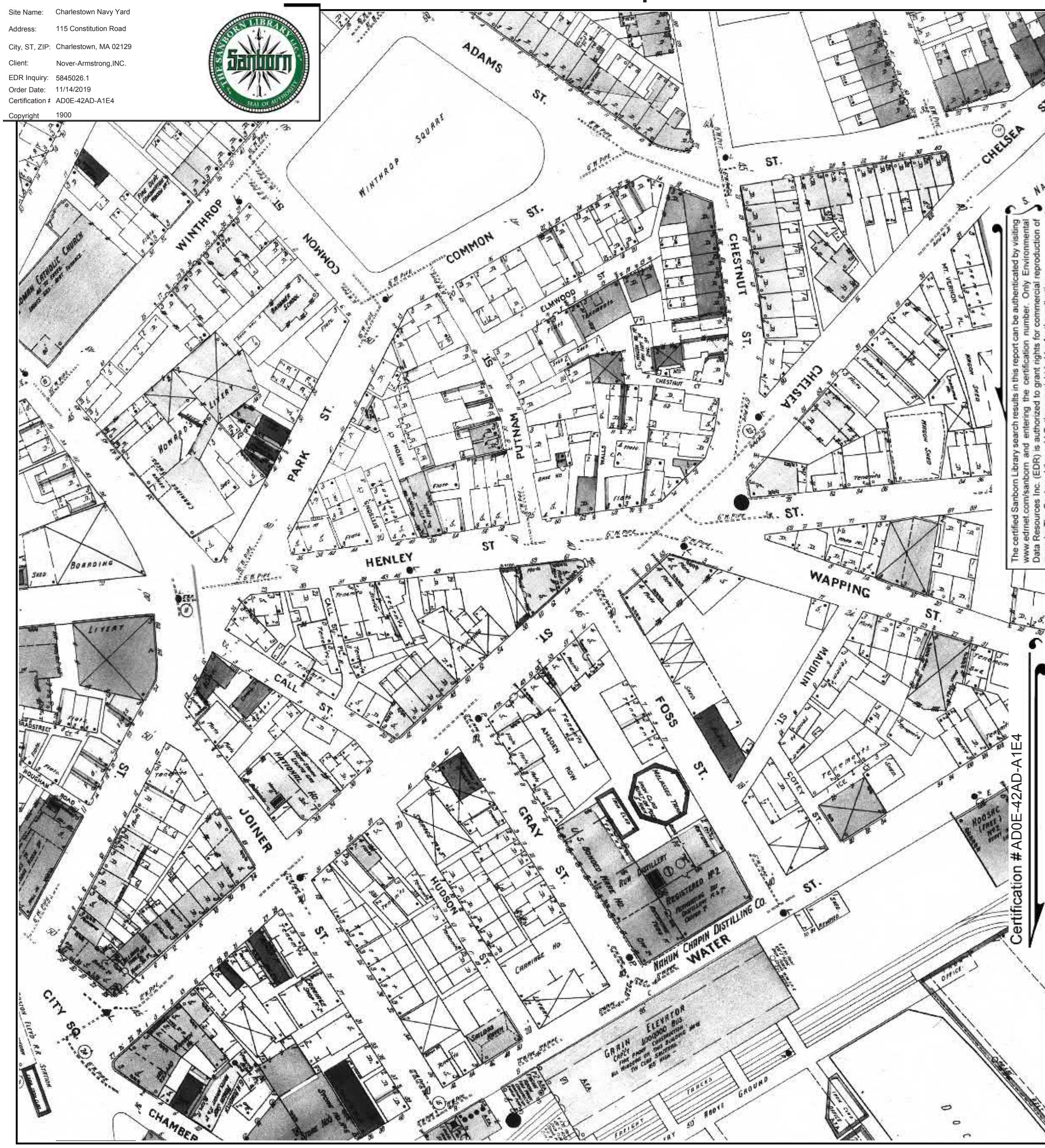
Site Name:	Charlestown Navy Yard
Address:	115 Constitution Road
City, ST, ZIP:	Charlestown, MA 02129
Client:	Nover-Armstrong,INC.
EDR Inquiry:	5845026.1
Order Date:	11/14/2019
Certification #	AD0E-42AD-A1E4
Copyright	1900

Certified Sanborn® Map

1900



This Certified Sanborn Map combines the following sheets.
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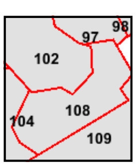

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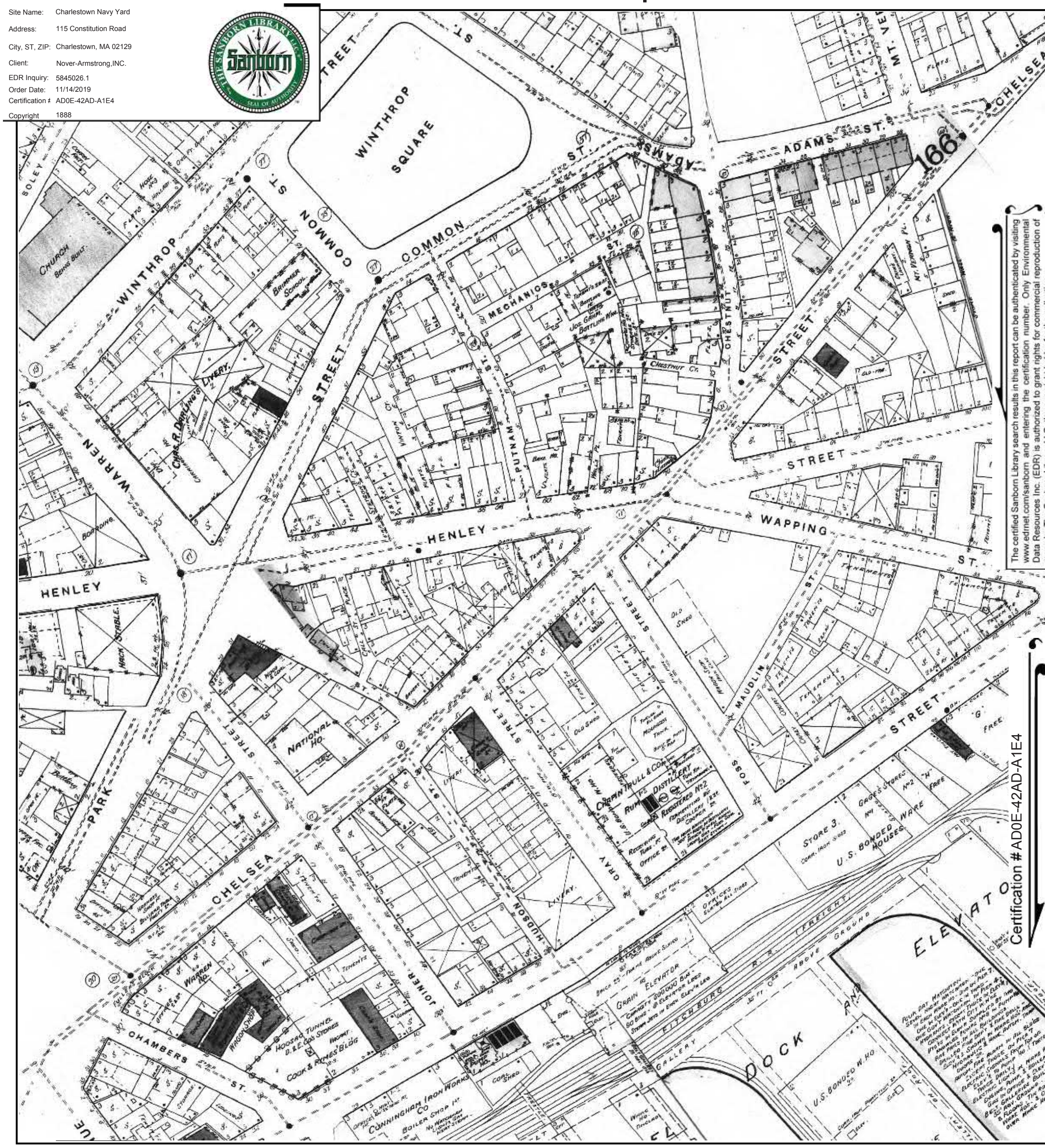
EDR®

Certified Sanborn® Map

1888

Site Name:	Charlestown Navy Yard
Address:	115 Constitution Road
City, ST, ZIP:	Charlestown, MA 02129
Client:	Nover-Armstrong,INC.
EDR Inquiry:	5845026.1
Order Date:	11/14/2019
Certification #	AD0E-42AD-A1E4
Copyright	1888



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Certification # AD0E-42AD-A1E4

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

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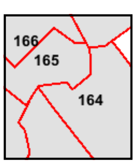

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Hoosac Stores
114 16th Street
Charlestown, MA 02129

Inquiry Number: 5887223.1
November 27, 2019

The EDR Aerial Photo Decade Package

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

11/27/19

Site Name:	Client Name:
Hoosac Stores	Nover-Armstrong,INC.
114 16th Street	124 Main Street
Charlestown, MA 02129	CARVER, MA 02330
EDR Inquiry # 5887223.1	Contact: Mykel Mendes

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	*Scale*	*Details*	*Source*
2016	1"=500'	Flight Year: 2016	USDA/NAIP
2012	1"=500'	Flight Year: 2012	USDA/NAIP
2008	1"=500'	Flight Year: 2008	USDA/NAIP
1995	1"=500'	Acquisition Date: April 03, 1995	USGS/DOQQ
1985	1"=500'	Flight Date: April 17, 1985	USDA
1980	1"=500'	Flight Date: September 28, 1980	USDA
1978	1"=500'	Flight Date: April 23, 1978	USGS
1970	1"=500'	Flight Date: October 29, 1970	USDA
1969	1"=500'	Flight Date: April 09, 1969	USGS
1960	1"=500'	Flight Date: May 01, 1960	USGS
1955	1"=500'	Flight Date: December 01, 1955	USGS
1952	1"=500'	Flight Date: August 24, 1952	USDA
1946	1"=500'	Flight Date: June 15, 1946	USGS
1938	1"=500'	Flight Date: December 15, 1938	USGS

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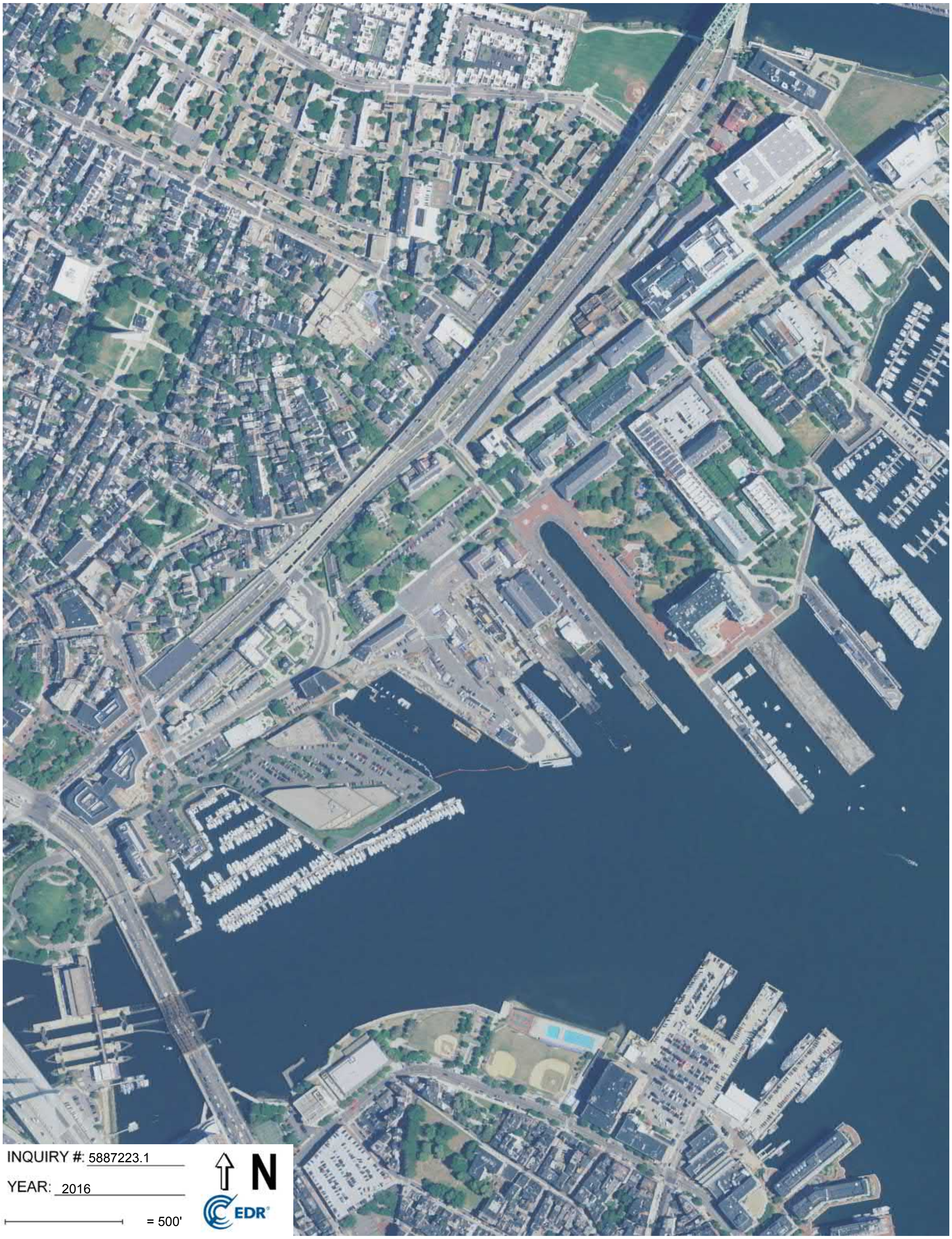
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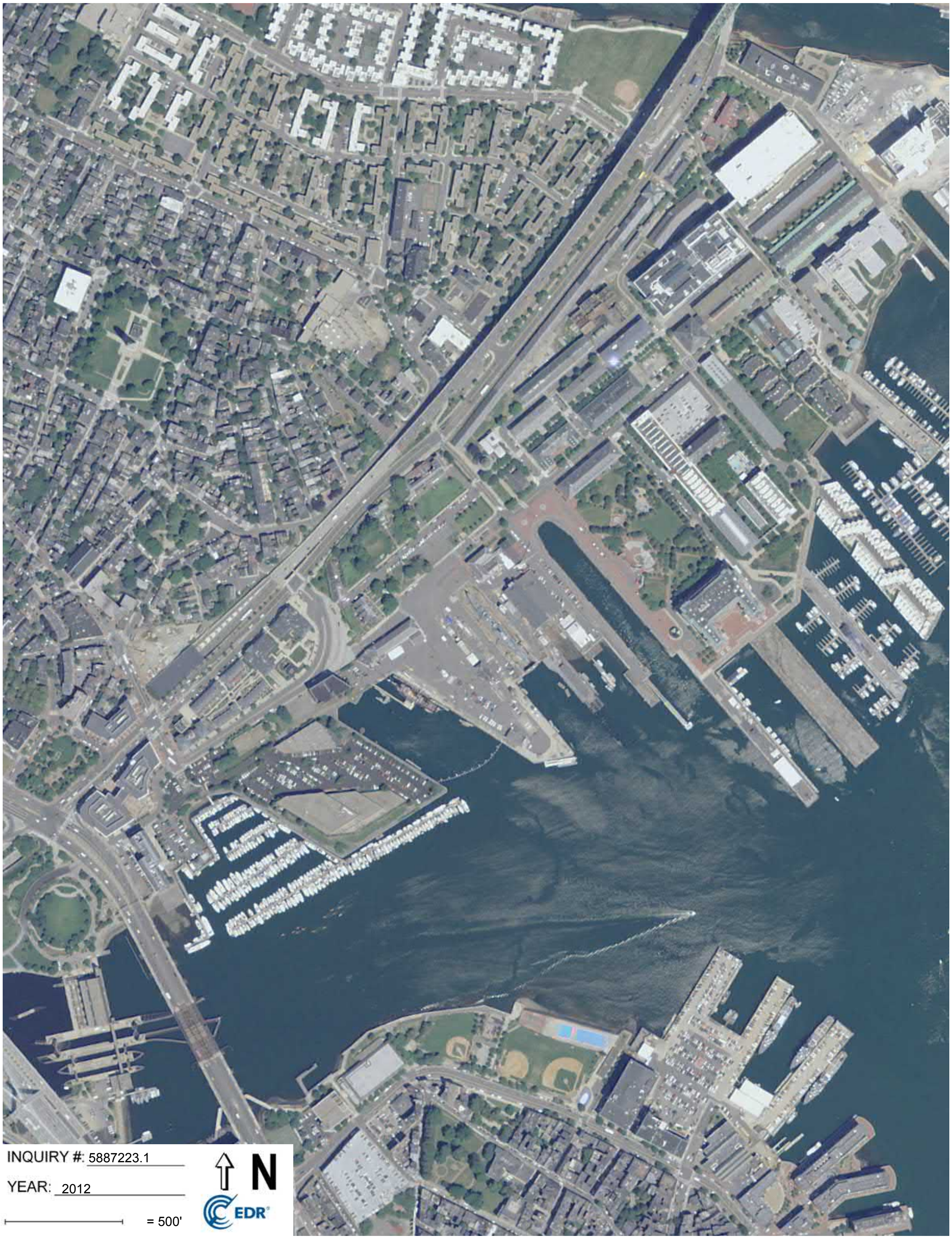
EDR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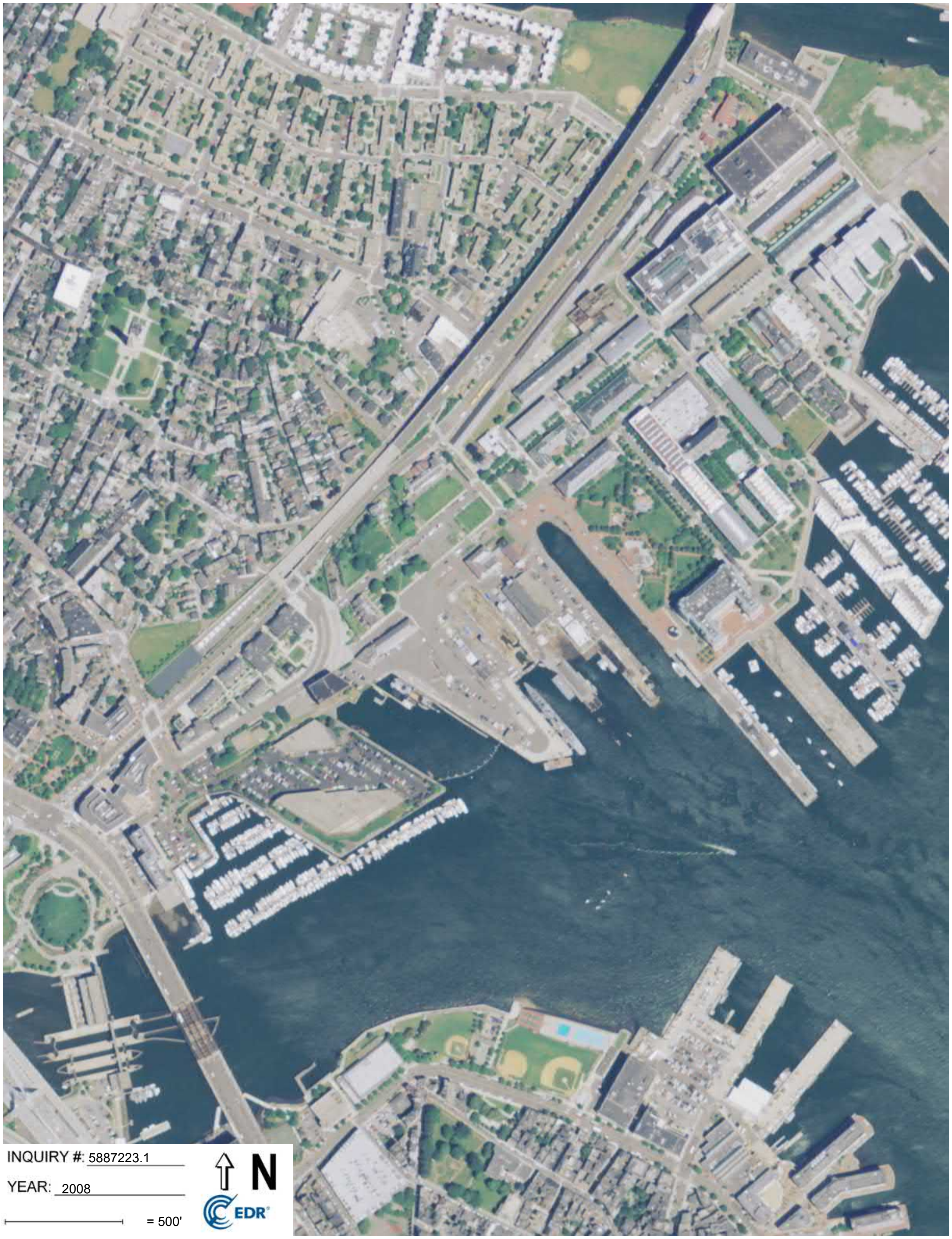
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EDR


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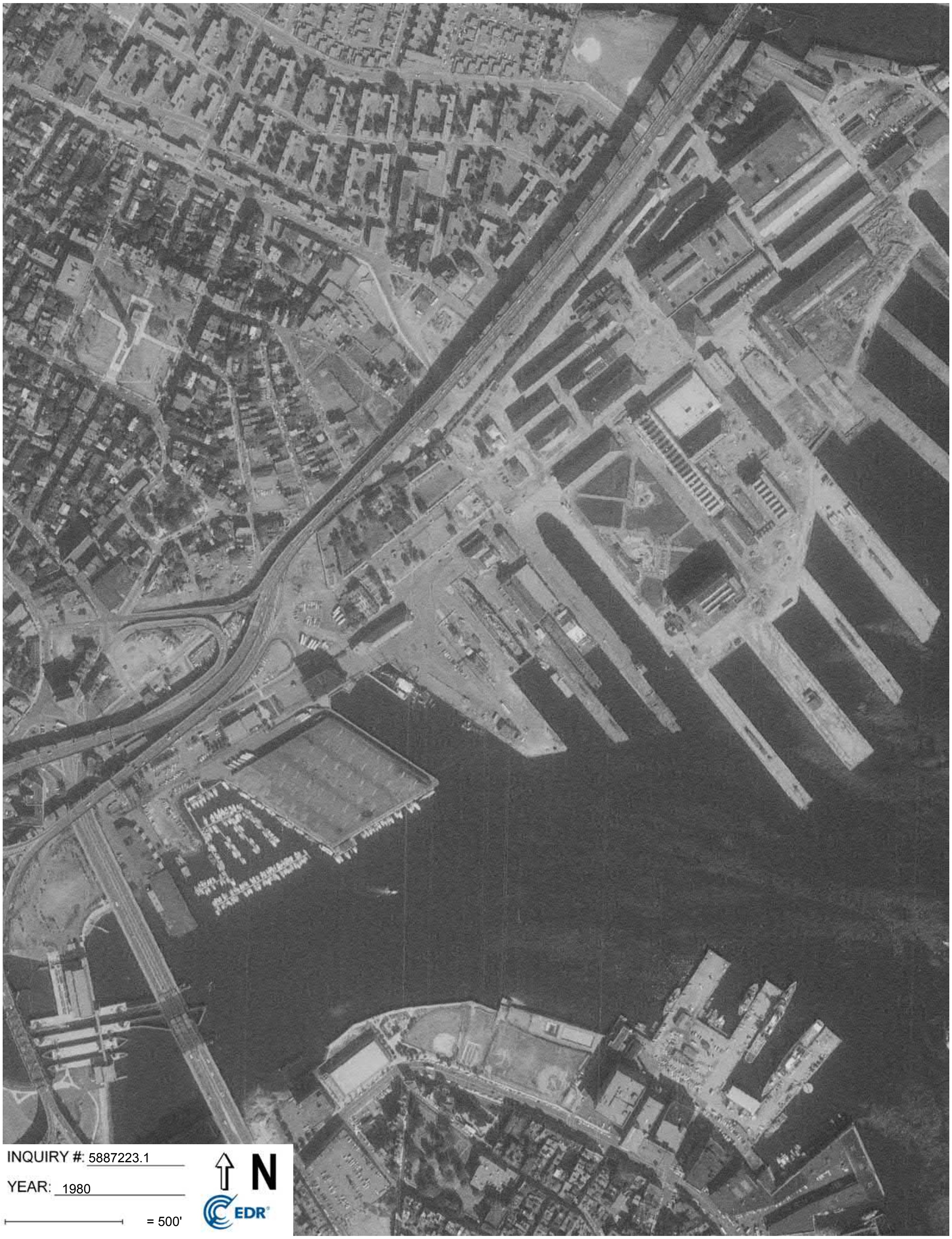
EDR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EDR


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EDR

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EDR


INQUIRY #: 5887223.1
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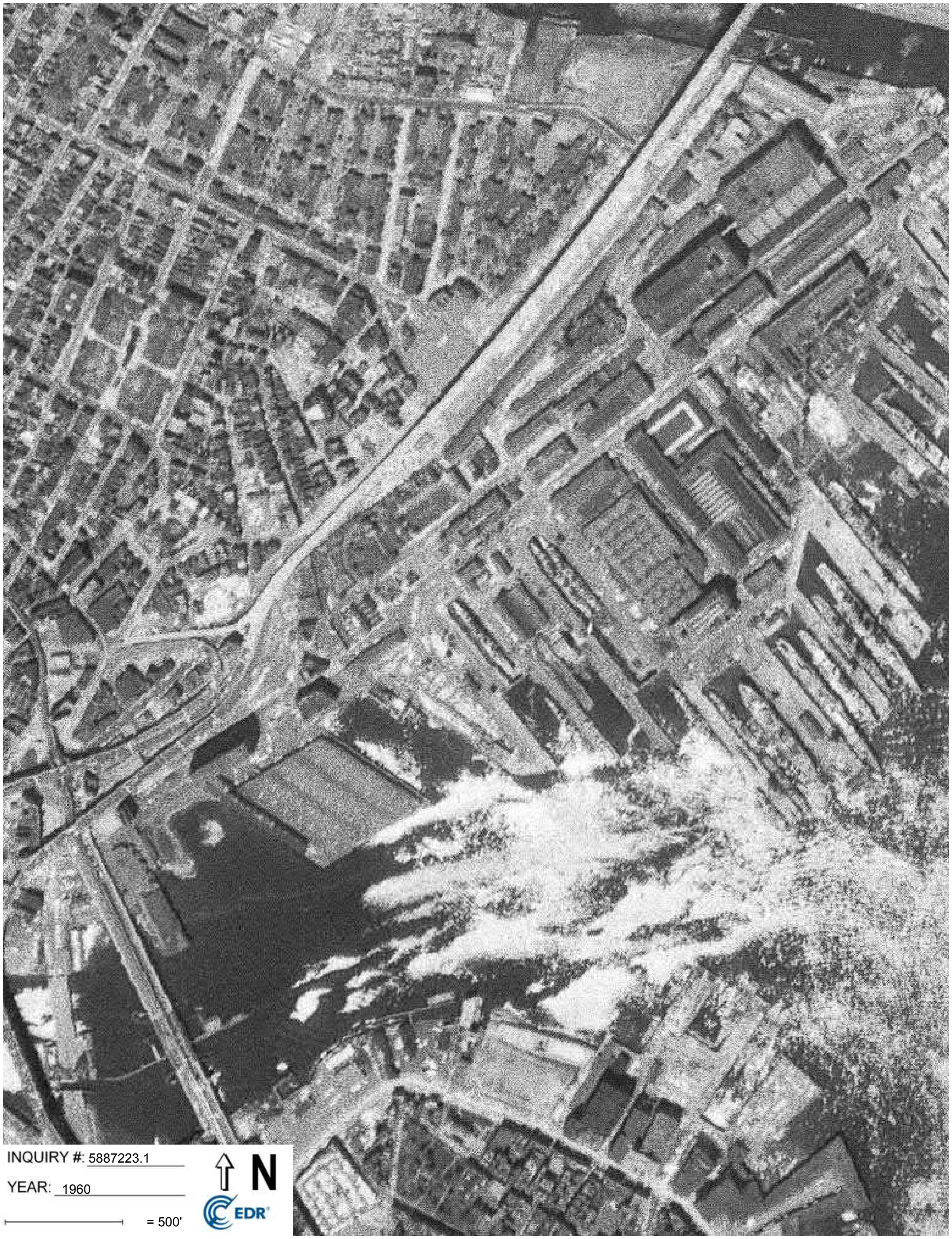
EDR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= 500'
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EDR


INQUIRY #: 5887223.1
YEAR: 1955
= 500'
N
EDR


INQUIRY #: 5887223.1
YEAR: 1952
= 500'
N
EDR


INQUIRY #: 5887223.1
YEAR: 1946
= 500'
N
EDR

INQUIRY #: 5887223.1
YEAR: 1938
= 500'
N
EDR

APPENDIX B

Photographic Documentation Log

Photo 1

Photo shows an exterior view of the western wall of the Hoosac Stores building (facing east).

Photo 2

Photo shows the northwestern corner of the property. The pink paint represents the outline of the underground concrete slab.

Photo 3

Photo shows a view of the western abutting paved parking area; the small shed is pictured on the right.

Photo 4

Photo shows the vent/roof drainage pipe extending from the roof of the small shed.

PHOTOGRAPHIC DOCUMENTATION
Hoosac Stores Building
115 Constitution Road
Charlestown, Massachusetts
Photographs Documented 11.2019
Job No: 06283.00

BETA

Photo 5

Photo shows the western exterior former loading zone of the Hoosacs Building.

Photo 6

Photo shows the Freedom Trail /sidewalk abutting the north side of the Hoosacs Building .

Photo 7

Photo shows the southwestern portion of the property; this area is where the former railroad lay and the Charlestown Harborwalk is pictured to the far left.

Photo 8

Photo shows the southern portion of the property facing east to the USS Consitution. The Charlestown Harborwalk is pictured to the right.

PHOTOGRAPHIC DOCUMENTATION
Hoosac Stores Building
115 Constitution Road
Charlestown, Massachusetts
Photographs Documented 11.2019
Job No: 06283.00

BETA

Photo 9

Photo shows an exterior view of the southern of the building.

Photo 10

Photo shows the southern corner and read portion of the Hoosac's building. The grassy area is where the former Fitchburg Railroad lay and the USS Constitution is pictured in the right corner.

Photo 11

Photo shows the eastern exterior of the building. The pink paint is to indicate an unknown underground utility extending from the building.

Photo 12

Photo shows a larger view of the eastern exterior portion of the building.

PHOTOGRAPHIC DOCUMENTATION
Hoosac Stores Building
115 Constitution Road
Charlestown, Massachusetts
Photographs Documented 11.2019
Job No: 06283.00

BETA

APPENDIX C

Geophysical Survey Report

November 26th, 2019

Marylou Armstrong
Beta Group, Inc.
701 George Washington Hwy
Lincoln, RI
02865

Project: Geophysical Survey – 115 Constitution Rd, Charlestown, MA

Dear Marylou,

The following is a brief letter report detailing the results of the geophysical survey performed at the above referenced site. Site maps and/or pertinent ground penetrating radar (GPR) transects are contained in the report and Appendix A. It would be helpful to review Appendix A and the site maps when reading this report. TPI's standard practice is to indicate the results of the geophysical survey by marking all identified utility lines, tanks, and GPR anomalies etc. with chalk, paint or flags. It should be noted that this report is a means of transferring data and results of data interpretation, which was performed during the time allotted for the fieldwork.

Project Scope and Visual Site Inspection

TPI Environmental, Inc. (TPI) was contracted by Beta Group Inc. (client) to scan areas of concern (AOC) at the above referenced location to confirm or deny the presence of potential underground storage tanks (USTs). Additionally, TPI was tasked with locating private utilities. The site consists of a vacant warehouse building located at the above address and as indicated on Figure 1. Upon arrival to the site on November 15th, 2019, TPI reviewed the site history with the client and performed a site walk to search for any visual evidence of USTs and/or on-site utilities. During the site walk the following areas of interest were noted:

- TPI noted no visual evidence of USTs.
- Utilities to be investigated include private electric, water, gas, communication, storm sewer, and sanitary sewer.

Methodology

Geophysical surveys are typically accomplished by employing the following techniques; GPR, Fisher TW6 electromagnetic metal detection (TW6 EM), a Geonics EM61-MK2 Time – Domain Electromagnetic Detector unit (EM61), radio frequency line locating (RF), and magnetics. The EM61 is a high power, high sensitivity metal detector capable of detecting both ferrous and non-ferrous metal. The TW6 EM unit sounds an audible alarm in the presence of a large mass of metal such as an UST. A description and discussion of these geophysical methods as well as TPI's standard procedures for performing geophysical surveys is found in Appendix A. In general, "blind surveys" are typically performed by initially scanning the site with a TW6 EM unit and/or an EM61 unit and noting areas of relatively high EM response. Locations with a high EM response are further investigated with GPR. Known utilities are typically traced with the RF unit, GPR, and the TW6 EM unit depending on the size, matrix and conductive properties of the line. EM units are typically not effective and practical in areas underlain with reinforced concrete and/or the presence of ubiquitous metallic objects.

During EM61 surveys the EM response is sampled at four time positions at each survey point (every 0.62-feet). These four readings allow for the discrimination of targets based on target size, shape, material, and orientation. Furthermore the EM61 is designed in such a way that it is possible to distinguish deeper objects from shallow ones. In Channel D mode, the system suppresses near surface targets that may mask the response of deeper, more important targets. This feature is useful when the purpose of the survey is to locate deeper targets, such as USTs, in the presence of near-surface metallic objects.

Geophysical Survey Results

The geophysical survey at this site was accomplished with the TW6 EM, EM61, RF, and GPR units. The EM61 unit was used to scan accessible sections of the parking lot on the west side of the building with the exception of areas within five-feet of metallic objects (walls, vehicles, fences, etc.). The TW6 EM unit was used to scan the landscaped area immediately east of the building. The GPR survey was performed over metallic anomalies identified during the EM surveys and in areas immediately around metallic objects. Known utilities were traced with RF and confirmed with GPR. Results of the geophysical survey were marked on the ground with paint. Maps of the survey results are contained in this report and Appendix A. Results of the geophysical survey are as follows:

Parking lot west of building (UST and Utility Scan)
- TPI detected a 50’ x 16’ significant metallic anomaly within the EM61 data (“A1”, Figure 1 and 2). GPR transects collected across the anomaly indicated a steel reinforced concrete slab at approximately 1.5’ below ground surface.
- While no distinct, UST-style reflections were detected, steel reinforcement limits the effectiveness of GPR. As a result, TPI can never eliminate the possibility of an undetected UST below any steel reinforced slab.
- TPI detected and marked water lines in addition to a pipe-style anomaly (unknown utility) as indicated in Figure 1.

Landscaped area east of building (UST and Utility Scan)
- TPI detected no significant metallic anomalies within this survey area.
- TPI detected and marked a water line in addition to a pipe-style anomaly (unknown utility) as indicated in Figure 1.

Rail spur area south of building (Utility Scan only due to presence of steel rails)
- TPI detected and marked a water line as indicated in Figure 1.

TPI completes non-intrusive geophysical surveys using equipment and techniques representing best available technology. TPI does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen and varying site-specific conditions such as metal-reinforced concrete. In practical terms, TPI serves to reduce the risk of encountering subsurface utilities during excavation operations or greatly increase the chance of locating man made subsurface objects depending on the goal of the project. The results of this investigation should only be used as a tool and should not be considered a guarantee regarding the presence or absence of USTs or piping.

If you should have any questions or concerns, please do not hesitate to contact us.

Your Project Team at TPI:

Frank Fendler, M.S., P.G.
President
ffendler@tpienv.com

Mike Robbins, M.S.
Geologist/Boston Manager
mrobbins@tpienv.com

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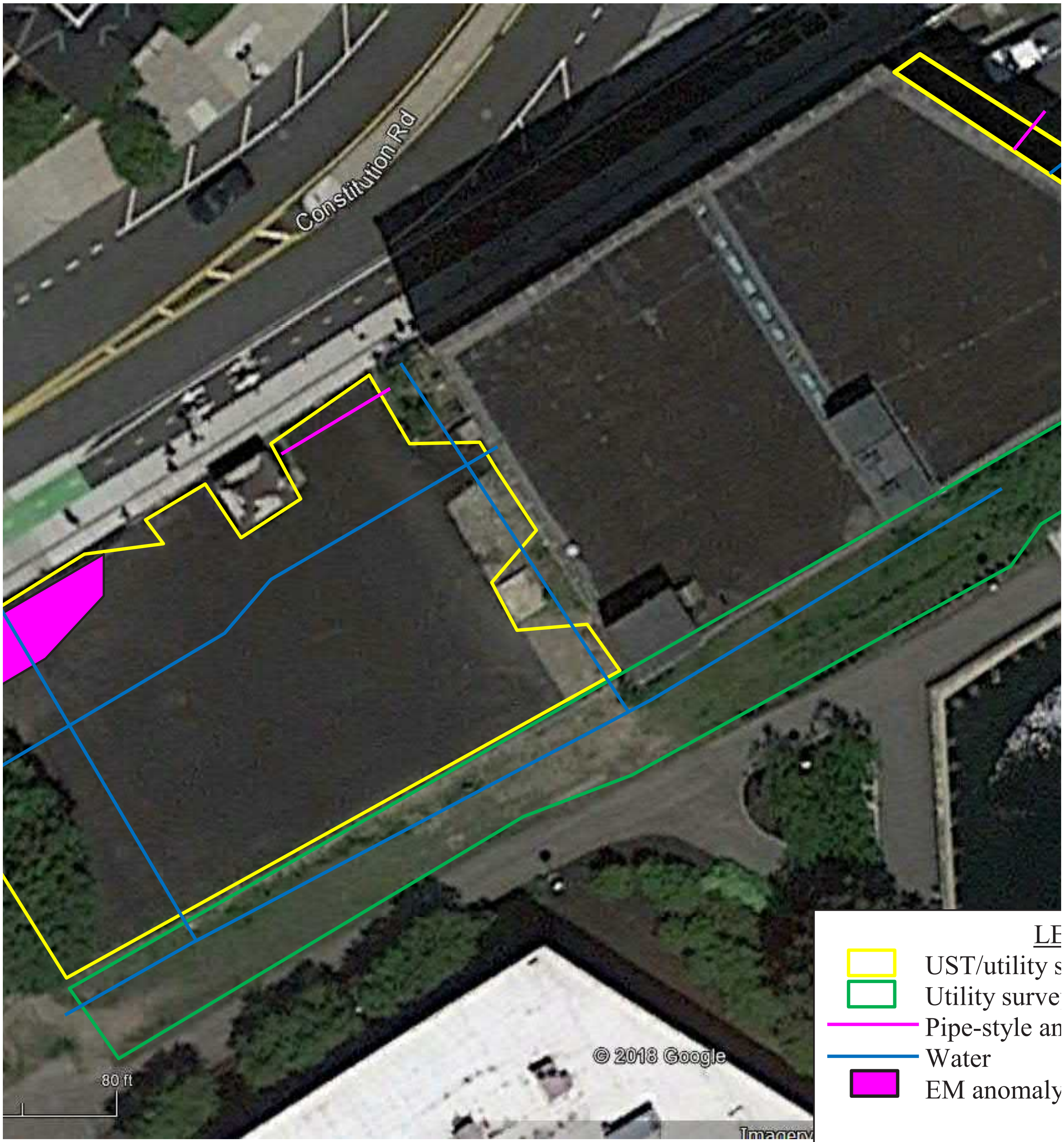
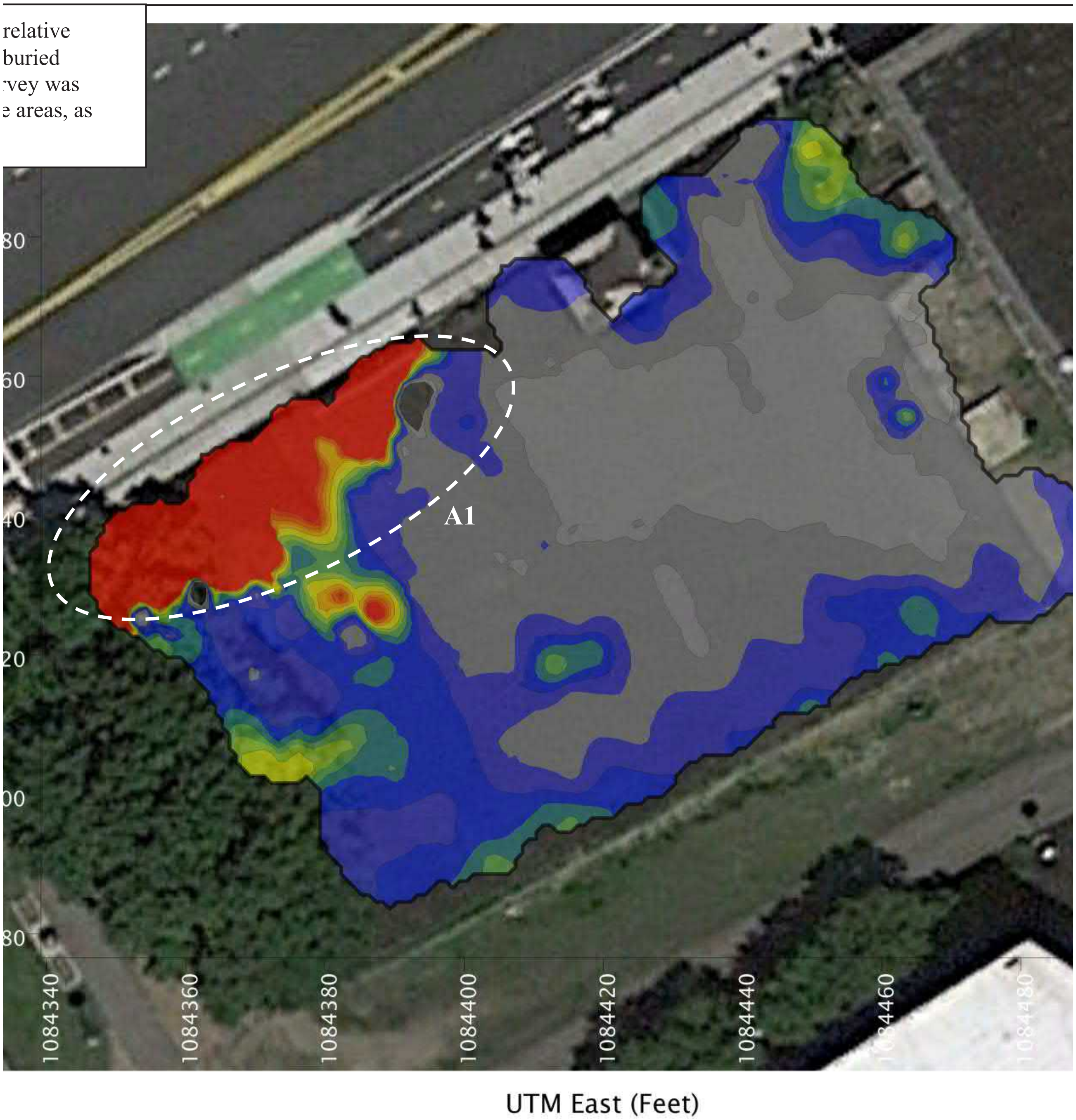


	115 Constitution Rd, Charlestown MA		Fig
	Client: Beta	Date: 11/15/19	Geophysical

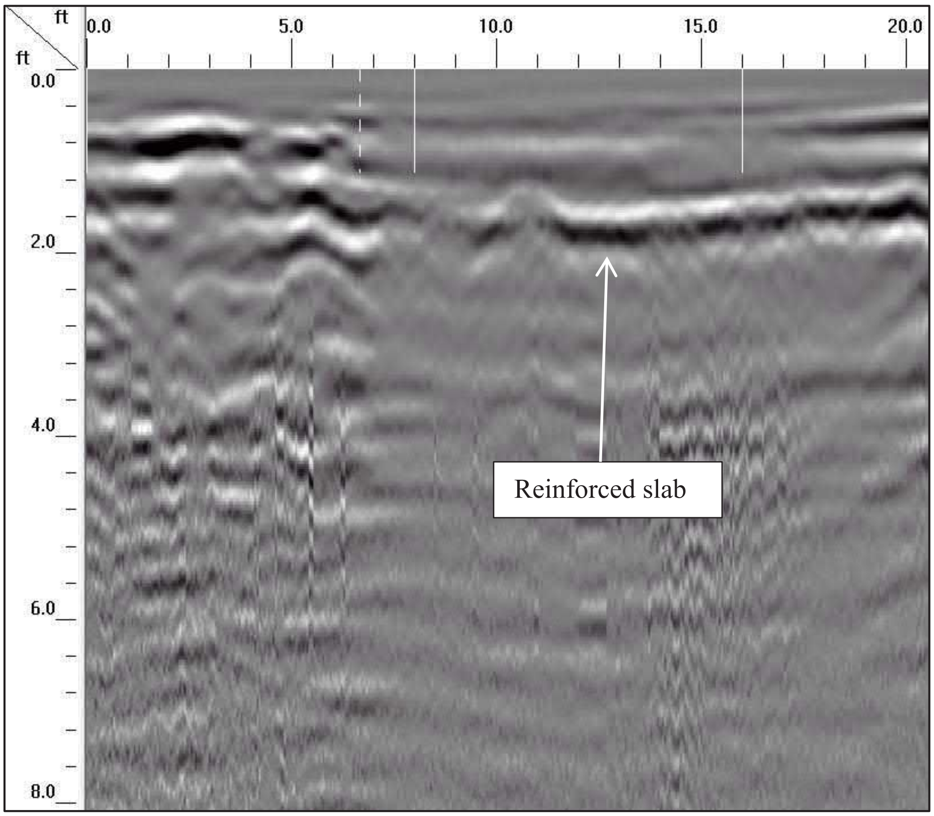


	115 Constitution Rd, Charlestown MA		F
	Client: Beta	Date: 11/15/19	EM61 Results

Appendix A

Representative GPR Transect and Survey Methods

GPR Transect 1
West across A1 (steel reinforced slab)

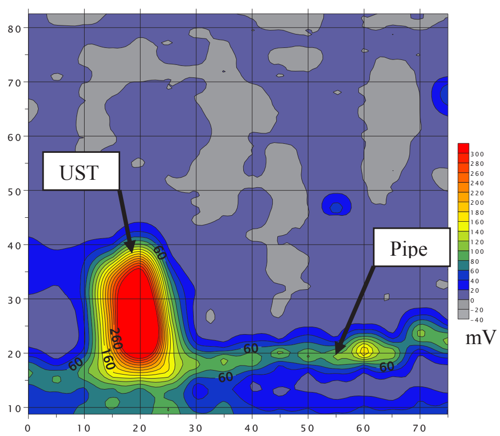


Attachment A
TPI's Geophysical Survey Equipment & Methods

Geonics EM61-MK2

The EM61 is a high resolution time-domain metal detector which is used to detect ferrous and non-ferrous metallic objects. It consists of a powerful transmitter that generates a pulsed primary magnetic field, which induces eddy currents in nearby metallic objects. The decay of these currents is measured by two receiver coils mounted on the coil assembly. The responses are recorded and displayed by an integrated computer based digital data logger with real time numeric and graphic display. Two ports on the logger allows simultaneous collection of EM and GPS data. For further processing and interpretation data can be transferred to a laptop computer in the field and a color contoured map of the EM61 reponse is prepared (see below).

EM61 Color Contoured Map



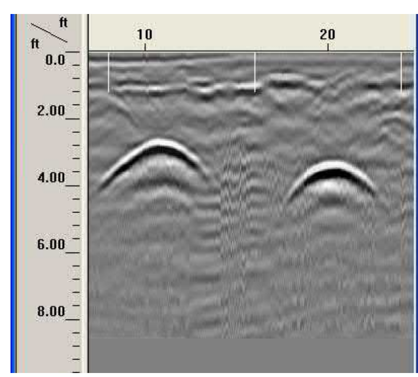
The EM61-MK2 detects a single 55 gallon drum at a depth of over 10-feet beneath the instrument, yet it is relatively insentsitive to interference from nearby surface metal such as fences, buildings, cars, etc. By making the measurement at a relatively long time after termination of the primary pulse, the response is practically independent of the electrical conductivity of the ground.

Due to its unique coil arrangements, the response curve is a single well defined positive peak greatly facilitating quick and accurate location of the target, the depth of which can usually be estimated from the width of the response and/or from relative response from each of the two receiver coils.

GPR

This method is one of the most powerful and cost effective methods of locating man made objects and stratigraphic layers in the subsurface. It is an active method that transmits electromagnetic pulses into the ground, the radar pulses are reflected from materials or layers of differing dielectric and electrical conductive properties. The GPR computer measures the elapsed time in billionths of a second (nanoseconds) from when the pulses are sent and when they are received back at the surface that can then be converted to depth. Results of the radar scan are displayed as a continuous cross-section of the subsurface on the computer screen in real time. Metallic materials such as tanks, pipes, conduits, rebar etc. have vastly different dielectric properties then soils so there reflections are striking and relatively easy to identify. Pipes and tanks constructed of PVC, concrete, and terracotta also produce distinct reflections, however, these reflections are typically not as striking as metallic materials. A typical radar image of two metallic underground storage tanks is found below.

GPR Image of Two Metallic USTs



GPR surveys are conducted with the most advanced GPR equipment currently available

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Attachment A
TPI's Geophysical Survey Equipment & Methods

including a Geophysical Survey Systems (GSSI) SIR-3000 subsurface radar unit with a 400 MHz antenna. The 400 MHz antenna has a depth range of approximately 20-feet and other antennas may be employed with the system depending on specific site conditions and objectives of the survey. The GPR transect data may be saved on the internal hard drive and transferred to a PC for storage, printing, and post processing. GSSI is the world leader in the development of GPR systems and was the first company to commercialize GPR in 1970. GPR hardware and software has improved dramatically over the last several years allowing for relatively rapid and economical GPR surveys. With 3-dimensional capabilities, the latest GPR software takes data processing a step farther then the former 2-dimensional viewing method. Three-dimensional visualization helps you to see the whole picture, giving you a powerful tool to interpret complex utility layouts and identify subtle linear features that may have otherwise been missed.

GPR surveys are typically conducted by searching for GPR hyperbolas indicative of subsurface pipes or tanks signatures in the vicinity of known entities. Theses signatures are marked on the ground and areas progressively further from the known entity are scanned and marked. This process is continued until the GPR operator performed enough scans to determine and mark the subsurface pipe, tank or anomaly. During this process the GPR data is typically not saved due to the immense size of the data files. After this phase of the GPR survey is completed, representative GPR transects or grids are performed and saved for the report and post processing. Some of the factors that may negatively affect GPR results include clay soils, rebar in concrete, high moisture content, depth of the target, and the integrity, size, and material of the target.

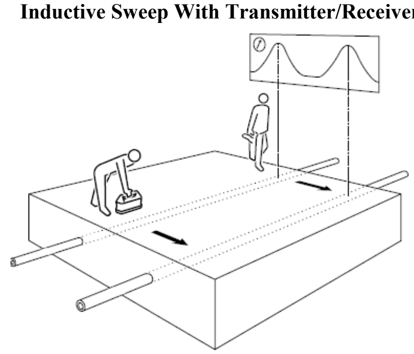
TW-6 EM Unit

TPI routinely employs a Fisher TW-6 electromagnetic metal detector when performing GPR surveys. The TW-6 creates an electromagnetic field with a transmitting coil and measures the strength of that field with a receiving coil. As the TW-6 passes over electrically conductive materials such as metal tanks or drums the field is distorted and the instrument produces an audible alarm based on the degree of the distortion. The TW-6 can detect conductive materials the size of drums or small tanks to depths of 10-feet. The instrument is actually a relatively poor metal detector which makes it ideal for locating large conductive materials such as metal drums, medium to large metal pipes, reinforced concrete pipes, and metal tanks. A more sensitive metal detector would produce "false positives" on small pieces of metal that are typically found in fill and throughout developed sites. If the survey area is underlain by reinforced concrete or cars and other large surficial metallic features are within 10-feet, the TW-6 will not be useful.

Line Locating

Line locating is performed with a Radiodetection RD400 PXL-2 line locator with a 433 HCTX-2 transmitter. The transmitter emits a specific radio or electromagnetic signal which is indirectly induced or directly conducted onto the metallic line. The transmitter is capable of producing frequencies of 512 Hz, 8 kHz, or 33 kHz and the receiver is configured for the specific transmitted frequency. The induced signal is coupled with the line by either using an induction clamp which surrounds an exposed line or placing the transmitter above a buried line and transmitting the signal to it. The receiver may also be used in a passive locate mode (power) to identify the presence of current carrying lines. Nonmetallic lines may also be located by snaking a sonde down accessible lines with push rods. A sonde is a small transmitter that emits a specific electromagnetic frequency which can be detected by the receiver at depths of 12 to 16-feet.

Inductive Sweep With Transmitter/Receiver



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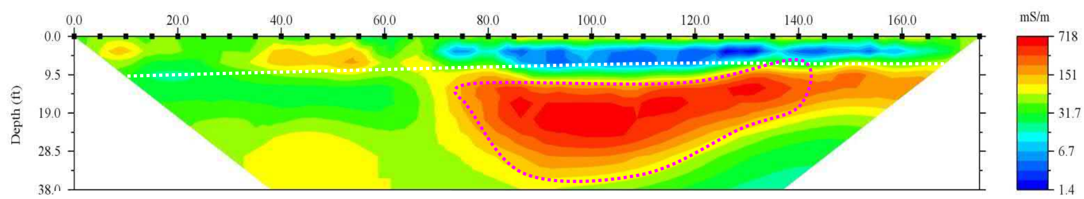
Attachment A
TPI's Geophysical Survey Equipment & Methods

Resistivity

TPI conducts subsurface resistivity surveys using the AGI SuperSting R8 IP Earth Resistivity and IP Meter. The SuperSting unit measures the voltage drop of an induced electrical current across numerous electrodes as it travels through the electrically heterogenous subsurface. Multiple survey profiles are completed in this manner based upon the specific conditions of the field area in order to assemble a complete characterization of the ground resistivity properties. The resistivity data is then processed and examined for evidence of significant subsurface features including bedrock surfaces, perched groundwater tables, cavities/sinkholes, or potential contaminant plumes.

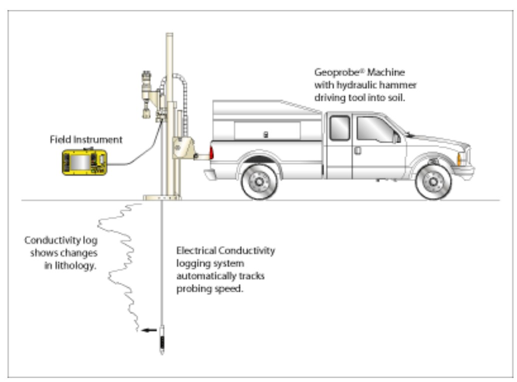
AGI SuperSting R8 IP Earth Resistivity and IP Meter assembly.



Resistivity pseudosection across a backfilled canal. Approximately 10' of high resistivity/low conductivity surficial fill (blue) over low resistivity/high conductivity canal backfill (orange-red).

Down-hole Conductivity

TPI is also able to collect down-hole soil conductivity data with an electric conductivity probe. The EC probe is driven into the subsurface by a direct push unit. A current is induced in the native soil between two contacts at opposite ends of the probe. The soil conductivity is then calculated based upon the ratio of induced current to resultant voltage across the probe. Down-hole EC profiling is particularly useful in the efficient determination of soil grain size (permeable sands vs impermeable clays), water content, and metal content.



Electrical conductivity probe

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APPENDIX D

Boring Logs, prepared by Jacobs Engineering Group

GrfcText\BORING LOG KEY 4/8/2016 11:34:36 AM

JACOBS

BORING LOG KEY

120 St. James Ave
5th Floor
Boston, Massachusetts
02216

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
1	2	3	4	5	6	7	8	9	10	11

COLUMN DESCRIPTIONS

1 ELEV (feet): Elevation in feet as per datum specified on log.
2 DEPTH (feet): Depth in feet below the ground surface or barge.
3 SAMPLE DATA: Type of soil/rock sample and data collected over the depth interval shown.
4 N-VALUE (Uncorrected): Cumulative number of uncorrected blows for the middle two six-inch intervals (blows/foot).
5 SAMPLE NUMBER: Sample identification number.
6 DEPTH INTERVAL (feet): Depth interval of the soil or rock sample collected.
7 PEN/REC (inch/inch): Soil or rock sample penetration / amount of soil or rock recovered.
8 PID (parts per million): PID reading observed during drilling.
9 LAYER NAME: Inferred name and delineation of subsurface strata.
10 SOIL AND ROCK DESCRIPTION: Description of material encountered.
11 NOTES: Comments/observations regarding drilling/sampling made by driller or field personnel.

BURMISTER SOIL CLASSIFICATION (INORGANIC)

COMPONENT	NAME	PROPORTIONAL TERM	PERCENT BY WEIGHT	GRADATION DESIGNATIONS	PROPORTIONS OF GRANULAR COMPONENT
MAJOR	GRAVEL SAND FINES*	n/a	> 50	fine medium	< 10% coarse & medium < 10% coarse & fine
Minor	Gravel Sand Fines*	and some little trace	35 - 50 20 - 35 10 - 20 0 - 10	fine to medium medium to coarse fine to coarse	< 10% coarse < 10% fine all > 10%

PARTICLE SIZE DEFINITIONS

SOIL	FRACTION	SIEVE NO.	SIEVE SIZE
Gravel	coarse fine	3 in to 3/4 in 3/4 in to No.4	75mm - 19mm 19mm - 4.75mm
Sand	coarse medium fine	No.4 to No.10 No.10 to No.40 No.40 to No.200	4.75mm - 2.0mm 2.0mm - .43mm 0.43mm - 0.08mm
Silt	n/a	< No.200	< 0.075mm

GRANULAR SOILS: DENSITY	GRANULAR SOILS: SPT N-VALUE	PLASTICITY	PLASTICITY INDEX	FINES*	THREAD DIAMETER	FINE SOILS: CONSISTENCY	FINE SOILS: SPT N-VALUE	FINE SOILS: UC STRENGTH
Very Loose	< 4	Non-Plastic	0	SILT	None	Very Soft	< 2	< 0.25 tsf
Loose	4 - 10	Slight	1 - 5	Clayey SILT	1/4" (6mm)	Soft	2 - 4	0.25 - 0.50 tsf
Medium Dense	10 - 30	Low	5 - 10	SILT & CLAY	1/8" (3mm)	Medium	4 - 8	0.50 - 1.0 tsf
Dense	30 - 50	Medium	10 - 20	CLAY & SILT	1/16" (1.5mm)	Stiff	8 - 15	1.0 - 2.0 tsf
Very Dense	> 50	High	20 - 40	Silty CLAY	1/32" (0.75mm)	Very Stiff	15 - 30	2.0 - 4.0 tsf
		Very High	> 40	CLAY	1/64" (0.4mm)	Hard	> 30	> 4.0 tsf

BURMISTER SOIL CLASSIFICATION (ORGANIC)

Fibrous PEAT - Light weight, spongy, mostly visible organic matter, water squeezes readily from sample. Typically near top of deposit.
Fine Grained PEAT - Light weight, spongy, little visible organic matter, water squeezes readily from sample. Typically below fibrous PEAT.
Organic SILT - Typically gray to dark gray, often has strong H2S odor. Typically contains shells or shell fragment. Light weight. Usually found near coastal regions. May contain wide range of sand fractions.

MASSDOT VISUAL IDENTIFICATION OF SOILS

COMPONENT	NAME	PROPORTIONAL TERM	PERCENT BY WEIGHT
MAJOR	GRAVEL SAND FINES	n/a	> 50
Minor	Gravel Sand Fines	and some trace	40 - 50 10 - 40 < 10

PARTICLE SIZE DEFINITIONS

SOIL	FRACTION	SIEVE NO.	SIEVE SIZE
Boulders	n/a	> 12 in	> 305mm
Cobbles	n/a	12 in to 3 in	305mm - 75mm
Gravel	coarse medium fine	3 to 1 in 1 in to 3/8 in 3/8 in to No.10	75mm - 25mm 25mm - 9.5mm 9.5mm - 2.0mm
Sand	coarse fine	No.10 to No.40 No.40 to No.200	2.0mm - 0.425mm 0.425mm - 0.075mm
Silt	n/a	< No.200	< 0.075mm

GRANULAR SOILS: DENSITY	GRANULAR SOILS: SPT N-VALUE	FINE SOILS: CONSISTENCY	FINE SOILS: SPT N-VALUE
Very Loose	< 4	Very Soft	< 2
Loose	4 - 10	Soft	2 - 4
Medium Dense	10 - 30	Medium Stiff	4 - 8
Dense	30 - 50	Stiff	8 - 15
Very Dense	> 50	Very Stiff	15 - 30
		Hard	> 30

GRAPHIC SYMBOLS

Split-Spoon Sample (SS) and Blow Counts per 6" REC (in)

Rock Core (RC) and RQD (%) REC (%)

Undisturbed (U) Shelby Tube (P) Piston

Auger Sample (AS)

Jar Sample (JS)

Bag Sample (B)

ABBREVIATIONS

SS = Split Spoon Sampler
U = Undisturbed Sample (Shelby Tube)
P = Piston Sample
WOR = Weight of Rods
WOH = Weight of Hammer
SPT = Stadard Penetration Test (ASTM D2487)
PP = Pocket Penetrometer
PI = Plasticity Index
UC STRENGTH = Unconfined Compressive Strength
PID = Photoionization Detector
ppm = Part Per Million
REC = Recovery
RQD = Rock Quality Designation
Water Level

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-1
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	S. Mattloob	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID	N
20.0	Wash Boring w/3"Casing	10-08-2019 / 7:00 AM	10.0	Casing at depth 15'		COORD	E
84.0	NX Rock Core	10-11-2019 / 10:00 AM	10.0	Upon Completion (Casing pulled)		DATE START	10/7/19
94.0	Terminated					DATE END	10/11/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
									(0 - 1') Concrete	
		5 6 4 5	10	S1	1 - 3	24/4		FILL	S1: Moist, medium dense, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
		13 6 5 6	11	S2	3 - 5	24/0			S2: No Recovery	1
	5	12 10 9 4	19	S3	5 - 7	24/0 24/6			S3: No Recovery S3R: Similar to S1	2
		9 4 3 8	7	S4	7 - 9	24/4			S4: Wet, loose, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	3
	10	16 14 13 16	27	S5	9 - 11	24/5			S5: Wet, medium dense, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	15	22 40 40 30	80	S6	14 - 16	24/6			S6: Wet, very dense, brown, fine to coarse SAND, trace Gravel, trace Silt.	
								19		
	20	16 13 15 22	28	S7	19 - 21	24/20		CLAY	S7A (Top 14"): Wet, gray, Silty CLAY. PP = 2 tsf. S7B (Bottom 6"): Wet, gray, SILT, some fine Sand.	4
	25	8 9 12 14	21	S8	24 - 26	24/10			S8: Wet, very stiff, gray, Silty CLAY. PP = 1.5 tsf.	
	30	9 7 12 13	19	S9	29 - 31	24/24			S9: Wet, very stiff, gray, Silty CLAY. PP = 2 tsf.	
	35	6	30	S10	34 - 36	24/24			S10: Similar to S9	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Piece of gravel at spoon tip.
2. Redrove 3" diameter spoon to collect sample.
3. Piece of gravel at spoon tip.
4. PP indicates pocket penetrometer, the pocket penetrometer estimates unconfined compressive strength in tons per square foot (tsf).

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-1
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		SHEET 2 OF 3
JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		13 17 34								
	40	37 100/6"	100/6"	S11	39 - 40	12/8			S11: Wet, hard, gray, Silty CLAY. PP = 2 tsf.	5
								44		
	45	100/12"	100/12"	S12	44 - 45	12/2		TILL	S12: Wet, hard, SILT, some fine Sand, some fine to coarse Gravel.	6
	50	100/3"	100/3"	S13	49 - 49.3	3/1		TILL	S13: Wet, very dense, gray, fine to coarse GRAVEL, little fine to coarse Sand, little Silt.	7
	55	26 100/7"	100/7"	S14	54 - 55.1	13/2		TILL	S14: Wet, very dense, gray, fine to medium SAND and fine to coarse Gravel, little Silt.	
	60	100/3"	100/3"	S15	59 - 59.3	3/3		TILL	S15: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little Silt.	
	65	100/6"	100/6"	S16	64 - 64.5	6/6		TILL	S16: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, some Silt.	
	70	100/4"	100/4"	S17	69 - 69.3	4/0		TILL	S17: No Recovery	8
		100/5"	100/5"	S18	74 - 74.4	5/3		TILL		9

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

5. Piece of gravel stuck at spoon tip.
6. Boulder at depth 45' to 47'.
7. Added the drilling mud to the drilling water.
8. Piece of gravel stuck at spoon tip.
9. Piece of gravel stuck at spoon tip.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-1
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 3 OF 3
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75								S18: Wet, very denes, gray, fine to medium SAND, some fine Gravel, some Silt.	
	80	100/3"	100/3"	S19	79 - 79.3	3/1			S19: Wet, very dense, gray, fine to medium SAND and fine to coarse Gravel, little Silt.	
	85	RQD=31.3		C1	84 - 88	48/42		84 BEDROCK	C1: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 6 - 4 - 7 - 8	10
	90	RQD=20		C2	88 - 93	60/39			C2: Similar to C1	
	95	RQD=0		C3	93 - 94	12/10		94	C3: Moderately hard, moderately to slightly weathered, moderately fractured, amorphous, gray, ARGILLITE with closely spaced, moderately dipping to sub-horizontal fractures. Bottom of Borehole at 94 feet below mudline.	11
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

10. Top of bedrock at 84'.
11. Upon completion, borehole backfilled with cement, bentonite and sand.

LOG OF TEST BORING

JACOBS					
PROJECT	The Hoosac Building			BORING NO.	B-2/B-2A
LOCATION	Charlestown, Boston, MA				
OWNER	National Park Service				
JOB NUMBER	FDZE6000				SHEET 1 OF 2

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3" Casing	10-16-2019 / 9:00 AM	10.0 / Upon Completion (Casing pulled)			COORD E	
39.6	Terminated					DATE START	10/14/19
						DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
								FILL	(0 - 1') Concrete	
		5 6 6 6	12	S1	1 - 3	24/12		FILL	S1: Moist, medium dense, dark brown, fine to medium SAND and fine to coarse Gravel, trace Silt.	
	5	6 16 17 17	33	S2	4 - 6	24/0		FILL	S2: No Recovery	
	10	19 22 23 23	45	S3	9 - 11	24/8		FILL	S3: Moist, dense, dark brown, fine to coarse SAND, some fine Gravel, trace Silt.	1 2
	15	23 28 33 36	61	S4	14 - 16	24/8		FILL	S4: Moist, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, little Silt, trace brick fragments.	
								19		
	20	12 13 13 20	26	S5	19 - 21	24/24		CLAY	S5: Moist, very stiff, gray, Silty CLAY.	
	25	15 13 14 14	27	S6	24 - 26	24/24		CLAY	S6: Wet, very stiff, gray, Silty CLAY.	
	30	16 15 15 15	30	S7	29 - 31	24/24		CLAY	S7: Similar to S4	
	35	120/6"	120/6"	S8	34 - 34.6	6/4		CLAY	S8: Wet, hard, gray, CLAY, some fine to medium Gravel, trace Sand.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. At depth 13'; Lost all the drilling water; put casing down and hitted steel. Moved the hole 2'.
2. Upon completion, borehole backfilled with cement, bentonite and sand. Offset hole 2 feet south, redrill, see B-2A.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-2/B-2A
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 2 OF 2
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
								39		
	40	120/6"	120/6"	S9	39 - 39.6	6/4		39.6	S9: Wet, very dense, fine to medium SAND and Silt, some fine to medium Gravel (Till). Bottom of Borehole at 39.6 feet below mudline.	3 4
	45									
	50									
	55									
	60									
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

3. Upon completion, borehole backfilled with cement, bentonite and sand.
4. Boring logged by the driller.

LOG OF TEST BORING

JACOBS						
PROJECT	The Hoosac Building				BORING NO.	B-3
LOCATION	Charlestown, Boston, MA					
OWNER	National Park Service					
JOB NUMBER	FDZE6000					SHEET 1 OF 3
INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3" Casing	10-16-2019 / 2:00 PM	10.0 / Upon Completion (In Casing)			COORD E	
83.0	Terminated					DATE START	10/16/19
						DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	5	22 16 26	42	S1	4 - 5.5	18/4		FILL	S1: Wet, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt, trace brick fragments.	
	10	15 15 15	30	S2	9 - 10.5	18/10		FILL	S2: Wet, dense, dark brown, fine to medium SAND, trace brick fragments.	
	15	17 16 16 20	32	S3	14 - 16	24/10		FILL	S3: Wet, dense, dark brown, fine to medium SAND, and fine to coarse Gravel, some brick fragments.	
	19									
	20	8 10 9 9	19	S4	19 - 21	24/21		CLAY	S4: Wet, very stiff, gray, Silty CLAY.	
	25	13 13 13 13	26	S5	24 - 26	24/24		CLAY	S5: Similar to S4	
	30	15 15 13 15	28	S6	29 - 31	24/24		CLAY	S6: Similar to S5	
	34									
	35	16	54	S7	34 - 35.8	21/20			S7: Wet, hard, gray, Silty CLAY and fine to medium Sand.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-3
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		16 38 100/3"								
	40	29 33 100/4"	133/10"	S8	39 - 40.3	16/8			S8: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little Silt.	1
	45									
	50									
	55									
	60							TILL		
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-3
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 3 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
	80									
								83	Bottom of Borehole at 83 feet below mudline.	2 3 4
	85									
	90									
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Roller bit refusal at 83', possible top of bedrock.
3. Upon completion, borehole backfilled with cement, bentonite and sand.
4. Boring logged by the driller.

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-4
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		
JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	J. Mientkiewicz	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D-50 ATV	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft)	REMARKS / SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3" Casing	10-14-2019 / 2:00 PM	9.0	Upon Completion (In Casing)		COORD E	
79.0	Terminated					DATE START	10/14/19
						DATE END	10/15/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		3 6 100/3"	106/9"	S1	0 - 1.3	15/10		FILL	S1: Dry, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	5	13 19 27 75	46	S2	4 - 6	24/12		FILL	S2: Dry, dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	10	8 15 27 33	42	S3	9 - 11	24/10		FILL	S3: Wet, dense, brown, fine to coarse SAND, trace Gravel.	
	15	5 3 3 5	6	S4	14 - 16	24/16		FILL	S4: Wet, medium stiff, gray, Silty CLAY, trace Gravel.	
								19		
	20	3 5 7 5	12	S5	19 - 21	24/12		CLAY	S5: Wet, stiff, gray, Silty CLAY.	
	25	3 4 5 4	9	S6	24 - 26	24/20		CLAY	S6: Similar to S5	
	30	6 5 6 6	11	S7	29 - 31	24/18		CLAY	S7: Similar to S5	
	35	7	12	S8	34 - 36	24/24		CLAY	S8: Similar to S5	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS			BORING NO.	B-4
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 2 OF 3
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		6 6 7								
								39		
	40	12 15 12 27	27	S9	39 - 41	24/10			S9: Wet, medium dense, fine to coarse SAND and SILT, some fine to coarse Gravel.	
	45	4 12 17 20	29	S10	44 - 46	24/10			S10: Wet, medium dense, fine to coarse SAND and fine to coarse Gravel, little Silt.	
	50	17 15 20 25	35	S11	49 - 51	24/12			S11: Wet, dense, brown, fine to coarse SAND and fine to coarse Gravel, little Silt.	1
	55									
	60							TILL		
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-4
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 3 OF 3
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
								79	Bottom of Borehole at 79 feet below mudline.	2 3 4
	80									
	85									
	90									
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Roller bit refusal at 79'. Possible top of bedrock.
3. Upon completion, hole backfilled with soil cuttings and sand, asphalt patched/restored.
4. Boring logged by the driller. Some soil descriptions editted by Jacobs.

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-6
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		
JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	J. Mientkiewicz	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D-50 ATV	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft)	REMARKS			
				SPT HAMMER	140 lb Safety	GRID	N
20.0	Wash Boring w/3"Casing	10-15-2019 / 3:00 PM	10.0	Upon Completion (In Casing)		COORD	E
84.0	NX Rock Core					DATE START	10/15/19
93.0	Terminated					DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		9 9 9 5	18	S1	0 - 2	24/10		FILL	S1: Dry, medium dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	5	4 2 4 4	6	S2	4 - 6	24/6			S2: Dry, loose, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	10	10 8 8 9	16	S3	9 - 11	24/6			S3: Wet, medium dense, brown, fine to coarse SAND, trace Silt.	
	15	3 3 5 8	8	S4	14 - 16	24/12			S4: Wet, loose, brown, fine to coarse SAND, trace Gravel, trace Silt.	
								19		
	20	1 2 3 4	5	S5	19 - 21	24/24		CLAY	S5: Wet, medium stiff, gray, Silty CLAY.	
	25	WOH 2 3 2	5	S6	24 - 26	24/24			S6: Similar to S5	
	30	WOH WOH WOH 4	0	S7	29 - 31	24/24			S7: Wet, very soft, gray, Silty CLAY.	
	35	WOH	4	S8	34 - 36	24/24			S8: Wet, soft, gray, Silty CLAY.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS			BORING NO.	B-6
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 2 OF 3
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOH 4 4								
	40	WOH WOH 2 4	2	S9	39 - 41	24/22			S9: Similar to S8	
	45	WOH WOH 6 5	6	S10	44 - 46	24/24			S10: Wet, medium stiff, gray, Silty CLAY and fine Sand.	
								49		
	50	7 3 3 9	6	S11	49 - 51	24/14		TILL	S11: Wet, medium stiff, gray, SILT, trace Gravel.	
	55	6 5 7 8	12	S12	54 - 56	24/12			S12: Wet, stiff, gray, SILT, trace Gravel.	1
	60									
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS		
PROJECT	The Hoosac Building	BORING NO. B-6
LOCATION	Charlestown, Boston, MA	
OWNER	National Park Service	SHEET 3 OF 3
JOB NUMBER	FDZE6000	

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
	80									
	84	RQD=0		C1	84 - 86	24/18		84 BEDROCK	C1: Moderately hard, moderately to slightly weathered, moderately fractured, amorphous, gray, ARGILLITE with closely spaced, moderately dipping to sub-horizontal fractures. Coring Time (mins/ft): 3 - 6	2
	86	RQD=42.7		C2	86 - 90	48/41		BEDROCK	C2: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 3 - 3 - 5 - 5	
	90	RQD=38.9		C3	90 - 93	36/33		BEDROCK	C3: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 6 - 7 - 6	
	93							93	Bottom of Borehole at 93 feet below mudline.	3 4
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Top of Bedrock at 84'.
3. Upon completion, hole backfilled with soil cuttings and sand, asphalt patched/restored.
4. Boring logged by the driller. Some soil descriptions editted by Jacobs.

APPENDIX E

Certificates of Analysis

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Marylou Armstrong
Beta Engineering
315 Norwood Park South
Norwood, MA 02062

RE: Hoosacs - CNY (6283)
ESS Laboratory Work Order Number: 19J1001

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

SAMPLE RECEIPT

The following samples were received on October 28, 2019 for the analyses specified on the enclosed Chain of Custody Record.

To achieve CAM compliance for MCP data, ESS Laboratory has reviewed all QA/QC Requirements and Performance Standards listed in each method. Holding times and preservation have also been reviewed. All CAM requirements have been performed and achieved unless noted in the project narrative.

Each method has been set-up in the laboratory to reach required MCP standards. The methods for aqueous VOA and Soil Methanol VOA have known limitations for certain analytes. The regulatory standards may not be achieved due to these limitations. In addition, for all methods, matrix interferences, dilutions, and %Solids may elevate method reporting limits above regulatory standards. ESS Laboratory can provide, upon request, a Limit Checker (regulatory standard comparison spreadsheet) electronic deliverable which will highlight these exceedances.

Low Level VOA vials were frozen by ESS Laboratory on 10/28/19 at 22:15.

Question I: All samples for EPh and Metals were analyzed for a subset of the required MCP list per the client's request.

Lab Number	Sample Name	Matrix	Analysis
19J1001-01	B-3	Soil	6010C, 7471B, 8082A, 8100M, 8260B Low, 8270D, 9050A
19J1001-02	B-4	Soil	6010C, 7471B, 8082A, 8100M, 8260B Low, 8270D, 9050A
19J1001-03	B-6	Soil	6010C, 7471B, 8082A, 8100M, 8260B Low, 8270D, 9050A

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
ESS Laboratory Work Order: 19J1001

PROJECT NARRATIVE

5035/8260B Volatile Organic Compounds / Low Level

19J1001-02 **Surrogate recovery(ies) outside of criteria. Reextraction/Reanalysis confirms results (SC).**
Dibromofluoromethane (18% @ 70-130%)

C9J0618-CCV1 **Continuing Calibration %Diff/Drift is below control limit (CD-).**
Methylene Chloride (22% @ 20%)

8082A Polychlorinated Biphenyls (PCB)

19J1001-01 **Surrogate recovery(ies) below lower control limit (S-).**
Tetrachloro-m-xylene (29% @ 30-150%)

8270D Semi-Volatile Organic Compounds

19J1001-02 **Surrogate recovery(ies) outside of criteria. Reextraction/Reanalysis confirms results (SC).**
2,4,6-Tribromophenol (% @ 30-130%), 2-Chlorophenol-d4 (7% @ 30-130%), 2-Fluorophenol (3% @ 30-130%), Phenol-d6 (21% @ 30-130%)

C9J0575-CCV1 **Calibration required quadratic regression (Q).**
2,4-Dinitrophenol (95% @ 80-120%), Pentachlorophenol (89% @ 80-120%)

C9J0575-CCV1 **Continuing Calibration %Diff/Drift is below control limit (CD-).**
Di-n-octylphthalate (26% @ 20%), N-Nitrosodimethylamine (28% @ 20%)

C9J0602-CCV1 **Calibration required quadratic regression (Q).**
2,4-Dinitrophenol (104% @ 80-120%), Pentachlorophenol (92% @ 80-120%)

C9K0009-CCV1 **Calibration required quadratic regression (Q).**
2,4-Dinitrophenol (101% @ 80-120%), Pentachlorophenol (94% @ 80-120%)

C9K0028-CCV1 **Calibration required quadratic regression (Q).**
2,4-Dinitrophenol (80% @ 80-120%), Di-n-octylphthalate (103% @ 80-120%), Pentachlorophenol (91% @ 80-120%)

CJ92909-BS1 **Blank Spike recovery is below lower control limit (B-).**
N-Nitrosodimethylamine (38% @ 40-140%)

No other observations noted.

End of Project Narrative.

DATA USABILITY LINKS

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Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

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CERTIFICATE OF ANALYSIS

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CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

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CERTIFICATE OF ANALYSIS

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ESS Laboratory Work Order: 19J1001

MassDEP Analytical Protocol Certification Form

MADEP RTN: ______________________________

This form provides certification for the following data set: **19J1001-01 through 19J1001-03**

Matrices: ( ) Ground Water/Surface Water (X) Soil/Sediment ( ) Drinking Water ( ) Air ( ) Other:______________

CAM Protocol (check all that apply below):

(X) 8260 VOC CAM II A	(X) 7470/7471 Hg CAM III B	( ) MassDEP VPH (GC/PID/FID) CAM IV A	(X) 8082 PCB CAM V A	( ) 9014 Total Cyanide/PAC CAM VI A	( ) 6860 Perchlorate CAM VIII B
(X) 8270 SVOC CAM II B	( ) 7010 Metals CAM III C	( ) MassDEP VPH (GC/MS) CAM IV C	( ) 8081 Pesticides CAM V B	( ) 7196 Hex Cr CAM VI B	( ) MassDEP APH CAM IX A
(X) 6010 Metals CAM III A	( ) 6020 Metals CAM III D	(X) MassDEP EPH CAM IV B	( ) 8151 Herbicides CAM V C	( ) Explosives CAM VIII A	( ) TO-15 VOC CAM IX B

Affirmative responses to questions A through F are required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	Yes ( ) No (X)
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	Yes (X) No ( )
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	Yes (X) No ( )
D	Does the laboratory report comply with all the reporting requirements specified in the CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"?	Yes (X) No ( )
E	VPH, EPH, APH and TO-15 only: a. Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	Yes (X) No ( )
	b. APH and TO-15 Methods only: Was the complete analyte list reported for each method?	Yes ( ) No ( )
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	Yes (X) No ( )

Responses to Questions G, H and I below are required for "'Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocols(s)?	Yes (X) No ( )*
	***Data User Note:** Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.*	
H	Were **all** QC performance standards specified in the CAM protocol(s) achieved?	Yes ( ) No (X)*
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	Yes ( ) No (X)*

All negative responses must be addressed in an attached laboratory narrative.

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Laurel Stoddard

Date: November 05, 2019

Printed Name: Laurel Stoddard

Position: Laboratory Director

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry

Extraction Method: 3050B

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Arsenic	**3.46** (1.93)		6010C		1	KJK	11/01/19 19:12	2.9	100	CJ93161
Cadmium	ND (0.39)		6010C		1	KJK	11/01/19 19:12	2.9	100	CJ93161
Chromium	**10.9** (0.77)		6010C		1	KJK	11/01/19 19:12	2.9	100	CJ93161
Lead	**80.9** (3.85)		6010C		1	KJK	11/01/19 19:12	2.9	100	CJ93161
Mercury	**1.73** (0.376)		7471B		25	MKS	11/04/19 15:50	1.47	40	CJ93162

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 4.7
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,1,1,2-Tetrachloroethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1,1-Trichloroethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1,2,2-Tetrachloroethane	ND (0.0024)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1,2-Trichloroethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1-Dichloroethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1-Dichloroethene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,1-Dichloropropene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2,3-Trichlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2,3-Trichloropropane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2,4-Trichlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2,4-Trimethylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2-Dibromo-3-Chloropropane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2-Dibromoethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2-Dichlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2-Dichloroethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,2-Dichloropropane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,3,5-Trimethylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,3-Dichlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,3-Dichloropropane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,4-Dichlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
1,4-Dioxane	ND (0.119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
2,2-Dichloropropane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
2-Butanone	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
2-Chlorotoluene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
2-Hexanone	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
4-Chlorotoluene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
4-Isopropyltoluene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
4-Methyl-2-Pentanone	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Acetone	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Benzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Bromobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Bromochloromethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 4.7
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Bromodichloromethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Bromoform	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Bromomethane	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Carbon Disulfide	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Carbon Tetrachloride	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Chlorobenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Chloroethane	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Chloroform	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Chloromethane	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
cis-1,2-Dichloroethene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
cis-1,3-Dichloropropene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Dibromochloromethane	ND (0.0024)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Dibromomethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Dichlorodifluoromethane	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Diethyl Ether	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Di-isopropyl ether	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Ethyl tertiary-butyl ether	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Ethylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Hexachlorobutadiene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Isopropylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Methyl tert-Butyl Ether	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Methylene Chloride	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Naphthalene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
n-Butylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
n-Propylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
sec-Butylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Styrene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
tert-Butylbenzene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Tertiary-amyl methyl ether	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Tetrachloroethene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Tetrahydrofuran	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Toluene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 4.7
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
trans-1,2-Dichloroethene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
trans-1,3-Dichloropropene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Trichloroethene	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Trichlorofluoromethane	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Vinyl Chloride	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Xylene O	ND (0.0059)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Xylene P,M	ND (0.0119)		8260B Low		1	10/30/19 20:55	C9J0587	CJ93035
Xylenes (Total)	ND (0.0119)		8260B Low		1	10/30/19 20:55		[CALC]

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichloroethane-d4	*111 %*		*70-130*
Surrogate: 4-Bromofluorobenzene	*91 %*		*70-130*
Surrogate: Dibromofluoromethane	*103 %*		*70-130*
Surrogate: Toluene-d8	*104 %*		*70-130*

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 19.3
Final Volume: 10
Extraction Method: 3540C

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MJV
Prepared: 10/30/19 15:44

8082A Polychlorinated Biphenyls (PCB)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Aroclor 1016	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1221	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1232	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1242	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1248	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1254	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1260	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1262	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010
Aroclor 1268	ND (0.06)		8082A		1	10/31/19 18:07		CJ93010

	%Recovery	Qualifier	Limits
Surrogate: Decachlorobiphenyl	*75 %*		*30-150*
Surrogate: Decachlorobiphenyl [2C]	*70 %*		*30-150*
Surrogate: Tetrachloro-m-xylene	*29 %*	*S-*	*30-150*
Surrogate: Tetrachloro-m-xylene [2C]	*33 %*		*30-150*

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BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 20
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: CAD
Prepared: 10/29/19 12:19

8100M Total Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Total Petroleum Hydrocarbons	**31.4** (11.2)		8100M		1	10/30/19 15:59	C9J0571	CJ92911

	%Recovery	Qualifier	Limits
Surrogate: O-Terphenyl	*97 %*		*40-140*

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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 14
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,2,4-Trichlorobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
1,2-Dichlorobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
1,3-Dichlorobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
1,4-Dichlorobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4,5-Trichlorophenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4,6-Trichlorophenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4-Dichlorophenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4-Dimethylphenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4-Dinitrophenol	ND (2.00)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,4-Dinitrotoluene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2,6-Dinitrotoluene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2-Chloronaphthalene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2-Chlorophenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2-Methylnaphthalene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2-Methylphenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
2-Nitrophenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
3,3´-Dichlorobenzidine	ND (0.799)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
3+4-Methylphenol	ND (0.799)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
4-Bromophenyl-phenylether	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
4-Chloroaniline	ND (0.799)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
4-Nitrophenol	ND (2.00)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Acenaphthene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Acenaphthylene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Acetophenone	ND (0.799)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Aniline	ND (2.00)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Anthracene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Azobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Benzo(a)anthracene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Benzo(a)pyrene	ND (0.200)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Benzo(b)fluoranthene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Benzo(g,h,i)perylene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Benzo(k)fluoranthene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering	
Client Project ID: Hoosacs - CNY	ESS Laboratory Work Order: 19J1001
Client Sample ID: B-3	ESS Laboratory Sample ID: 19J1001-01
Date Sampled: 10/17/19 00:00	Sample Matrix: Soil
Percent Solids: 89	Units: mg/kg dry
Initial Volume: 14	Analyst: TAJ
Final Volume: 0.5	Prepared: 10/29/19 13:51
Extraction Method: 3546	

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
bis(2-Chloroethoxy)methane	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
bis(2-Chloroethyl)ether	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
bis(2-chloroisopropyl)Ether	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
bis(2-Ethylhexyl)phthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Butylbenzylphthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Chrysene	ND (0.200)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Dibenzo(a,h)Anthracene	ND (0.200)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Dibenzofuran	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Diethylphthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Dimethylphthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Di-n-butylphthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Di-n-octylphthalate	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Fluoranthene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Fluorene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Hexachlorobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Hexachlorobutadiene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Hexachloroethane	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Indeno(1,2,3-cd)Pyrene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Isophorone	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Naphthalene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Nitrobenzene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
N-Nitrosodimethylamine	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Pentachlorophenol	ND (2.00)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Phenanthrene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Phenol	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909
Pyrene	ND (0.399)		8270D		1	11/01/19 16:23	C9K0009	CJ92909

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichlorobenzene-d4	*58 %*		*30-130*
Surrogate: 2,4,6-Tribromophenol	*61 %*		*30-130*
Surrogate: 2-Chlorophenol-d4	*62 %*		*30-130*
Surrogate: 2-Fluorobiphenyl	*58 %*		*30-130*

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89
Initial Volume: 14
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Surrogate: 2-Fluorophenol		*62 %*		*30-130*				
Surrogate: Nitrobenzene-d5		*58 %*		*30-130*				
Surrogate: Phenol-d6		*64 %*		*30-130*				
Surrogate: p-Terphenyl-d14		*69 %*		*30-130*				

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-3
Date Sampled: 10/17/19 00:00
Percent Solids: 89

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-01
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Conductivity	**WL 1940** (5)		9050A		1	JLK	10/30/19 16:46	umhos/cm	CJ93061

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry

Extraction Method: 3050B

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Arsenic	**9.22** (1.94)		6010C		1	KJK	11/01/19 19:45	3.47	100	CJ93161
Cadmium	ND (0.39)		6010C		1	KJK	11/01/19 19:45	3.47	100	CJ93161
Chromium	**37.5** (0.78)		6010C		1	KJK	11/01/19 19:45	3.47	100	CJ93161
Lead	**9.03** (3.88)		6010C		1	KJK	11/01/19 19:45	3.47	100	CJ93161
Mercury	ND (0.027)		7471B		1	MKS	11/04/19 11:49	0.97	40	CJ93162

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 4.1
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,1,1,2-Tetrachloroethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1,1-Trichloroethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1,2,2-Tetrachloroethane	ND (0.0033)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1,2-Trichloroethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1-Dichloroethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1-Dichloroethene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,1-Dichloropropene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2,3-Trichlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2,3-Trichloropropane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2,4-Trichlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2,4-Trimethylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2-Dibromo-3-Chloropropane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2-Dibromoethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2-Dichlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2-Dichloroethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,2-Dichloropropane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,3,5-Trimethylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,3-Dichlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,3-Dichloropropane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,4-Dichlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
1,4-Dioxane	ND (0.164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
2,2-Dichloropropane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
2-Butanone	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
2-Chlorotoluene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
2-Hexanone	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
4-Chlorotoluene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
4-Isopropyltoluene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
4-Methyl-2-Pentanone	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Acetone	**0.0998** (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Benzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Bromobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Bromochloromethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035

ESS Laboratory
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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 4.1
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Bromodichloromethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Bromoform	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Bromomethane	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Carbon Disulfide	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Carbon Tetrachloride	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Chlorobenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Chloroethane	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Chloroform	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Chloromethane	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
cis-1,2-Dichloroethene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
cis-1,3-Dichloropropene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Dibromochloromethane	ND (0.0033)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Dibromomethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Dichlorodifluoromethane	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Diethyl Ether	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Di-isopropyl ether	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Ethyl tertiary-butyl ether	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Ethylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Hexachlorobutadiene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Isopropylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Methyl tert-Butyl Ether	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Methylene Chloride	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Naphthalene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
n-Butylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
n-Propylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
sec-Butylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Styrene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
tert-Butylbenzene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Tertiary-amyl methyl ether	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Tetrachloroethene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Tetrahydrofuran	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Toluene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 4.1
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
trans-1,2-Dichloroethene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
trans-1,3-Dichloropropene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Trichloroethene	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Trichlorofluoromethane	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Vinyl Chloride	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Xylene O	ND (0.0082)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Xylene P,M	ND (0.0164)		8260B Low		1	10/30/19 21:20	C9J0587	CJ93035
Xylenes (Total)	ND (0.0164)		8260B Low		1	10/30/19 21:20		[CALC]

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichloroethane-d4	*113 %*		*70-130*
Surrogate: 4-Bromofluorobenzene	*94 %*		*70-130*
Surrogate: Dibromofluoromethane	*18 %*	*SC*	*70-130*
Surrogate: Toluene-d8	*99 %*		*70-130*

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BAL Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 19.4
Final Volume: 10
Extraction Method: 3540C

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MJV
Prepared: 10/30/19 15:44

8082A Polychlorinated Biphenyls (PCB)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Aroclor 1016	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1221	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1232	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1242	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1248	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1254	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1260	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1262	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010
Aroclor 1268	ND (0.07)		8082A		1	10/31/19 18:27		CJ93010

	%Recovery	Qualifier	Limits
Surrogate: Decachlorobiphenyl	*82 %*		*30-150*
Surrogate: Decachlorobiphenyl [2C]	*77 %*		*30-150*
Surrogate: Tetrachloro-m-xylene	*76 %*		*30-150*
Surrogate: Tetrachloro-m-xylene [2C]	*81 %*		*30-150*

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 19.7
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: CAD
Prepared: 10/29/19 12:19

8100M Total Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Total Petroleum Hydrocarbons	**16.8** (13.7)		8100M		1	10/30/19 16:35	C9J0571	CJ92911

	%Recovery	Qualifier	Limits
Surrogate: O-Terphenyl	*98 %*		*40-140*

ESS Laboratory
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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 15.1
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,2,4-Trichlorobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
1,2-Dichlorobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
1,3-Dichlorobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
1,4-Dichlorobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4,5-Trichlorophenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4,6-Trichlorophenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4-Dichlorophenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4-Dimethylphenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4-Dinitrophenol	ND (2.23)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,4-Dinitrotoluene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2,6-Dinitrotoluene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2-Chloronaphthalene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2-Chlorophenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2-Methylnaphthalene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2-Methylphenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
2-Nitrophenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
3,3´-Dichlorobenzidine	ND (0.892)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
3+4-Methylphenol	ND (0.892)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
4-Bromophenyl-phenylether	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
4-Chloroaniline	ND (0.892)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
4-Nitrophenol	ND (2.23)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Acenaphthene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Acenaphthylene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Acetophenone	ND (0.892)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Aniline	ND (2.23)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Anthracene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Azobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Benzo(a)anthracene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Benzo(a)pyrene	ND (0.223)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Benzo(b)fluoranthene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Benzo(g,h,i)perylene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Benzo(k)fluoranthene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 15.1
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
bis(2-Chloroethoxy)methane	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
bis(2-Chloroethyl)ether	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
bis(2-chloroisopropyl)Ether	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
bis(2-Ethylhexyl)phthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Butylbenzylphthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Chrysene	ND (0.223)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Dibenzo(a,h)Anthracene	ND (0.223)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Dibenzofuran	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Diethylphthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Dimethylphthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Di-n-butylphthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Di-n-octylphthalate	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Fluoranthene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Fluorene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Hexachlorobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Hexachlorobutadiene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Hexachloroethane	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Indeno(1,2,3-cd)Pyrene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Isophorone	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Naphthalene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Nitrobenzene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
N-Nitrosodimethylamine	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Pentachlorophenol	ND (2.23)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Phenanthrene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Phenol	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909
Pyrene	ND (0.445)		8270D		1	11/01/19 16:52	C9K0009	CJ92909

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichlorobenzene-d4	*60 %*		*30-130*
Surrogate: 2,4,6-Tribromophenol	*%*	*SC*	*30-130*
Surrogate: 2-Chlorophenol-d4	*7 %*	*SC*	*30-130*
Surrogate: 2-Fluorobiphenyl	*61 %*		*30-130*

ESS Laboratory
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BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74
Initial Volume: 15.1
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Surrogate: 2-Fluorophenol		*3 %*	*SC*	*30-130*				
Surrogate: Nitrobenzene-d5		*60 %*		*30-130*				
Surrogate: Phenol-d6		*21 %*	*SC*	*30-130*				
Surrogate: p-Terphenyl-d14		*69 %*		*30-130*				

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Client Sample ID: B-4
Date Sampled: 10/17/19 00:00
Percent Solids: 74

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-02
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Conductivity	**WL 4380** (5)		9050A		1	JLK	10/30/19 16:46	umhos/cm	CJ93061

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry

Extraction Method: 3050B

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Arsenic	**21.0** (2.85)		6010C		1	KJK	11/01/19 20:07	2.1	100	CJ93161
Cadmium	ND (0.57)		6010C		1	KJK	11/01/19 20:07	2.1	100	CJ93161
Chromium	**36.7** (1.14)		6010C		1	KJK	11/01/19 20:07	2.1	100	CJ93161
Lead	**8.98** (5.70)		6010C		1	KJK	11/01/19 20:07	2.1	100	CJ93161
Mercury	ND (0.015)		7471B		1	MKS	11/04/19 12:03	1.53	40	CJ93162

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 6.9
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,1,1,2-Tetrachloroethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1,1-Trichloroethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1,2,2-Tetrachloroethane	ND (0.0017)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1,2-Trichloroethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1-Dichloroethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1-Dichloroethene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,1-Dichloropropene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2,3-Trichlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2,3-Trichloropropane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2,4-Trichlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2,4-Trimethylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2-Dibromo-3-Chloropropane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2-Dibromoethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2-Dichlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2-Dichloroethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,2-Dichloropropane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,3,5-Trimethylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,3-Dichlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,3-Dichloropropane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,4-Dichlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
1,4-Dioxane	ND (0.0867)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
2,2-Dichloropropane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
2-Butanone	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
2-Chlorotoluene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
2-Hexanone	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
4-Chlorotoluene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
4-Isopropyltoluene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
4-Methyl-2-Pentanone	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Acetone	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Benzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Bromobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Bromochloromethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 6.9
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Bromodichloromethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Bromoform	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Bromomethane	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Carbon Disulfide	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Carbon Tetrachloride	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Chlorobenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Chloroethane	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Chloroform	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Chloromethane	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
cis-1,2-Dichloroethene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
cis-1,3-Dichloropropene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Dibromochloromethane	ND (0.0017)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Dibromomethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Dichlorodifluoromethane	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Diethyl Ether	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Di-isopropyl ether	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Ethyl tertiary-butyl ether	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Ethylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Hexachlorobutadiene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Isopropylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Methyl tert-Butyl Ether	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Methylene Chloride	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Naphthalene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
n-Butylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
n-Propylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
sec-Butylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Styrene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
tert-Butylbenzene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Tertiary-amyl methyl ether	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Tetrachloroethene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Tetrahydrofuran	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Toluene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035

185 Frances Avenue, Cranston, RI 02910-2211 Tel: 401-461-7181 Fax: 401-461-4486 http://www.ESSLaboratory.com

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Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 6.9
Final Volume: 10
Extraction Method: 5035

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MEK

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
trans-1,2-Dichloroethene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
trans-1,3-Dichloropropene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Trichloroethene	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Trichlorofluoromethane	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Vinyl Chloride	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Xylene O	ND (0.0043)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Xylene P,M	ND (0.0087)		8260B Low		1	10/30/19 21:46	C9J0587	CJ93035
Xylenes (Total)	ND (0.00867)		8260B Low		1	10/30/19 21:46		[CALC]

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichloroethane-d4	*109 %*		*70-130*
Surrogate: 4-Bromofluorobenzene	*94 %*		*70-130*
Surrogate: Dibromofluoromethane	*104 %*		*70-130*
Surrogate: Toluene-d8	*101 %*		*70-130*

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 19.5
Final Volume: 10
Extraction Method: 3540C

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: MJV
Prepared: 10/30/19 15:44

8082A Polychlorinated Biphenyls (PCB)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Aroclor 1016	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1221	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1232	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1242	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1248	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1254	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1260	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1262	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010
Aroclor 1268	ND (0.06)		8082A		1	10/31/19 18:46		CJ93010

	%Recovery	Qualifier	Limits
Surrogate: Decachlorobiphenyl	*71 %*		*30-150*
Surrogate: Decachlorobiphenyl [2C]	*67 %*		*30-150*
Surrogate: Tetrachloro-m-xylene	*64 %*		*30-150*
Surrogate: Tetrachloro-m-xylene [2C]	*68 %*		*30-150*

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 19.2
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: CAD
Prepared: 10/29/19 12:19

8100M Total Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Total Petroleum Hydrocarbons	**148** (12.5)		8100M		1	10/30/19 17:11	C9J0571	CJ92911

	%Recovery	Qualifier	Limits
Surrogate: O-Terphenyl	*92 %*		*40-140*

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 14.3
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,2,4-Trichlorobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
1,2-Dichlorobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
1,3-Dichlorobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
1,4-Dichlorobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4,5-Trichlorophenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4,6-Trichlorophenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4-Dichlorophenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4-Dimethylphenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4-Dinitrophenol	ND (2.10)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,4-Dinitrotoluene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2,6-Dinitrotoluene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2-Chloronaphthalene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2-Chlorophenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2-Methylnaphthalene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2-Methylphenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
2-Nitrophenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
3,3´-Dichlorobenzidine	ND (0.837)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
3+4-Methylphenol	ND (0.837)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
4-Bromophenyl-phenylether	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
4-Chloroaniline	ND (0.837)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
4-Nitrophenol	ND (2.10)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Acenaphthene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Acenaphthylene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Acetophenone	ND (0.837)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Aniline	ND (2.10)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Anthracene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Azobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Benzo(a)anthracene	**0.530** (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Benzo(a)pyrene	**0.445** (0.210)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Benzo(b)fluoranthene	**0.459** (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Benzo(g,h,i)perylene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Benzo(k)fluoranthene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 14.3
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
bis(2-Chloroethoxy)methane	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
bis(2-Chloroethyl)ether	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
bis(2-chloroisopropyl)Ether	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
bis(2-Ethylhexyl)phthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Butylbenzylphthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Chrysene	**0.507** (0.210)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Dibenzo(a,h)Anthracene	ND (0.210)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Dibenzofuran	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Diethylphthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Dimethylphthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Di-n-butylphthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Di-n-octylphthalate	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Fluoranthene	**1.17** (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Fluorene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Hexachlorobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Hexachlorobutadiene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Hexachloroethane	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Indeno(1,2,3-cd)Pyrene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Isophorone	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Naphthalene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Nitrobenzene	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
N-Nitrosodimethylamine	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Pentachlorophenol	ND (2.10)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Phenanthrene	**0.912** (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Phenol	ND (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909
Pyrene	**1.03** (0.418)		8270D		1	11/01/19 17:20	C9K0009	CJ92909

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichlorobenzene-d4	*60 %*		*30-130*
Surrogate: 2,4,6-Tribromophenol	*61 %*		*30-130*
Surrogate: 2-Chlorophenol-d4	*65 %*		*30-130*
Surrogate: 2-Fluorobiphenyl	*62 %*		*30-130*

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
Client Sample ID: B-6
Date Sampled: 10/17/19 00:00
Percent Solids: 84
Initial Volume: 14.3
Final Volume: 0.5
Extraction Method: 3546

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil
Units: mg/kg dry
Analyst: TAJ
Prepared: 10/29/19 13:51

8270D Semi-Volatile Organic Compounds

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
Surrogate: 2-Fluorophenol		*64 %*		*30-130*				
Surrogate: Nitrobenzene-d5		*61 %*		*30-130*				
Surrogate: Phenol-d6		*68 %*		*30-130*				
Surrogate: p-Terphenyl-d14		*72 %*		*30-130*				

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Date Sampled: 10/17/19 00:00
Percent Solids: 84

ESS Laboratory Work Order: 19J1001
ESS Laboratory Sample ID: 19J1001-03
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Conductivity	**WL 3480** (5)		9050A		1	JLK	10/30/19 16:46	umhos/cm	CJ93061

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Client Project ID: Hoosacs - CNY
ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Total Metals										
Batch CJ93161 - 3050B										
Blank										
Arsenic	ND	2.50	mg/kg wet							
Cadmium	ND	0.50	mg/kg wet							
Chromium	ND	1.00	mg/kg wet							
Lead	ND	5.00	mg/kg wet							
LCS										
Arsenic	184	8.06	mg/kg wet	202.0		91	80-120			
Cadmium	123	1.61	mg/kg wet	149.0		83	80-120			
Chromium	156	3.23	mg/kg wet	182.0		86	80-120			
Lead	285	16.1	mg/kg wet	333.0		85	80-120			
LCS Dup										
Arsenic	191	8.20	mg/kg wet	202.0		95	80-120	4	20	
Cadmium	129	1.64	mg/kg wet	149.0		87	80-120	5	20	
Chromium	165	3.28	mg/kg wet	182.0		91	80-120	5	20	
Lead	298	16.4	mg/kg wet	333.0		89	80-120	4	20	
Batch CJ93162 - 7471B										
Blank										
Mercury	ND	0.033	mg/kg wet							
LCS										
Mercury	7.91	0.609	mg/kg wet	7.760		102	80-120			
LCS Dup										
Mercury	8.26	0.514	mg/kg wet	7.760		106	80-120	4	20	
5035/8260B Volatile Organic Compounds / Low Level										
Batch CJ93035 - 5035										
Blank										
1,1,1,2-Tetrachloroethane	ND	0.0050	mg/kg wet							
1,1,1-Trichloroethane	ND	0.0050	mg/kg wet							
1,1,2,2-Tetrachloroethane	ND	0.0020	mg/kg wet							
1,1,2-Trichloroethane	ND	0.0050	mg/kg wet							
1,1-Dichloroethane	ND	0.0050	mg/kg wet							
1,1-Dichloroethene	ND	0.0050	mg/kg wet							
1,1-Dichloropropene	ND	0.0050	mg/kg wet							
1,2,3-Trichlorobenzene	ND	0.0050	mg/kg wet							
1,2,3-Trichloropropane	ND	0.0050	mg/kg wet							
1,2,4-Trichlorobenzene	ND	0.0050	mg/kg wet							
1,2,4-Trimethylbenzene	ND	0.0050	mg/kg wet							
1,2-Dibromo-3-Chloropropane	ND	0.0050	mg/kg wet							
1,2-Dibromoethane	ND	0.0050	mg/kg wet							
1,2-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,2-Dichloroethane	ND	0.0050	mg/kg wet							
1,2-Dichloropropane	ND	0.0050	mg/kg wet							
1,3,5-Trimethylbenzene	ND	0.0050	mg/kg wet							

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Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
5035/8260B Volatile Organic Compounds / Low Level										
Batch CJ93035 - 5035										
1,3-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,3-Dichloropropane	ND	0.0050	mg/kg wet							
1,4-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,4-Dioxane	ND	0.0800	mg/kg wet							
2,2-Dichloropropane	ND	0.0050	mg/kg wet							
2-Butanone	ND	0.0100	mg/kg wet							
2-Chlorotoluene	ND	0.0050	mg/kg wet							
2-Hexanone	ND	0.0100	mg/kg wet							
4-Chlorotoluene	ND	0.0050	mg/kg wet							
4-Isopropyltoluene	ND	0.0050	mg/kg wet							
4-Methyl-2-Pentanone	ND	0.0100	mg/kg wet							
Acetone	ND	0.0100	mg/kg wet							
Benzene	ND	0.0050	mg/kg wet							
Bromobenzene	ND	0.0050	mg/kg wet							
Bromochloromethane	ND	0.0050	mg/kg wet							
Bromodichloromethane	ND	0.0050	mg/kg wet							
Bromoform	ND	0.0050	mg/kg wet							
Bromomethane	ND	0.0100	mg/kg wet							
Carbon Disulfide	ND	0.0050	mg/kg wet							
Carbon Tetrachloride	ND	0.0050	mg/kg wet							
Chlorobenzene	ND	0.0050	mg/kg wet							
Chloroethane	ND	0.0100	mg/kg wet							
Chloroform	ND	0.0050	mg/kg wet							
Chloromethane	ND	0.0100	mg/kg wet							
cis-1,2-Dichloroethene	ND	0.0050	mg/kg wet							
cis-1,3-Dichloropropene	ND	0.0050	mg/kg wet							
Dibromochloromethane	ND	0.0020	mg/kg wet							
Dibromomethane	ND	0.0050	mg/kg wet							
Dichlorodifluoromethane	ND	0.0100	mg/kg wet							
Diethyl Ether	ND	0.0050	mg/kg wet							
Di-isopropyl ether	ND	0.0050	mg/kg wet							
Ethyl tertiary-butyl ether	ND	0.0050	mg/kg wet							
Ethylbenzene	ND	0.0050	mg/kg wet							
Hexachlorobutadiene	ND	0.0050	mg/kg wet							
Isopropylbenzene	ND	0.0050	mg/kg wet							
Methyl tert-Butyl Ether	ND	0.0050	mg/kg wet							
Methylene Chloride	ND	0.0100	mg/kg wet							
Naphthalene	ND	0.0050	mg/kg wet							
n-Butylbenzene	ND	0.0050	mg/kg wet							
n-Propylbenzene	ND	0.0050	mg/kg wet							
sec-Butylbenzene	ND	0.0050	mg/kg wet							
Styrene	ND	0.0050	mg/kg wet							
tert-Butylbenzene	ND	0.0050	mg/kg wet							
Tertiary-amyl methyl ether	ND	0.0050	mg/kg wet							
Tetrachloroethene	ND	0.0050	mg/kg wet							

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
5035/8260B Volatile Organic Compounds / Low Level										
Batch CJ93035 - 5035										
Tetrahydrofuran	ND	0.0050	mg/kg wet							
Toluene	ND	0.0050	mg/kg wet							
trans-1,2-Dichloroethene	ND	0.0050	mg/kg wet							
trans-1,3-Dichloropropene	ND	0.0050	mg/kg wet							
Trichloroethene	ND	0.0050	mg/kg wet							
Trichlorofluoromethane	ND	0.0050	mg/kg wet							
Vinyl Chloride	ND	0.0100	mg/kg wet							
Xylene O	ND	0.0050	mg/kg wet							
Xylene P,M	ND	0.0100	mg/kg wet							
Surrogate: 1,2-Dichloroethane-d4	*0.0546*		mg/kg wet	*0.05000*		*109*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*0.0465*		mg/kg wet	*0.05000*		*93*	*70-130*			
Surrogate: Dibromofluoromethane	*0.0509*		mg/kg wet	*0.05000*		*102*	*70-130*			
Surrogate: Toluene-d8	*0.0504*		mg/kg wet	*0.05000*		*101*	*70-130*			
LCS										
1,1,1,2-Tetrachloroethane	0.0512	0.0050	mg/kg wet	0.05000		102	70-130			
1,1,1-Trichloroethane	0.0480	0.0050	mg/kg wet	0.05000		96	70-130			
1,1,2,2-Tetrachloroethane	0.0476	0.0020	mg/kg wet	0.05000		95	70-130			
1,1,2-Trichloroethane	0.0495	0.0050	mg/kg wet	0.05000		99	70-130			
1,1-Dichloroethane	0.0492	0.0050	mg/kg wet	0.05000		98	70-130			
1,1-Dichloroethene	0.0517	0.0050	mg/kg wet	0.05000		103	70-130			
1,1-Dichloropropene	0.0505	0.0050	mg/kg wet	0.05000		101	70-130			
1,2,3-Trichlorobenzene	0.0542	0.0050	mg/kg wet	0.05000		108	70-130			
1,2,3-Trichloropropane	0.0482	0.0050	mg/kg wet	0.05000		96	70-130			
1,2,4-Trichlorobenzene	0.0490	0.0050	mg/kg wet	0.05000		98	70-130			
1,2,4-Trimethylbenzene	0.0509	0.0050	mg/kg wet	0.05000		102	70-130			
1,2-Dibromo-3-Chloropropane	0.0419	0.0050	mg/kg wet	0.05000		84	70-130			
1,2-Dibromoethane	0.0511	0.0050	mg/kg wet	0.05000		102	70-130			
1,2-Dichlorobenzene	0.0500	0.0050	mg/kg wet	0.05000		100	70-130			
1,2-Dichloroethane	0.0491	0.0050	mg/kg wet	0.05000		98	70-130			
1,2-Dichloropropane	0.0501	0.0050	mg/kg wet	0.05000		100	70-130			
1,3,5-Trimethylbenzene	0.0508	0.0050	mg/kg wet	0.05000		102	70-130			
1,3-Dichlorobenzene	0.0487	0.0050	mg/kg wet	0.05000		97	70-130			
1,3-Dichloropropane	0.0523	0.0050	mg/kg wet	0.05000		105	70-130			
1,4-Dichlorobenzene	0.0496	0.0050	mg/kg wet	0.05000		99	70-130			
1,4-Dioxane	1.00	0.0800	mg/kg wet	1.000		100	70-130			
2,2-Dichloropropane	0.0502	0.0050	mg/kg wet	0.05000		100	70-130			
2-Butanone	0.235	0.0100	mg/kg wet	0.2500		94	70-130			
2-Chlorotoluene	0.0503	0.0050	mg/kg wet	0.05000		101	70-130			
2-Hexanone	0.240	0.0100	mg/kg wet	0.2500		96	70-130			
4-Chlorotoluene	0.0511	0.0050	mg/kg wet	0.05000		102	70-130			
4-Isopropyltoluene	0.0499	0.0050	mg/kg wet	0.05000		100	70-130			
4-Methyl-2-Pentanone	0.240	0.0100	mg/kg wet	0.2500		96	70-130			
Acetone	0.240	0.0100	mg/kg wet	0.2500		96	70-130			
Benzene	0.0488	0.0050	mg/kg wet	0.05000		98	70-130			
Bromobenzene	0.0507	0.0050	mg/kg wet	0.05000		101	70-130			

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BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
			5035/8260B Volatile Organic Compounds / Low Level							
Batch CJ93035 - 5035										
Bromochloromethane	0.0491	0.0050	mg/kg wet	0.05000		98	70-130			
Bromodichloromethane	0.0520	0.0050	mg/kg wet	0.05000		104	70-130			
Bromoform	0.0460	0.0050	mg/kg wet	0.05000		92	70-130			
Bromomethane	0.0475	0.0100	mg/kg wet	0.05000		95	70-130			
Carbon Disulfide	0.0494	0.0050	mg/kg wet	0.05000		99	70-130			
Carbon Tetrachloride	0.0490	0.0050	mg/kg wet	0.05000		98	70-130			
Chlorobenzene	0.0489	0.0050	mg/kg wet	0.05000		98	70-130			
Chloroethane	0.0431	0.0100	mg/kg wet	0.05000		86	70-130			
Chloroform	0.0494	0.0050	mg/kg wet	0.05000		99	70-130			
Chloromethane	0.0427	0.0100	mg/kg wet	0.05000		85	70-130			
cis-1,2-Dichloroethene	0.0503	0.0050	mg/kg wet	0.05000		101	70-130			
cis-1,3-Dichloropropene	0.0500	0.0050	mg/kg wet	0.05000		100	70-130			
Dibromochloromethane	0.0485	0.0020	mg/kg wet	0.05000		97	70-130			
Dibromomethane	0.0507	0.0050	mg/kg wet	0.05000		101	70-130			
Dichlorodifluoromethane	0.0375	0.0100	mg/kg wet	0.05000		75	70-130			
Diethyl Ether	0.0512	0.0050	mg/kg wet	0.05000		102	70-130			
Di-isopropyl ether	0.0532	0.0050	mg/kg wet	0.05000		106	70-130			
Ethyl tertiary-butyl ether	0.0531	0.0050	mg/kg wet	0.05000		106	70-130			
Ethylbenzene	0.0525	0.0050	mg/kg wet	0.05000		105	70-130			
Hexachlorobutadiene	0.0496	0.0050	mg/kg wet	0.05000		99	70-130			
Isopropylbenzene	0.0490	0.0050	mg/kg wet	0.05000		98	70-130			
Methyl tert-Butyl Ether	0.0563	0.0050	mg/kg wet	0.05000		113	70-130			
Methylene Chloride	0.0503	0.0100	mg/kg wet	0.05000		101	70-130			
Naphthalene	0.0474	0.0050	mg/kg wet	0.05000		95	70-130			
n-Butylbenzene	0.0500	0.0050	mg/kg wet	0.05000		100	70-130			
n-Propylbenzene	0.0518	0.0050	mg/kg wet	0.05000		104	70-130			
sec-Butylbenzene	0.0491	0.0050	mg/kg wet	0.05000		98	70-130			
Styrene	0.0492	0.0050	mg/kg wet	0.05000		98	70-130			
tert-Butylbenzene	0.0488	0.0050	mg/kg wet	0.05000		98	70-130			
Tertiary-amyl methyl ether	0.0514	0.0050	mg/kg wet	0.05000		103	70-130			
Tetrachloroethene	0.0477	0.0050	mg/kg wet	0.05000		95	70-130			
Tetrahydrofuran	0.0502	0.0050	mg/kg wet	0.05000		100	70-130			
Toluene	0.0486	0.0050	mg/kg wet	0.05000		97	70-130			
trans-1,2-Dichloroethene	0.0502	0.0050	mg/kg wet	0.05000		100	70-130			
trans-1,3-Dichloropropene	0.0494	0.0050	mg/kg wet	0.05000		99	70-130			
Trichloroethene	0.0476	0.0050	mg/kg wet	0.05000		95	70-130			
Trichlorofluoromethane	0.0476	0.0050	mg/kg wet	0.05000		95	70-130			
Vinyl Chloride	0.0386	0.0100	mg/kg wet	0.05000		77	70-130			
Xylene O	0.0506	0.0050	mg/kg wet	0.05000		101	70-130			
Xylene P,M	0.101	0.0100	mg/kg wet	0.1000		101	70-130			
Surrogate: 1,2-Dichloroethane-d4	*0.0479*		mg/kg wet	*0.05000*		*96*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*0.0502*		mg/kg wet	*0.05000*		*100*	*70-130*			
Surrogate: Dibromofluoromethane	*0.0489*		mg/kg wet	*0.05000*		*98*	*70-130*			
Surrogate: Toluene-d8	*0.0506*		mg/kg wet	*0.05000*		*101*	*70-130*			
LCS Dup										

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CERTIFICATE OF ANALYSIS

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ESS Laboratory Work Order: 19J1001

Quality Control Data

5035/8260B Volatile Organic Compounds / Low Level

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch CJ93035 - 5035										
1,1,1,2-Tetrachloroethane	0.0521	0.0050	mg/kg wet	0.05000		104	70-130	2	20	
1,1,1-Trichloroethane	0.0496	0.0050	mg/kg wet	0.05000		99	70-130	3	20	
1,1,2,2-Tetrachloroethane	0.0501	0.0020	mg/kg wet	0.05000		100	70-130	5	20	
1,1,2-Trichloroethane	0.0515	0.0050	mg/kg wet	0.05000		103	70-130	4	20	
1,1-Dichloroethane	0.0499	0.0050	mg/kg wet	0.05000		100	70-130	1	20	
1,1-Dichloroethene	0.0540	0.0050	mg/kg wet	0.05000		108	70-130	4	20	
1,1-Dichloropropene	0.0521	0.0050	mg/kg wet	0.05000		104	70-130	3	20	
1,2,3-Trichlorobenzene	0.0562	0.0050	mg/kg wet	0.05000		112	70-130	4	20	
1,2,3-Trichloropropane	0.0509	0.0050	mg/kg wet	0.05000		102	70-130	5	20	
1,2,4-Trichlorobenzene	0.0505	0.0050	mg/kg wet	0.05000		101	70-130	3	20	
1,2,4-Trimethylbenzene	0.0521	0.0050	mg/kg wet	0.05000		104	70-130	2	20	
1,2-Dibromo-3-Chloropropane	0.0440	0.0050	mg/kg wet	0.05000		88	70-130	5	20	
1,2-Dibromoethane	0.0529	0.0050	mg/kg wet	0.05000		106	70-130	4	20	
1,2-Dichlorobenzene	0.0511	0.0050	mg/kg wet	0.05000		102	70-130	2	20	
1,2-Dichloroethane	0.0495	0.0050	mg/kg wet	0.05000		99	70-130	0.7	20	
1,2-Dichloropropane	0.0511	0.0050	mg/kg wet	0.05000		102	70-130	2	20	
1,3,5-Trimethylbenzene	0.0515	0.0050	mg/kg wet	0.05000		103	70-130	1	20	
1,3-Dichlorobenzene	0.0499	0.0050	mg/kg wet	0.05000		100	70-130	2	20	
1,3-Dichloropropane	0.0535	0.0050	mg/kg wet	0.05000		107	70-130	2	20	
1,4-Dichlorobenzene	0.0493	0.0050	mg/kg wet	0.05000		99	70-130	0.7	20	
1,4-Dioxane	1.09	0.0800	mg/kg wet	1.000		109	70-130	9	20	
2,2-Dichloropropane	0.0515	0.0050	mg/kg wet	0.05000		103	70-130	2	20	
2-Butanone	0.245	0.0100	mg/kg wet	0.2500		98	70-130	4	20	
2-Chlorotoluene	0.0505	0.0050	mg/kg wet	0.05000		101	70-130	0.3	20	
2-Hexanone	0.257	0.0100	mg/kg wet	0.2500		103	70-130	7	20	
4-Chlorotoluene	0.0518	0.0050	mg/kg wet	0.05000		104	70-130	1	20	
4-Isopropyltoluene	0.0510	0.0050	mg/kg wet	0.05000		102	70-130	2	20	
4-Methyl-2-Pentanone	0.257	0.0100	mg/kg wet	0.2500		103	70-130	7	20	
Acetone	0.256	0.0100	mg/kg wet	0.2500		102	70-130	7	20	
Benzene	0.0496	0.0050	mg/kg wet	0.05000		99	70-130	2	20	
Bromobenzene	0.0520	0.0050	mg/kg wet	0.05000		104	70-130	2	20	
Bromochloromethane	0.0498	0.0050	mg/kg wet	0.05000		100	70-130	1	20	
Bromodichloromethane	0.0525	0.0050	mg/kg wet	0.05000		105	70-130	0.9	20	
Bromoform	0.0476	0.0050	mg/kg wet	0.05000		95	70-130	3	20	
Bromomethane	0.0463	0.0100	mg/kg wet	0.05000		93	70-130	3	20	
Carbon Disulfide	0.0504	0.0050	mg/kg wet	0.05000		101	70-130	2	20	
Carbon Tetrachloride	0.0503	0.0050	mg/kg wet	0.05000		101	70-130	3	20	
Chlorobenzene	0.0493	0.0050	mg/kg wet	0.05000		99	70-130	0.8	20	
Chloroethane	0.0442	0.0100	mg/kg wet	0.05000		88	70-130	3	20	
Chloroform	0.0496	0.0050	mg/kg wet	0.05000		99	70-130	0.4	20	
Chloromethane	0.0432	0.0100	mg/kg wet	0.05000		86	70-130	1	20	
cis-1,2-Dichloroethene	0.0509	0.0050	mg/kg wet	0.05000		102	70-130	1	20	
cis-1,3-Dichloropropene	0.0511	0.0050	mg/kg wet	0.05000		102	70-130	2	20	
Dibromochloromethane	0.0506	0.0020	mg/kg wet	0.05000		101	70-130	4	20	
Dibromomethane	0.0515	0.0050	mg/kg wet	0.05000		103	70-130	2	20	

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
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ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
5035/8260B Volatile Organic Compounds / Low Level										
Batch CJ93035 - 5035										
Dichlorodifluoromethane	0.0383	0.0100	mg/kg wet	0.05000		77	70-130	2	20	
Diethyl Ether	0.0532	0.0050	mg/kg wet	0.05000		106	70-130	4	20	
Di-isopropyl ether	0.0535	0.0050	mg/kg wet	0.05000		107	70-130	0.7	20	
Ethyl tertiary-butyl ether	0.0546	0.0050	mg/kg wet	0.05000		109	70-130	3	20	
Ethylbenzene	0.0533	0.0050	mg/kg wet	0.05000		107	70-130	1	20	
Hexachlorobutadiene	0.0510	0.0050	mg/kg wet	0.05000		102	70-130	3	20	
Isopropylbenzene	0.0504	0.0050	mg/kg wet	0.05000		101	70-130	3	20	
Methyl tert-Butyl Ether	0.0583	0.0050	mg/kg wet	0.05000		117	70-130	4	20	
Methylene Chloride	0.0505	0.0100	mg/kg wet	0.05000		101	70-130	0.5	20	
Naphthalene	0.0507	0.0050	mg/kg wet	0.05000		101	70-130	7	20	
n-Butylbenzene	0.0516	0.0050	mg/kg wet	0.05000		103	70-130	3	20	
n-Propylbenzene	0.0527	0.0050	mg/kg wet	0.05000		105	70-130	2	20	
sec-Butylbenzene	0.0505	0.0050	mg/kg wet	0.05000		101	70-130	3	20	
Styrene	0.0495	0.0050	mg/kg wet	0.05000		99	70-130	0.5	20	
tert-Butylbenzene	0.0498	0.0050	mg/kg wet	0.05000		100	70-130	2	20	
Tertiary-amyl methyl ether	0.0528	0.0050	mg/kg wet	0.05000		106	70-130	3	20	
Tetrachloroethene	0.0497	0.0050	mg/kg wet	0.05000		99	70-130	4	20	
Tetrahydrofuran	0.0539	0.0050	mg/kg wet	0.05000		108	70-130	7	20	
Toluene	0.0498	0.0050	mg/kg wet	0.05000		100	70-130	3	20	
trans-1,2-Dichloroethene	0.0510	0.0050	mg/kg wet	0.05000		102	70-130	2	20	
trans-1,3-Dichloropropene	0.0502	0.0050	mg/kg wet	0.05000		100	70-130	2	20	
Trichloroethene	0.0492	0.0050	mg/kg wet	0.05000		98	70-130	3	20	
Trichlorofluoromethane	0.0487	0.0050	mg/kg wet	0.05000		97	70-130	2	20	
Vinyl Chloride	0.0400	0.0100	mg/kg wet	0.05000		80	70-130	4	20	
Xylene O	0.0507	0.0050	mg/kg wet	0.05000		101	70-130	0.4	20	
Xylene P,M	0.103	0.0100	mg/kg wet	0.1000		103	70-130	2	20	
Surrogate: 1,2-Dichloroethane-d4	*0.0473*		mg/kg wet	*0.05000*		*95*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*0.0503*		mg/kg wet	*0.05000*		*101*	*70-130*			
Surrogate: Dibromofluoromethane	*0.0492*		mg/kg wet	*0.05000*		*98*	*70-130*			
Surrogate: Toluene-d8	*0.0508*		mg/kg wet	*0.05000*		*102*	*70-130*			
8082A Polychlorinated Biphenyls (PCB)										
Batch CJ93010 - 3540C										
Blank										
Aroclor 1016	ND	0.05	mg/kg wet							
Aroclor 1016 [2C]	ND	0.05	mg/kg wet							
Aroclor 1221	ND	0.05	mg/kg wet							
Aroclor 1221 [2C]	ND	0.05	mg/kg wet							
Aroclor 1232	ND	0.05	mg/kg wet							
Aroclor 1232 [2C]	ND	0.05	mg/kg wet							
Aroclor 1242	ND	0.05	mg/kg wet							
Aroclor 1242 [2C]	ND	0.05	mg/kg wet							
Aroclor 1248	ND	0.05	mg/kg wet							
Aroclor 1248 [2C]	ND	0.05	mg/kg wet							
Aroclor 1254	ND	0.05	mg/kg wet							

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Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8082A Polychlorinated Biphenyls (PCB)										
Batch CJ93010 - 3540C										
Aroclor 1254 [2C]	ND	0.05	mg/kg wet							
Aroclor 1260	ND	0.05	mg/kg wet							
Aroclor 1260 [2C]	ND	0.05	mg/kg wet							
Aroclor 1262	ND	0.05	mg/kg wet							
Aroclor 1262 [2C]	ND	0.05	mg/kg wet							
Aroclor 1268	ND	0.05	mg/kg wet							
Aroclor 1268 [2C]	ND	0.05	mg/kg wet							
Surrogate: Decachlorobiphenyl	*0.0214*		mg/kg wet	*0.02500*		*86*	*30-150*			
Surrogate: Decachlorobiphenyl [2C]	*0.0209*		mg/kg wet	*0.02500*		*84*	*30-150*			
Surrogate: Tetrachloro-m-xylene	*0.0161*		mg/kg wet	*0.02500*		*64*	*30-150*			
Surrogate: Tetrachloro-m-xylene [2C]	*0.0167*		mg/kg wet	*0.02500*		*67*	*30-150*			
LCS										
Aroclor 1016	0.5	0.05	mg/kg wet	0.5000		96	40-140			
Aroclor 1016 [2C]	0.5	0.05	mg/kg wet	0.5000		97	40-140			
Aroclor 1260	0.5	0.05	mg/kg wet	0.5000		98	40-140			
Aroclor 1260 [2C]	0.5	0.05	mg/kg wet	0.5000		100	40-140			
Surrogate: Decachlorobiphenyl	*0.0211*		mg/kg wet	*0.02500*		*84*	*30-150*			
Surrogate: Decachlorobiphenyl [2C]	*0.0215*		mg/kg wet	*0.02500*		*86*	*30-150*			
Surrogate: Tetrachloro-m-xylene	*0.0179*		mg/kg wet	*0.02500*		*71*	*30-150*			
Surrogate: Tetrachloro-m-xylene [2C]	*0.0172*		mg/kg wet	*0.02500*		*69*	*30-150*			
LCS Dup										
Aroclor 1016	0.4	0.05	mg/kg wet	0.5000		87	40-140	10	30	
Aroclor 1016 [2C]	0.4	0.05	mg/kg wet	0.5000		87	40-140	10	30	
Aroclor 1260	0.4	0.05	mg/kg wet	0.5000		88	40-140	11	30	
Aroclor 1260 [2C]	0.4	0.05	mg/kg wet	0.5000		90	40-140	11	30	
Surrogate: Decachlorobiphenyl	*0.0190*		mg/kg wet	*0.02500*		*76*	*30-150*			
Surrogate: Decachlorobiphenyl [2C]	*0.0193*		mg/kg wet	*0.02500*		*77*	*30-150*			
Surrogate: Tetrachloro-m-xylene	*0.0159*		mg/kg wet	*0.02500*		*64*	*30-150*			
Surrogate: Tetrachloro-m-xylene [2C]	*0.0152*		mg/kg wet	*0.02500*		*61*	*30-150*			
8100M Total Petroleum Hydrocarbons										
Batch CJ92911 - 3546										
Blank										
Decane (C10)	ND	0.2	mg/kg wet							
Docosane (C22)	ND	0.2	mg/kg wet							
Dodecane (C12)	ND	0.2	mg/kg wet							
Eicosane (C20)	ND	0.2	mg/kg wet							
Hexacosane (C26)	ND	0.2	mg/kg wet							
Hexadecane (C16)	ND	0.2	mg/kg wet							
Hexatriacontane (C36)	ND	0.2	mg/kg wet							
Nonadecane (C19)	ND	0.2	mg/kg wet							
Nonane (C9)	ND	0.2	mg/kg wet							

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Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8100M Total Petroleum Hydrocarbons										
Batch CJ92911 - 3546										
Octacosane (C28)	ND	0.2	mg/kg wet							
Octadecane (C18)	ND	0.2	mg/kg wet							
Tetracosane (C24)	ND	0.2	mg/kg wet							
Tetradecane (C14)	ND	0.2	mg/kg wet							
Total Petroleum Hydrocarbons	ND	10.0	mg/kg wet							
Triacontane (C30)	ND	0.2	mg/kg wet							
Surrogate: O-Terphenyl	*5.07*		mg/kg wet	*5.000*		*101*	*40-140*			
LCS										
Decane (C10)	1.9	0.2	mg/kg wet	2.500		75	40-140			
Docosane (C22)	2.5	0.2	mg/kg wet	2.500		100	40-140			
Dodecane (C12)	2.1	0.2	mg/kg wet	2.500		83	40-140			
Eicosane (C20)	2.4	0.2	mg/kg wet	2.500		97	40-140			
Hexacosane (C26)	2.5	0.2	mg/kg wet	2.500		99	40-140			
Hexadecane (C16)	2.3	0.2	mg/kg wet	2.500		90	40-140			
Hexatriacontane (C36)	2.5	0.2	mg/kg wet	2.500		102	40-140			
Nonadecane (C19)	2.5	0.2	mg/kg wet	2.500		100	40-140			
Nonane (C9)	1.6	0.2	mg/kg wet	2.500		66	30-140			
Octacosane (C28)	2.5	0.2	mg/kg wet	2.500		100	40-140			
Octadecane (C18)	2.3	0.2	mg/kg wet	2.500		94	40-140			
Tetracosane (C24)	2.5	0.2	mg/kg wet	2.500		100	40-140			
Tetradecane (C14)	2.2	0.2	mg/kg wet	2.500		87	40-140			
Total Petroleum Hydrocarbons	32.1	10.0	mg/kg wet	35.00		92	40-140			
Triacontane (C30)	2.5	0.2	mg/kg wet	2.500		100	40-140			
Surrogate: O-Terphenyl	*5.18*		mg/kg wet	*5.000*		*104*	*40-140*			
LCS Dup										
Decane (C10)	1.9	0.2	mg/kg wet	2.500		77	40-140	2	25	
Docosane (C22)	2.6	0.2	mg/kg wet	2.500		103	40-140	3	25	
Dodecane (C12)	2.1	0.2	mg/kg wet	2.500		85	40-140	2	25	
Eicosane (C20)	2.5	0.2	mg/kg wet	2.500		100	40-140	3	25	
Hexacosane (C26)	2.6	0.2	mg/kg wet	2.500		103	40-140	3	25	
Hexadecane (C16)	2.3	0.2	mg/kg wet	2.500		92	40-140	2	25	
Hexatriacontane (C36)	2.6	0.2	mg/kg wet	2.500		102	40-140	0.6	25	
Nonadecane (C19)	2.6	0.2	mg/kg wet	2.500		103	40-140	2	25	
Nonane (C9)	1.7	0.2	mg/kg wet	2.500		67	30-140	2	25	
Octacosane (C28)	2.6	0.2	mg/kg wet	2.500		104	40-140	3	25	
Octadecane (C18)	2.4	0.2	mg/kg wet	2.500		96	40-140	2	25	
Tetracosane (C24)	2.6	0.2	mg/kg wet	2.500		104	40-140	4	25	
Tetradecane (C14)	2.2	0.2	mg/kg wet	2.500		89	40-140	2	25	
Total Petroleum Hydrocarbons	33.0	10.0	mg/kg wet	35.00		94	40-140	3	25	
Triacontane (C30)	2.6	0.2	mg/kg wet	2.500		103	40-140	3	25	
Surrogate: O-Terphenyl	*5.24*		mg/kg wet	*5.000*		*105*	*40-140*			
8270D Semi-Volatile Organic Compounds										

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY
ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8270D Semi-Volatile Organic Compounds										
Batch CJ92909 - 3546										
Blank										
1,2,4-Trichlorobenzene	ND	0.167	mg/kg wet							
1,2-Dichlorobenzene	ND	0.333	mg/kg wet							
1,3-Dichlorobenzene	ND	0.167	mg/kg wet							
1,4-Dichlorobenzene	ND	0.167	mg/kg wet							
2,4,5-Trichlorophenol	ND	0.167	mg/kg wet							
2,4,6-Trichlorophenol	ND	0.167	mg/kg wet							
2,4-Dichlorophenol	ND	0.167	mg/kg wet							
2,4-Dimethylphenol	ND	0.167	mg/kg wet							
2,4-Dinitrophenol	ND	0.667	mg/kg wet							
2,4-Dinitrotoluene	ND	0.167	mg/kg wet							
2,6-Dinitrotoluene	ND	0.333	mg/kg wet							
2-Chloronaphthalene	ND	0.333	mg/kg wet							
2-Chlorophenol	ND	0.167	mg/kg wet							
2-Methylnaphthalene	ND	0.167	mg/kg wet							
2-Methylphenol	ND	0.333	mg/kg wet							
2-Nitrophenol	ND	0.333	mg/kg wet							
3,3´-Dichlorobenzidine	ND	0.333	mg/kg wet							
3+4-Methylphenol	ND	0.667	mg/kg wet							
4-Bromophenyl-phenylether	ND	0.333	mg/kg wet							
4-Chloroaniline	ND	0.333	mg/kg wet							
4-Nitrophenol	ND	1.67	mg/kg wet							
Acenaphthene	ND	0.167	mg/kg wet							
Acenaphthylene	ND	0.167	mg/kg wet							
Acetophenone	ND	0.667	mg/kg wet							
Aniline	ND	1.67	mg/kg wet							
Anthracene	ND	0.333	mg/kg wet							
Azobenzene	ND	0.333	mg/kg wet							
Benzo(a)anthracene	ND	0.167	mg/kg wet							
Benzo(a)pyrene	ND	0.083	mg/kg wet							
Benzo(b)fluoranthene	ND	0.167	mg/kg wet							
Benzo(g,h,i)perylene	ND	0.333	mg/kg wet							
Benzo(k)fluoranthene	ND	0.333	mg/kg wet							
bis(2-Chloroethoxy)methane	ND	0.333	mg/kg wet							
bis(2-Chloroethyl)ether	ND	0.167	mg/kg wet							
bis(2-chloroisopropyl)Ether	ND	0.167	mg/kg wet							
bis(2-Ethylhexyl)phthalate	ND	0.333	mg/kg wet							
Butylbenzylphthalate	ND	0.333	mg/kg wet							
Chrysene	ND	0.167	mg/kg wet							
Dibenzo(a,h)Anthracene	ND	0.083	mg/kg wet							
Dibenzofuran	ND	0.333	mg/kg wet							
Diethylphthalate	ND	0.333	mg/kg wet							
Dimethylphthalate	ND	0.333	mg/kg wet							
Di-n-butylphthalate	ND	0.333	mg/kg wet							
Di-n-octylphthalate	ND	0.333	mg/kg wet							

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Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8270D Semi-Volatile Organic Compounds										
Batch CJ92909 - 3546										
Fluoranthene	ND	0.333	mg/kg wet							
Fluorene	ND	0.333	mg/kg wet							
Hexachlorobenzene	ND	0.167	mg/kg wet							
Hexachlorobutadiene	ND	0.167	mg/kg wet							
Hexachloroethane	ND	0.167	mg/kg wet							
Indeno(1,2,3-cd)Pyrene	ND	0.167	mg/kg wet							
Isophorone	ND	0.333	mg/kg wet							
Naphthalene	ND	0.333	mg/kg wet							
Nitrobenzene	ND	0.333	mg/kg wet							
N-Nitrosodimethylamine	ND	0.333	mg/kg wet							
Pentachlorophenol	ND	0.667	mg/kg wet							
Phenanthrene	ND	0.333	mg/kg wet							
Phenol	ND	0.167	mg/kg wet							
Pyrene	ND	0.333	mg/kg wet							
Surrogate: 1,2-Dichlorobenzene-d4	*2.19*		mg/kg wet	*3.333*		*66*	*30-130*			
Surrogate: 2,4,6-Tribromophenol	*3.96*		mg/kg wet	*5.000*		*79*	*30-130*			
Surrogate: 2-Chlorophenol-d4	*3.56*		mg/kg wet	*5.000*		*71*	*30-130*			
Surrogate: 2-Fluorobiphenyl	*2.24*		mg/kg wet	*3.333*		*67*	*30-130*			
Surrogate: 2-Fluorophenol	*3.36*		mg/kg wet	*5.000*		*67*	*30-130*			
Surrogate: Nitrobenzene-d5	*2.23*		mg/kg wet	*3.333*		*67*	*30-130*			
Surrogate: Phenol-d6	*3.68*		mg/kg wet	*5.000*		*74*	*30-130*			
Surrogate: p-Terphenyl-d14	*3.37*		mg/kg wet	*3.333*		*101*	*30-130*			
LCS										
1,2,4-Trichlorobenzene	1.84	0.167	mg/kg wet	3.333		55	40-140			
1,2-Dichlorobenzene	1.88	0.333	mg/kg wet	3.333		56	40-140			
1,3-Dichlorobenzene	1.85	0.167	mg/kg wet	3.333		55	40-140			
1,4-Dichlorobenzene	1.79	0.167	mg/kg wet	3.333		54	40-140			
2,4,5-Trichlorophenol	2.51	0.167	mg/kg wet	3.333		75	30-130			
2,4,6-Trichlorophenol	2.32	0.167	mg/kg wet	3.333		70	30-130			
2,4-Dichlorophenol	2.30	0.167	mg/kg wet	3.333		69	30-130			
2,4-Dimethylphenol	2.18	0.167	mg/kg wet	3.333		66	30-130			
2,4-Dinitrophenol	3.07	0.667	mg/kg wet	3.333		92	30-130			
2,4-Dinitrotoluene	2.91	0.167	mg/kg wet	3.333		87	40-140			
2,6-Dinitrotoluene	2.61	0.333	mg/kg wet	3.333		78	40-140			
2-Chloronaphthalene	1.98	0.333	mg/kg wet	3.333		59	40-140			
2-Chlorophenol	2.06	0.167	mg/kg wet	3.333		62	30-130			
2-Methylnaphthalene	2.16	0.167	mg/kg wet	3.333		65	40-140			
2-Methylphenol	2.27	0.333	mg/kg wet	3.333		68	30-130			
2-Nitrophenol	1.82	0.333	mg/kg wet	3.333		55	30-130			
3,3´-Dichlorobenzidine	2.39	0.333	mg/kg wet	3.333		72	40-140			
3+4-Methylphenol	4.74	0.667	mg/kg wet	6.667		71	30-130			
4-Bromophenyl-phenylether	2.58	0.333	mg/kg wet	3.333		77	40-140			
4-Chloroaniline	1.83	0.333	mg/kg wet	3.333		55	40-140			
4-Nitrophenol	2.93	1.67	mg/kg wet	3.333		88	30-130			
Acenaphthene	2.34	0.167	mg/kg wet	3.333		70	40-140			

ESS Laboratory
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BAL Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
				8270D Semi-Volatile Organic Compounds						
Batch CJ92909 - 3546										
Acenaphthylene	2.38	0.167	mg/kg wet	3.333		71	40-140			
Acetophenone	2.12	0.667	mg/kg wet	3.333		64	40-140			
Aniline	1.67	1.67	mg/kg wet	3.333		50	40-140			
Anthracene	2.86	0.333	mg/kg wet	3.333		86	40-140			
Azobenzene	2.63	0.333	mg/kg wet	3.333		79	40-140			
Benzo(a)anthracene	3.03	0.167	mg/kg wet	3.333		91	40-140			
Benzo(a)pyrene	2.87	0.083	mg/kg wet	3.333		86	40-140			
Benzo(b)fluoranthene	2.94	0.167	mg/kg wet	3.333		88	40-140			
Benzo(g,h,i)perylene	3.30	0.333	mg/kg wet	3.333		99	40-140			
Benzo(k)fluoranthene	2.89	0.333	mg/kg wet	3.333		87	40-140			
bis(2-Chloroethoxy)methane	2.07	0.333	mg/kg wet	3.333		62	40-140			
bis(2-Chloroethyl)ether	2.01	0.167	mg/kg wet	3.333		60	40-140			
bis(2-chloroisopropyl)Ether	1.95	0.167	mg/kg wet	3.333		59	40-140			
bis(2-Ethylhexyl)phthalate	2.78	0.333	mg/kg wet	3.333		83	40-140			
Butylbenzylphthalate	2.82	0.333	mg/kg wet	3.333		85	40-140			
Chrysene	2.91	0.167	mg/kg wet	3.333		87	40-140			
Dibenzo(a,h)Anthracene	3.08	0.083	mg/kg wet	3.333		92	40-140			
Dibenzofuran	2.47	0.333	mg/kg wet	3.333		74	40-140			
Diethylphthalate	2.93	0.333	mg/kg wet	3.333		88	40-140			
Dimethylphthalate	2.74	0.333	mg/kg wet	3.333		82	40-140			
Di-n-butylphthalate	2.96	0.333	mg/kg wet	3.333		89	40-140			
Di-n-octylphthalate	2.35	0.333	mg/kg wet	3.333		70	40-140			
Fluoranthene	3.01	0.333	mg/kg wet	3.333		90	40-140			
Fluorene	2.77	0.333	mg/kg wet	3.333		83	40-140			
Hexachlorobenzene	2.61	0.167	mg/kg wet	3.333		78	40-140			
Hexachlorobutadiene	1.73	0.167	mg/kg wet	3.333		52	40-140			
Hexachloroethane	1.83	0.167	mg/kg wet	3.333		55	40-140			
Indeno(1,2,3-cd)Pyrene	3.18	0.167	mg/kg wet	3.333		95	40-140			
Isophorone	1.95	0.333	mg/kg wet	3.333		58	40-140			
Naphthalene	1.96	0.333	mg/kg wet	3.333		59	40-140			
Nitrobenzene	1.89	0.333	mg/kg wet	3.333		57	40-140			
N-Nitrosodimethylamine	1.27	0.333	mg/kg wet	3.333		38	40-140			B-
Pentachlorophenol	2.85	0.667	mg/kg wet	3.333		86	30-130			
Phenanthrene	2.77	0.333	mg/kg wet	3.333		83	40-140			
Phenol	2.17	0.167	mg/kg wet	3.333		65	30-130			
Pyrene	2.90	0.333	mg/kg wet	3.333		87	40-140			
Surrogate: 1,2-Dichlorobenzene-d4	*1.95*		mg/kg wet	*3.333*		*59*	*30-130*			
Surrogate: 2,4,6-Tribromophenol	*4.23*		mg/kg wet	*5.000*		*85*	*30-130*			
Surrogate: 2-Chlorophenol-d4	*3.30*		mg/kg wet	*5.000*		*66*	*30-130*			
Surrogate: 2-Fluorobiphenyl	*2.18*		mg/kg wet	*3.333*		*65*	*30-130*			
Surrogate: 2-Fluorophenol	*3.02*		mg/kg wet	*5.000*		*60*	*30-130*			
Surrogate: Nitrobenzene-d5	*1.99*		mg/kg wet	*3.333*		*60*	*30-130*			
Surrogate: Phenol-d6	*3.49*		mg/kg wet	*5.000*		*70*	*30-130*			
Surrogate: p-Terphenyl-d14	*2.96*		mg/kg wet	*3.333*		*89*	*30-130*			
LCS Dup										

ESS Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
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ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
				8270D Semi-Volatile Organic Compounds						
Batch CJ92909 - 3546										
1,2,4-Trichlorobenzene	2.02	0.167	mg/kg wet	3.333		61	40-140	9	30	
1,2-Dichlorobenzene	2.06	0.333	mg/kg wet	3.333		62	40-140	9	30	
1,3-Dichlorobenzene	2.05	0.167	mg/kg wet	3.333		61	40-140	10	30	
1,4-Dichlorobenzene	2.01	0.167	mg/kg wet	3.333		60	40-140	11	30	
2,4,5-Trichlorophenol	2.43	0.167	mg/kg wet	3.333		73	30-130	3	30	
2,4,6-Trichlorophenol	2.26	0.167	mg/kg wet	3.333		68	30-130	3	30	
2,4-Dichlorophenol	2.33	0.167	mg/kg wet	3.333		70	30-130	1	30	
2,4-Dimethylphenol	2.20	0.167	mg/kg wet	3.333		66	30-130	0.7	30	
2,4-Dinitrophenol	3.00	0.667	mg/kg wet	3.333		90	30-130	2	30	
2,4-Dinitrotoluene	2.72	0.167	mg/kg wet	3.333		81	40-140	7	30	
2,6-Dinitrotoluene	2.49	0.333	mg/kg wet	3.333		75	40-140	5	30	
2-Chloronaphthalene	1.98	0.333	mg/kg wet	3.333		59	40-140	0.2	30	
2-Chlorophenol	2.21	0.167	mg/kg wet	3.333		66	30-130	7	30	
2-Methylnaphthalene	2.21	0.167	mg/kg wet	3.333		66	40-140	2	30	
2-Methylphenol	2.34	0.333	mg/kg wet	3.333		70	30-130	3	30	
2-Nitrophenol	2.00	0.333	mg/kg wet	3.333		60	30-130	9	30	
3,3´-Dichlorobenzidine	2.22	0.333	mg/kg wet	3.333		67	40-140	7	30	
3+4-Methylphenol	4.72	0.667	mg/kg wet	6.667		71	30-130	0.6	30	
4-Bromophenyl-phenylether	2.45	0.333	mg/kg wet	3.333		74	40-140	5	30	
4-Chloroaniline	1.82	0.333	mg/kg wet	3.333		54	40-140	0.7	30	
4-Nitrophenol	2.71	1.67	mg/kg wet	3.333		81	30-130	8	30	
Acenaphthene	2.31	0.167	mg/kg wet	3.333		69	40-140	1	30	
Acenaphthylene	2.34	0.167	mg/kg wet	3.333		70	40-140	2	30	
Acetophenone	2.20	0.667	mg/kg wet	3.333		66	40-140	4	30	
Aniline	1.78	1.67	mg/kg wet	3.333		53	40-140	6	30	
Anthracene	2.70	0.333	mg/kg wet	3.333		81	40-140	6	30	
Azobenzene	2.52	0.333	mg/kg wet	3.333		75	40-140	5	30	
Benzo(a)anthracene	2.85	0.167	mg/kg wet	3.333		85	40-140	6	30	
Benzo(a)pyrene	2.67	0.083	mg/kg wet	3.333		80	40-140	7	30	
Benzo(b)fluoranthene	2.72	0.167	mg/kg wet	3.333		82	40-140	8	30	
Benzo(g,h,i)perylene	3.03	0.333	mg/kg wet	3.333		91	40-140	8	30	
Benzo(k)fluoranthene	2.69	0.333	mg/kg wet	3.333		81	40-140	7	30	
bis(2-Chloroethoxy)methane	2.16	0.333	mg/kg wet	3.333		65	40-140	5	30	
bis(2-Chloroethyl)ether	2.18	0.167	mg/kg wet	3.333		65	40-140	8	30	
bis(2-chloroisopropyl)Ether	2.14	0.167	mg/kg wet	3.333		64	40-140	9	30	
bis(2-Ethylhexyl)phthalate	2.69	0.333	mg/kg wet	3.333		81	40-140	3	30	
Butylbenzylphthalate	2.71	0.333	mg/kg wet	3.333		81	40-140	4	30	
Chrysene	2.75	0.167	mg/kg wet	3.333		83	40-140	6	30	
Dibenzo(a,h)Anthracene	2.86	0.083	mg/kg wet	3.333		86	40-140	8	30	
Dibenzofuran	2.40	0.333	mg/kg wet	3.333		72	40-140	3	30	
Diethylphthalate	2.78	0.333	mg/kg wet	3.333		83	40-140	5	30	
Dimethylphthalate	2.60	0.333	mg/kg wet	3.333		78	40-140	5	30	
Di-n-butylphthalate	2.78	0.333	mg/kg wet	3.333		84	40-140	6	30	
Di-n-octylphthalate	2.24	0.333	mg/kg wet	3.333		67	40-140	4	30	
Fluoranthene	2.79	0.333	mg/kg wet	3.333		84	40-140	8	30	

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CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
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ESS Laboratory Work Order: 19J1001

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8270D Semi-Volatile Organic Compounds										
Batch CJ92909 - 3546										
Fluorene	2.64	0.333	mg/kg wet	3.333		79	40-140	5	30	
Hexachlorobenzene	2.48	0.167	mg/kg wet	3.333		74	40-140	5	30	
Hexachlorobutadiene	1.93	0.167	mg/kg wet	3.333		58	40-140	11	30	
Hexachloroethane	2.04	0.167	mg/kg wet	3.333		61	40-140	11	30	
Indeno(1,2,3-cd)Pyrene	2.93	0.167	mg/kg wet	3.333		88	40-140	8	30	
Isophorone	2.00	0.333	mg/kg wet	3.333		60	40-140	3	30	
Naphthalene	2.10	0.333	mg/kg wet	3.333		63	40-140	7	30	
Nitrobenzene	2.04	0.333	mg/kg wet	3.333		61	40-140	8	30	
N-Nitrosodimethylamine	1.38	0.333	mg/kg wet	3.333		41	40-140	8	30	
Pentachlorophenol	2.72	0.667	mg/kg wet	3.333		81	30-130	5	30	
Phenanthrene	2.62	0.333	mg/kg wet	3.333		78	40-140	6	30	
Phenol	2.22	0.167	mg/kg wet	3.333		67	30-130	2	30	
Pyrene	2.79	0.333	mg/kg wet	3.333		84	40-140	4	30	
Surrogate: 1,2-Dichlorobenzene-d4	*2.06*		mg/kg wet	*3.333*		*62*	*30-130*			
Surrogate: 2,4,6-Tribromophenol	*3.90*		mg/kg wet	*5.000*		*78*	*30-130*			
Surrogate: 2-Chlorophenol-d4	*3.42*		mg/kg wet	*5.000*		*68*	*30-130*			
Surrogate: 2-Fluorobiphenyl	*2.11*		mg/kg wet	*3.333*		*63*	*30-130*			
Surrogate: 2-Fluorophenol	*3.15*		mg/kg wet	*5.000*		*63*	*30-130*			
Surrogate: Nitrobenzene-d5	*2.06*		mg/kg wet	*3.333*		*62*	*30-130*			
Surrogate: Phenol-d6	*3.45*		mg/kg wet	*5.000*		*69*	*30-130*			
Surrogate: p-Terphenyl-d14	*2.77*		mg/kg wet	*3.333*		*83*	*30-130*			
Classical Chemistry										
Batch CJ93061 - General Preparation										
Blank										
Conductivity	ND	5	umhos/cm							
LCS										
Conductivity	1410		umhos/cm	1411		100	90-110			

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

Notes and Definitions

WL	Results obtained from a deionized water leach of the sample.
U	Analyte included in the analysis, but not detected
SC	Surrogate recovery(ies) outside of criteria. Reextraction/Reanalysis confirms results (SC).
S-	Surrogate recovery(ies) below lower control limit (S-).
Q	Calibration required quadratic regression (Q).
D	Diluted.
CD-	Continuing Calibration %Diff/Drift is below control limit (CD-).
B-	Blank Spike recovery is below lower control limit (B-).
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probably Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: Beta Engineering
Client Project ID: Hoosacs - CNY

ESS Laboratory Work Order: 19J1001

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: Beta Engineering - ML/ML

Shipped/Delivered Via: ESS Courier

ESS Project ID: 19J1001
Date Received: 10/28/2019
Project Due Date: 11/4/2019
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.9 Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No
    low level vials

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:

12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: 10/28/19 Time: 2215 By: TA

Sample Receiving Notes:
Collected 10/17 - VOC, TPH, SVOC out of hold 10/31
No indication low level vials frozen

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	405887	Yes	NA	Yes	VOA Vial - Methanol	MeOH	
01	405892	Yes	NA	Yes	VOA Vial - Other	Other	
01	405893	Yes	NA	Yes	VOA Vial - Other	Other	
01	406065	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
01	406066	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
02	405886	Yes	NA	Yes	VOA Vial - Methanol	MeOH	
02	405890	Yes	NA	Yes	VOA Vial - Other	Other	
02	405891	Yes	NA	Yes	VOA Vial - Other	Other	
02	406062	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
02	406063	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
02	406064	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
03	405885	Yes	NA	Yes	VOA Vial - Methanol	MeOH	
03	405888	Yes	NA	Yes	VOA Vial - Other	Other	
03	405889	Yes	NA	Yes	VOA Vial - Other	Other	
03	406059	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
03	406060	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
03	406061	Yes	NA	Yes	4 oz. Jar - Unpres	NP	

2nd Review
Were all containers scanned into storage/lab? Initials
Are barcode labels on correct containers? Yes / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

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ESS Laboratory Sample and Cooler Receipt Checklist

Client: Beta Engineering - ML/ML

ESS Project ID: 19J1001
Date Received: 10/28/2019

Are all Hex Chrome stickers attached?	Yes / No / NA
Are all QC stickers attached?	Yes / No / NA
Are VOA stickers attached if bubbles noted?	Yes / No / NA

Completed By: Date & Time: 10/28/19 2200

Reviewed By: Date & Time: 10/28/19 2015

Delivered By: 10/28/19 2015

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ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 19J1001

Turn Time: 5 Days
Regulatory State:
Is this project for any of the following?: ○ CT RCP ☒ MA MCP ○ RGP

Reporting Limits: MassDEP RCS-1
Electonic Deliverables: ☑ Data Checker ☑ Excel ☐ Other (Please Specify →)

Company Name: BETA Group, Inc.
Contact Person: Marylou Armstrong
City: Lincoln
State: RI
Telephone Number: 508-932-1196
FAX Number:
Project #: 6283
Project Name: Hoosacs - CNY
Address: 701 George Washington Hwy.
Zip Code: 02865
PO #: 6283
Email Address: marmstrong@BETA-Inc.com

Analysis: TPH-8100M, VOCs-8260B, SVOCs-8270D, PCB-8082A, 15 RCRA Metals, Conductivity

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	TPH-8100M	VOCs-8260B	SVOCs-8270D	PCB-8082A	15 RCRA Metals	Conductivity
1	10/17/19	P.M.	grab	soil	B-3	X	X	X	X	X	X
2	10/17/19	P.M.	grab	soil	B-4	X	X	X	X	X	X
3	10/17/19	P.M.	grab	soil	B-6	X	X	X	X	X	X
Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial						AG	V	AG	AG	AG	AG
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*						9	7	9	9	9	9
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*						1	6	1	1	1	1
Number of Containers per Sample:							3				

Laboratory Use Only
Cooler Present: ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 2.9 °C

Sampled by: Marylou Armstrong
Comments: Please specify "Other" preservative and containers types in this space
Sample B-3 has 2 full 4 oz. amber glass jars for these analyses.
Samples B-4 & B-6 have 3 full 4 oz. amber glass jars for these analyses.

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
[signature] 10/28/19 10:50 am	[signature] 10/28 12:18	[signature] 10/28 17:19	[signature] 10/28/19 17:19
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

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Historic and Archaeological Resources Status Report

The Public Archaeology Laboratory, Inc. (PAL) has completed this Historic and Archaeological Resources Status Report as part of the Marble Fairbanks team preparing a Simplified Feasibility Study for the Hoosac Stores for the U.S. General Services Administration (GSA) Public Buildings Service (PBS) and the National Park Service (NPS). This study is a component of the larger Hoosac Stores Modernization Project, also known as the Hoosac Stores Program Development Study & Design-Build Bridging Documents (Project) at 115 Constitution Road in the Charlestown Navy Yard (CNY or Navy Yard), Charlestown, MA. The study is being undertaken to determine whether the Hoosac Stores is adequate for the preferred alternative of reuse as a visitor center, offices, and museum.

Public Archaeology Laboratory

Report
Hoosac Stores Feasibility Study
Boston, MA

Historic and Archaeological Resources Status Report

Submitted to:

February 7, 2020
PAL Project No. 3593.01

Marble Fairbanks
20 Jay Street, Suite 202
Brooklyn, NY 11201

The Public Archaeology Laboratory, Inc. (PAL) has completed this Historic and Archaeological Resources Status Report as part of the Marble Fairbanks team preparing a Simplified Feasibility Study for the Hoosac Stores for the U.S. General Services Administration (GSA) Public Buildings Service (PBS) and the National Park Service (NPS). This study is a component of the larger Hoosac Stores Modernization Project, also known as the Hoosac Stores Program Development Study & Design-Build Bridging Documents (Project) at 115 Constitution Road in the Charlestown Navy Yard (CNY or Navy Yard), Charlestown, MA. The study is being undertaken to determine whether the Hoosac Stores is adequate for the preferred alternative of reuse as a visitor center, offices, and museum. This report follows from PAL's *Technical Memorandum, Hoosac Stores Modernization, Program Development Study, Boston, MA, Historic Research and Documentation for Submittal 2* of April 12, 2019 (Adams and Pineo 2019).

PAL staff involved in the Project were Virginia H. Adams, project manager/senior architectural historian, Kristen Heitert, senior archaeologist, and Gretchen Pineo, architectural historian.

Historic Preservation

Review and Update of Historic Preservation Information and Considerations

There have been no changes to the building's condition or status since the PAL Memorandum dated April 12, 2019, which includes the following summary narrative about the building. The Hoosac Stores 1 & 2, a single building constructed in 1895, is a contributing historic resource to the Hoosac Stores 1 & 2 and Hoosac Stores 3 Historic District, signed by the Keeper of the National Register of Historic Places on August 14, 1985. The Hoosac Stores 1 & 2 and Hoosac Stores 3 were concurrently listed in the Massachusetts State Historic Register. The Hoosac Stores 1 & 2 outbuilding was not evaluated as part of that documentation. The Hoosac Stores 1 & 2 and a freestanding boiler house outbuilding (1930–1940) in a paved parking lot to the southwest were included as part of the CNY unit in a 2014 documentation of the Boston National Historical Park (NHP) Historic District (listed October 26, 1974, updated documentation accepted by the Keeper May 5, 2015) and are non-contributing resources to the Boston NHP due to their lack of association with the historical themes associated with the Boston NHP. The Hoosac Stores 3 is no longer extant. Initially used as active warehouse storage, the Hoosac Stores 1 & 2 has been used as inactive storage, that is, items are placed into storage, but not frequently accessed, since about 1981. Following acquisition by the NPS in 1981, portions of the building have been used for storage by Boston NHP and Boston African

American National Historical Site (NHS) (now both part of the National Parks of Boston), partner organizations such as the USS Constitution Museum, and other cultural organizations like the Museum of Printing. The building continues to be used for inactive storage (Adams and Pineo 2019).

Planning Considerations

Any project which requires permits, funding, licensing, or approvals from state and/or federal agencies is potentially subject to compliance with the Section 106 of the National Historic Preservation Act and Massachusetts State Register Review requirements (Chapter 254). As the Hoosac Stores 1 & 2 is owned by a federal agency, the lead federal agency must notify the Massachusetts Historical Commission (MHC) regarding any work on the property that has the potential to cause a change in the historical, architectural, archaeological, or cultural qualities of the property in accordance with state and federal regulations. This section provides a summary of the regulations and their relevance to the Hoosac Stores 1 & 2.

Preservation Laws and Ordinances

Section 106 Review

As the Hoosac Stores 1 & 2 is listed in the National Register of Historic Places and is federally owned, any rehabilitation activities require review under Section 106 of the National Historic Preservation Act, as amended (54 U.S.C. 306108) and the regulations of the Advisory Council on Historic Preservation (ACHP) at 36 CFR 800. The review process involves identifying historic properties the Project has the potential to impact and determining what affect the proposed Project may have on the resources. This includes review by the State Historic Preservation Office/MHC, Tribal Historic Preservation Offices (THPO), and other consulting parties (e.g., the Boston Landmarks Commission [BLC] as the applicable Certified Local Government agency). If a proposed action is determined to have an adverse effect, consultation will occur to consider development alternatives that would eliminate, minimize, or mitigate adverse effects to the historic properties.

Review of the Project by the MHC and others typically commences with the submittal of a letter by the lead federal agency inviting participation in the process and providing supporting documentation.

State Register Review

Under M.G.L. Chapter 9, sections 26-27c, as amended by Chapter 254 of the Acts of 1988, (950 CMR 71) (referred to as "Chapter 254"), the MHC has review authority of projects undertaken, funded, or licensed by a state body to determine whether such project would have an adverse effect on properties listed in the State Register of Historic Places. The review process mirrors the Section 106 process (see above). MHC regulations allow for the coordination of Chapter 254 review with Section 106 review. Completed review under Section 106 fulfills compliance with Chapter 254. Additionally, the building is listed in the Massachusetts State Historic Register, so if any work on the building requires funding, licenses, or permits from any state agency, the project is subject to M.G.L. 950 CMR 71, which pertains to the protection of properties included in the State Register of Historic Places (Secretary of the Commonwealth 1988). Under 950 CMR 71, the MHC has jurisdiction over determining whether an undertaking will have any direct or indirect adverse effect on any property listed in the State Register of Historic Places. Adverse effects include (but are not limited to) the destruction or alteration of all or part of a State Register party, the introduction of visual, audible, or atmospheric elements that are out of character with, or alter the setting of the State Register property, and the isolation or alteration of a State Register property from its surrounding environment (Secretary of the Commonwealth 1988).

If required by MHC, a Project Notification Forms (PNF) must be completed prior to commencing work. Guidance for the PNF can be found at https://www.sec.state.ma.us/mhc/mhcpdf/pnfguide.pdf.

Article 85 of the Boston Zoning Code (Demolition Delay)

Article 85 of the Boston Zoning Code (commonly known as "demolition delay") requires owners and developers to notify the BLC of the proposed demolition of buildings, 50 years or older, within the City of Boston by submitting an Application for Article 85 Review.

An Article 85 application requires a description of the proposed work, photographs of the property and surrounding areas keyed to a map, a locus map, plot plan, plans and elevations of the new structure(s), notarized signatures of both the applicant and owner-of-record, and proof of ownership. Additional information may also be required, including adaptive reuse feasibility studies, structural analysis reports, availability of alternatives sites for the proposed post-demolition construction, effects of post-demolition on the community, and other materials that may help the Commission evaluate whether a property is subject to delay.

Within ten days, BLC staff will determine whether a demolition permit may be issued or whether the building(s) has been determined "significant." It is anticipated the BLC would find Hoosac Stores 1 & 2 "significant" for the purposes of Article 85 and a hearing with the full Commission would be scheduled within 40 days of the determination to decide if the property is subject to the 90-day demolition delay.

The Article 85 process requires the applicant to hold a community meeting at which the applicant presents alternatives that include preservation and reuse of the building proposed for demolition. At the Commission hearing following the community meeting, BLC determines whether the building is subject to demolition delay; if so, a 90-day moratorium on a demolition permit is imposed. If, based on the evaluation of alternatives, the Commission is satisfied that there are no feasible alternatives to demolition, the Commission may issue a determination prior to the expiration of the 90-day delay period authorizing the issuance of a demolition permit. If the delay is not lifted, the 90-day period will elapse, at which time the Commission will issue a notice that the demolition permit may be issued, completing the Article 85 process.

Massachusetts Environmental Policy Act

Massachusetts Environmental Policy Act (MEPA) review is required of projects that utilize state funding or permits and that exceed review thresholds. The MEPA review threshold for historic resources is the demolition of all or any exterior part of any historic resources included in the Massachusetts Inventory of Historic and Archaeological Assets of the Commonwealth or State Register, which requires the filing of an Environmental Notification Form (ENF).

Massachusetts Department of Environmental Protection Chapter 91

Due to the building's location adjacent to Boston Harbor, the project falls under the jurisdiction of the Massachusetts Public Waterfront Act, or Massachusetts General Court Chapter 91, which is administered by the Massachusetts Department of Environmental Protection (MassDEP). (MassDEP 2019). Under Chapter 91 regulations, changing the use of Hoosac Stores 1 & 2 requires authorization from MassDEP. Additionally, any change to the footprint of the building would likewise trigger Chapter 91 review by MassDEP (MassDEP 2019).

Archaeology

The Hoosac Stores 1 & 2 was constructed in 1895 at the edge of the fast (as opposed to made or filled) land at the southwest end of what are now the Navy Yard district boundaries. Built by the Boston & Main Railroad in 1895 at the northern end of the Hoosac Dock terminal (Carlson 2010:823), it was never owned by the United States Navy nor was it part of the historic Navy Yard complex. The extant storehouse—along with the adjacent parking lot containing a small boiler house building constructed in 1930–1940—are built on deep nineteenth-century fill deposits, but that fill likely caps some portion of an intact original shoreline.

Given the level of historical landscape disturbance, the building footprint and adjacent parking lot have been assessed with low pre-contact archaeological sensitivity. The post-contact archaeological sensitivity of the area is considered moderate to high with a specific potential to contain structural evidence of early wharf structures and bulkheads and wooden and granite seawalls buried beneath the fill (Heitert and Elam 2012). Limited geotechnical investigations in the parking lot to find the original coastline beneath nineteenth-century capping fill, however, was inconclusive (Weber Engineering Associates, LLC 2002).

Five Reuse Alternatives Review

PAL staff have reviewed the five reuse design alternatives developed by Marble Fairbanks and the National Park Service received on January 24, 2020 and coordinated with Jason Roberts of Marble Fairbanks. PAL considered the historic character-defining features of the Hoosac Stores 1 & 2 building and its site and the Secretary of the Interior's (SOI) *Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings* (Grimmer 2017) and other NPS guidance in offering the following observations and comments on the different proposed physical changes to the building and site.

Alternative 1

- Among the alternatives, has least intervention and effect on Hoosac Stores 1 & 2 building; work proposed likely would technically have an adverse effect, but could potentially be appropriately minimized and mitigated through sensitive design and suitable materials
- Stays within existing footprint and massing of building
- Adds four additional bays of windows on the north wall and 6 additional bays on the south wall
- Unclear if existing window opening sizes are altered

- Adds punched window openings to historically blank east and west elevations that are compatible with/shown as same size and rhythm as historic window openings on north and west elevations, which is recommended
- Treatment of the extant loading bay on west elevation unclear
- Adds a glass curtain wall instead of existing brick on first and second stories of north and east elevations; removes historic fabric
- Interior alterations include the removal of character-defining features including part of one floor for a double-height gallery and theater space for USSCM, removal of some support posts and replacement with lateral supports, removal of brick partition wall between Hoosac Stores 1 & 2, removal of stairs and elevators/shafts
- Retains boiler house on west lot

Alternatives 2, 3 and 4 contemplate various additions to Hoosac Stores 1 & 2. NPS *Preservation Brief 14: New Exterior Additions to Historic Buildings* by Anne E. Grimmer and Kay D. Weeks should be consulted for specific information regarding additions. In order to meet the SOI Standards and Guidelines, additions should preserve the historic character of the building, and must be compatible with the massing, size, scale, and architectural features of the original building. Rooftop additions should not be more than one story in height and should be set back at least one full bay from the primary elevation of the building, as well as from the other elevations if the building is free-standing or highly visible, both conditions which are met by Hoosac Stores 1 & 2. Preservation Brief 14 is silent on glass curtain wall additions.

Alternative 2

- Retains original building as in Alternative 1; glass curtain walls on first story at east end and first and second stories at east and west ends; window openings punched in east and west elevations
- Adds two-story glass curtain wall addition on roof; design shown is flush with original Hoosac Stores 1 & 2 walls. SOI requires at least one bay setback on all sides (Pres. Brief 14)
- Builds out east portion (half?) of south elevation with full-height glass curtain wall enclosing brick wall; addition extends onto historic rail right-of-way; glass generally considered appropriate for small-scale additions on historic buildings and not so extensive as to stand out and distract from historic building material (Pres. Brief 14)

Alternative 3

- Same treatment to Hoosac Stores 1 & 2 as Alternative 2
- Adds an 8-story brick building addition of approximate equal size to Hoosac Stores 1 and 2 on west lot, slated for hotel-type use; recommended that the new addition be subordinate in size to the historic building (Pres. Brief 14)
- Results in removal of historic boiler house
- Covers entire west elevation wall of Hoosac Stores building
- Addition walls are shown as same material and continuous with historic building; recommended to avoid unifying two volumes as a single whole and that they be differentiated by a gap created by a small-scale hyphen or setback treatment (Pres. Brief 14)
- Addition windows show as same rhythm and scale as historic building
- Addition does not fully build out west lot; massing mimics Hoosac Stores 1 & 2 on the north and west with L-shape footprint; on the south has a central light well and lower south wall section enclosing the light well.

Alternative 4

- Same treatment to Hoosac Stores 1 & 2 as Alternatives 2 and 3
- Adds an 8-story brick building addition of approximate equal size to Hoosac Stores 1 & 2 on west lot, slated for various leased uses; recommended that the new addition be subordinate in size to the historic building (Pres. Brief 14)
- Results in removal of historic boiler house
- Elements of addition building design and layout similar to Alternative 3
- Fully builds out west lot with full height walls on north, west, and south

Alternative 5

- Results in complete removal of Hoosac Stores 1 & 2
- Fully builds out lot with one new building
- Design shown reflects stepped configuration of non-historic buildings on nearby pier and is out of scale and massing with historic Navy Yard.
- If this alternative is selected, design of new building should be sympathetic to adjacent Charlestown Navy Yard

In summary, all of the alternatives present varying levels of challenge in meeting the SOI Standards. While the basic premise of each proposed change is theoretically possible, each intervention would likely require revision to scale back the impact of the new design elements and make the design more sensitive to the historic building and the surrounding environmental context of the Charlestown Navy Yard. Some tradeoffs might be necessary. The design concepts shown for Alternatives 1–4 could be made more compatible with the historic Hoosac Stores 1 & 2 building by considering topics noted above. Special attention is warranted in preserving elements that convey the historic integrity of Hoosac Stores 1 & 2 as a warehouse; maintaining it as a clearly identifiable, historic, freestanding building; reducing use of glass curtain wall treatments (including the removal of historic masonry wall and the side and rooftop additions) that distract from the historic character of the building; and reducing the size and articulating the design of the new potential west addition to differentiate it and subordinate it to the primary historic building and make the design more contemporary.

References

Adams, Virginia H. and Gretchen Pineo
2019 *Historic Research and Documentation for Submittal 2, Hoosac Stores Modernization, Program Development Study*. Submitted to Marble Fairbanks, Brooklyn, NY.

Boston Planning and Development Agency (BPDA)
2019a Article 42B – Harborpark District – Charlestown Waterfront. https://library.municode.com/ma/boston/codes/redevelopment_authority?nodeId=ART42BHADIHAWA, accessed November 2019.

2019b Zoning Board of Appeal. http://www.bostonplans.org/zoning/zoning-board-of-appeals, accessed December 2019.

Boston Redevelopment Authority (BRA)
2014 *A Citizen's Guide to Development Review under Article 80 of the Boston Zoning Code.* http://www.bostonplans.org/getattachment/610ddaf1-a547-4eb9-bb22-4d0938f354f6, accessed December 2019.

Carlson, Stephen P.
2010 *Charlestown Navy Yard Historic Resource Study*. Produced by the Division of Cultural Resources, Boston National Historical Park, National Park Service, U.S. Department of the Interior, Boston, MA.

Grimmer Anne E.
2017 *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings*. Technical Preservation Services, National Park Service, Washington, D.C. https://www.nps.gov/tps/standards/treatment-guidelines-2017.pdf, accessed January 2020.

Grimmer, Anne E. and Kay D. Weeks
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Heitert, Kristen and Jenifer Elam
2012 *Charlestown Navy Yard, Boston National Historical Park, Archeological Overview And Assessment, Boston, Massachusetts*. The Public Archaeology Laboratory, Inc. Report No. 2538. Submitted to the National Park Service, Boston National Historical Park, Charlestown Navy Yard, Boston, MA.

Massachusetts Department of Environmental Protection (MassDEP)
2019 Chapter 91, The Massachusetts Public Waterfront Act. https://www.mass.gov/guides/chapter-91-the-massachusetts-public-waterfront-act, accessed December 2019.

Massachusetts Historical Commission (MHC)
2019 *Guidance for Completing MHC's Project Notification Form (950 CMR 71.00, Appendix A).* https://www.sec.state.ma.us/mhc/mhcpdf/pnfguide.pdf, accessed December 2019.

Secretary of the Commonwealth of Massachusetts (Secretary of the Commonwealth)
1988 Protection of Properties Included in the State Register of Historic Places. https://www.mass.gov/doc/950-cmr-71-protection-of-properties-included-in-the-state-register-of-historic-places/download, accessed December 2019.

Weber Engineering Associates, LLC
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Possible Alternatives RoM Costing Report

The following RoM costing reports were prepared by Jacobs and were based on the five Possible Alternates developed by Marble Fairbanks. These evaluations were based on the programmatic breakdown of each of the Alternates as well as the narrative provided with each.

The Hoosac Store Modernization

Alternate 1

Conceptual Estimate

Job size **61400 SF**

Estimate Date 02-07-2020

JACOBS

The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Date: 02-07-2020

Description	Quantity	Total Cost/Unit	Total Amount
01 ALTERNATE 1			
A10 FOUNDATIONS	61,400 SF	21.80	1,338,669
B10 SUPERSTRUCTURE	61,400 SF	37.72	2,316,278
B20 EXTERIOR VERTICAL ENCLOSURE	61,400 SF	77.79	4,776,457
B30 EXTERIOR HORIZONTAL ENCLOSURE	61,400 SF	7.50	460,486
C10 INTERIOR CONSTRUCTION	61,400 SF	35.81	2,198,933
C30 INTERIOR FINISHES	61,400 SF	51.88	3,185,481
D10 CONVEYING	61,400 SF	13.37	820,601
D20 PLUMBING	61,400 SF	7.00	429,770
D30 HVAC	61,400 SF	49.35	3,030,348
D40 FIRE PROTECTION	61,400 SF	9.00	552,570
D50 ELECTRICAL	61,400 SF	44.36	2,723,426
D60 COMMUNICATION	61,400 SF	13.82	848,229
D70 ELECTRONIC SAFETY AND SECURITY	61,400 SF	6.61	405,961
E20 FURNISHINGS	61,400 SF	2.50	153,487
F20 FACILITY REMEDIATION	61,400 SF	16.05	985,488
F30 DEMOLITION	61,400 SF	20.02	1,229,430
01 ALTERNATE 1	***61,400 SF***	***414.59***	***25,455,614***

Estimate Totals

Description	Rate	Amount	Totals	Cost per Unit
Subtotal Direct Cost		***25,455,614***		***414.59 /SF***
Design Contingency	15.00 %	3,818,342		
LEED Premium	2.50 %	731,849		
General Conditions	10.00 %	3,000,580		
Construction Contingency	10.00 %	3,300,639		
GC Overhead	5.00 %	1,815,351		
GC Fee	5.00 %	1,906,119		
Performance & Payment Bond	1.00 %	400,285		
Gen Liability Insurance	5.00 %	2,021,439		
Builders Risk Insurance	0.14 %	59,430		
Escalation	6.00 %	2,550,579		
Subtotal Indirect Cost		***19,604,613***		
Total Construction Cost			***45,060,227***	***733.88 /SF***

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The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
01 ALTERNATE 1			
A10 FOUNDATIONS			
A1020 Special Foundations			
Structural bracing foundtion (micro-pile incl cap)	20 loc	35,000.00	700,000
Encased existing column base	36 loc	10,000.00	360,000
A1020 Special Foundations	***61,400 SF***	***17.26***	***1,060,000***
A4010 Standard Slab-on-Grade			
Patch and repair existing SOG - allowance	5,000 sf	10.73	53,670
Elevator Pit complete incl excavation	3 ea	25,000.00	75,000
A4010 Standard Slab-on-Grade			***128,669***
A9020 Construction Dewatering			
Dewatering allowance	1 ls	150,000.01	150,000
A9020 Construction Dewatering	***61,400 SF***	***2.44***	***150,000***
A10 FOUNDATIONS	***61,400 SF***	***21.80***	***1,338,669***
B10 SUPERSTRUCTURE			
B1010 Floor Construction			
Concrete fill on metal deck - (Floor replacement 6th floor - 25%)	2,558 sf	15.50	39,654
Concrete fill on metal deck - infill shafts/stairs	2,016 sf	15.50	31,249
Structural support for slab replacement 25% of 6th floor	20 ton	7,478.24	149,565
Structural support for slab infill at shaft/stair	15 ton	7,478.24	112,174
Metal floor decking - (Floor replacement 6th floor - 25%)	2,558 sf	6.28	16,068
Metal floor decking - infill shafts/stair	2,016 sf	6.28	12,663
Misc Metals - Existing Building	61,400 sf	5.50	337,688
Sprayed fireproofing	61,400 sf	3.50	214,935
B1010 Floor Construction	***61,400 SF***	***14.89***	***913,996***
B1020 Roof Construction			
New roof structure	102 ton	7,478.24	762,780
Allow Penthouse Framing/Dunnage	20 ton	5,500.00	110,000
Metal roof decking, steel - Existing Building	10,233 sf	4.84	49,502
B1020 Roof Construction	***61,400 SF***	***15.02***	***922,282***
B1080 Stairs			
Metal stair with railing	24 flt	20,000.00	480,000
B1080 Stairs			***480,000***
B10 SUPERSTRUCTURE	***61,400 SF***	***37.72***	***2,316,278***
B20 EXTERIOR VERTICAL ENCLOSURE			
B2010 Exterior Walls			
Exterior scaffolding	29,322 sf	15.00	439,830
Repoint & restore existing brick facade	16,909 sf	50.00	845,444
Exterior bracing along perimeter	138 ton	7,971.83	1,100,112
Structural steel support for exterior glazing	56 ton	7,971.83	444,031
Exterior caulking	29,322 sf	1.26	36,923
Punched windows	5,936 sf	110.00	652,963
Curtain wall	5,203 sf	165.00	858,495
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade	16,909 sf	14.00	236,717
Canopy at Entry Doors, allowance	1 ls	100,000.33	100,000

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The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
B2010 Exterior Walls	*61,400 SF*	*76.78*	*4,714,515*
B2050 Exterior Doors & Grilles			
Aluminum/glass door - exterior allowance	6 opng	10,323.67	61,942
B2050 Exterior Doors & Grilles	*61,400 SF*	*1.01*	*61,942*
B20 EXTERIOR VERTICAL ENCLOSURE	***61,400 SF***	***77.79***	***4,776,457***
B30 EXTERIOR HORIZONTAL ENCLOSURE			
B3010 Roof Coverings			
Built-up Roofing System complete	10,233 sf	45.00	460,486
B3010 Roof Coverings	*61,400 SF*	*7.50*	*460,486*
B30 EXTERIOR HORIZONTAL ENCLOSURE	***61,400 SF***	***7.50***	***460,486***
C10 INTERIOR CONSTRUCTION			
C1010 Interior Partitions			
Rough carpentry - building	61,400 sf	1.98	121,260
Misc Caulking & Sealants - Interior building	61,400 sf	0.65	39,910
Interior partition, Orientation Space	6,000 sf	20.00	120,002
Interior partition, NPS Space	17,800 sf	40.00	711,991
Interior partition, USSCM Space	37,600 sf	20.00	752,008
C1010 Interior Partitions	*61,400 SF*	*28.42*	*1,745,171*
C1030 Interior Doors			
Alum Frame/Wood Doors/Hardware	61,400 sf	5.64	346,277
C1030 Interior Doors	*61,400 SF*	*5.64*	*346,277*
C1090 Interior Specialties			
Interior signage	61,400 sf	1.25	76,769
Toilet accessories allowance	61,400 ea	0.50	30,716
C1090 Interior Specialties	*61,400 SF*	*1.75*	*107,485*
C10 INTERIOR CONSTRUCTION	***61,400 SF***	***35.81***	***2,198,933***
C30 INTERIOR FINISHES			
C3010 Wall Finishes			
Orientation space	6,000 sf	5.00	30,003
NPS Space	17,800 sf	5.00	89,009
USSCM Space	37,600 sf	15.00	564,003
C3010 Wall Finishes	*61,400 SF*	*11.12*	*683,015*
C3020 Floor Finishes			
Orientation space	6,000 sf	10.50	63,000
NPS Space	17,800 sf	7.50	133,495
USSCM Space	37,600 sf	35.00	1,315,996
C3020 Floor Finishes	*61,400 SF*	*24.63*	*1,512,491*
C3030 Ceiling Finishes			
Orientation space	6,000 sf	10.00	59,998
NPS Space	17,800 sf	10.00	177,995
USSCM Space	37,600 sf	20.00	751,981
C3030 Ceiling Finishes	*61,400 SF*	*16.12*	*989,975*
C30 INTERIOR FINISHES	***61,400 SF***	***51.88***	***3,185,481***
D10 CONVEYING			

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The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
D1010 Vertical Conveying System				
Electric traction freight elevators, 5000lb	6	stp	50,000.01	300,000
Electric Traction Passenger Elevators, 3500lb	12	stp	40,050.08	480,601
Passenger Elevator cab finishes allowance	2	ea	20,000.00	40,000
D1010 Vertical Conveying System	*61,400*	*SF*	*13.37*	*820,601*
D10 CONVEYING	***61,400***	***SF***	***13.37***	***820,601***
D20 PLUMBING				
D2010 Plumbing Fixtures				
Plumbing	61,400	sf	7.00	429,770
D2010 Plumbing Fixtures	*61,400*	*SF*	*7.00*	*429,770*
D20 PLUMBING	***61,400***	***SF***	***7.00***	***429,770***
D30 HVAC				
D3020 Heating Systems				
Condensing Boilers	1,842	mbh	40.00	73,680
D3020 Heating Systems	*61,400*	*SF*	*1.20*	*73,680*
D3030 Cooling Systems				
HVAC Piping Systems (CHW/CT/HW)	61,400	sf	10.00	614,015
Chillers	175	tons	500.00	87,500
Cooling tower	175	tons	300.00	52,500
D3030 Cooling Systems	*61,400*	*SF*	*12.28*	*754,015*
D3040 Distribution Systems				
Ductwork & Insulation	61,400	lb	14.00	859,575
Dampers (Volume/Motorized/Fire)	61,400	sf	0.50	30,681
Exhaust Fans	15,350	cfm	1.50	23,019
Diffusers & Grilles	61,400	sf	1.00	61,389
Air Handling Units	61,400	cfm	8.00	491,166
D3040 Distribution Systems	*61,400*	*SF*	*23.87*	*1,465,830*
D3050 Terminal & Package Units				
Terminal Units (VAV Boxes/Fan Coil Units/Unit Heaters)	61,400	sf	5.00	307,019
D3050 Terminal & Package Units	*61,400*	*SF*	*5.00*	*307,019*
D3060 Controls & Instrumentation				
Controls	61,400	sf	5.00	306,982
D3060 Controls & Instrumentation	*61,400*	*SF*	*5.00*	*306,982*
D3070 System Testing & Balancing				
Commissioning, Assistance, & Start-up	61,400	sf	1.00	61,399
Testing & Balancing	61,400	sf	1.00	61,422
D3070 System Testing & Balancing	*61,400*	*SF*	*2.00*	*122,821*
D30 HVAC	***61,400***	***SF***	***49.35***	***3,030,348***
D40 FIRE PROTECTION				
D4010 Fire Suppression				
Fire Suppression System	61,400	sf	9.00	552,570
D4010 Fire Suppression	*61,400*	*SF*	*9.00*	*552,570*
D40 FIRE PROTECTION	***61,400***	***SF***	***9.00***	***552,570***
D50 ELECTRICAL				

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The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D5020 Electrical Services and Distribution			
Temporary Light and Power for construction	61,400 sf	0.94	57,408
Building and Equipment Grounding	61,400 sf	0.58	35,673
Motor connections, Electrical Connection including conduit and wire	61,400 sf	1.21	74,416
New Building Transformers	61,400 sf	0.81	49,610
Main Incoming Substation 4000 amp Secondary	1 ea	500,798.83	500,799
New Building Panels	61,400 sf	1.04	63,548
Building Lightning Protection	61,400 sf	0.24	14,766
D5020 Electrical Services and Distribution	***61,400 SF***	***12.97***	***796,221***
D5030 General Purpose Electrical Systems			
New Electrical Feeders and Bus Duct risers	61,400 sf	4.01	245,904
Building Devices (Switches and Receptacles)	61,400 sf	5.03	308,531
Lighting Controls	61,400 sf	2.52	154,971
D5030 General Purpose Electrical Systems	***61,400 SF***	***11.55***	***709,406***
D5040 Lighting			
Building Lighting LED Package	61,400 sf	11.45	703,021
Museum Lighting Premium	37,600 sf	10.50	394,778
Outdoor Lighting Allow	1 ea	120,000.00	120,000
D5040 Lighting	***61,400 SF***	***19.83***	***1,217,799***
D50 ELECTRICAL	***61,400 SF***	***44.36***	***2,723,426***
D60 COMMUNICATION			
D6020 Voice Communication			
New Building Cable Tray	61,400 sf	0.55	34,015
Telcom and Data System	61,400 sf	7.93	486,895
Wireless Network	61,400 sf	1.04	63,548
Add for specical areas	61,400 sf	1.26	77,486
D6020 Voice Communication	***61,400 SF***	***10.78***	***661,944***
D6060 Distributed Communications and Monitoring			
A/V System Rough in, and Wiring Includes Conduit and back boxes, and Cables	61,400 sf	1.87	114,571
New Building Sound Masking System	61,400 sf	1.17	71,714
D6060 Distributed Communications and Monitoring	***61,400 SF***	***3.03***	***186,285***
D60 COMMUNICATION	***61,400 SF***	***13.82***	***848,229***
D70 ELECTRONIC SAFETY AND SECURITY			
D7050 Detection and Alarm			
Fire Alarm System	61,400 sf	4.02	247,104
D7050 Detection and Alarm	***61,400 SF***	***4.02***	***247,104***
D7090 Electronic Safety & Security Supplimentary Components			
Security and CCTV System	61,400 ea	2.59	158,857
D7090 Electronic Safety & Security Supplimentary Components	***61,400 SF***	***2.59***	***158,857***
D70 ELECTRONIC SAFETY AND SECURITY	***61,400 SF***	***6.61***	***405,961***
E20 FURNISHINGS			
E2050 Furnishings			
Millwork	61,400 SF	2.50	153,487
FF& E - NIC	***ls***		

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The Hoosac Store Modernization
Alternate 1
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
E2050 Furnishings	*61,400 SF*	*2.50*	*153,487*
E20 FURNISHINGS	***61,400 SF***	***2.50***	***153,487***
F20 FACILITY REMEDIATION			
F2010 Hazardous Materials Remediation			
Hazmat abatement	65,700 sf	15.00	985,488
F2010 Hazardous Materials Remediation			*985,488*
F20 FACILITY REMEDIATION	***61,400 SF***	***16.05***	***985,488***
F30 DEMOLITION			
F3030 Selective Demolition			
Demo existing building interior	65,700 sf	7.50	492,754
Remove existing brick facade	12,413 sf	10.00	124,131
Remove storage items from Existing Building - Allowance	1 ls	100,000.03	100,000
Demo existing roof complete incl structure	10,233 sf	15.00	153,501
Cut opening in structural slab for new elevator - 6 locations	6 loc	7,500.00	45,000
Cut opening in structural slab for new stairs - 12 locations	12 loc	5,000.00	60,000
Cut opening in SOG for new elevator, structral bracing and misc below grade work - assumed 50%	5,117 sf	10.00	51,167
Demo 25% of sixth floor structural slab	2,558 sf	15.00	38,375
Demo existing interior floor to create double-height space	4,300 sf	15.00	64,502
Shoring for structural demo - allowance	1 ls	100,000.32	100,000
F3030 Selective Demolition	*61,400 SF*	*20.02*	*1,229,430*
F30 DEMOLITION	***61,400 SF***	***20.02***	***1,229,430***
01 ALTERNATE 1	***61,400 SF***	***414.59***	***25,455,614***

The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Job size	**94232 SF**
Estimate Date	02-07-2020

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The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Date: 02-07-2020

Description	Quantity	Total Cost/Unit	Total Amount
02 ALTERNATE 2			
A10 FOUNDATIONS	94,232 SF	20.48	1,929,557
B10 SUPERSTRUCTURE	94,232 SF	46.06	4,340,280
B20 EXTERIOR VERTICAL ENCLOSURE	94,232 SF	85.33	8,041,174
B30 EXTERIOR HORIZONTAL ENCLOSURE	94,232 SF	5.64	531,001
C10 INTERIOR CONSTRUCTION	94,232 SF	27.53	2,594,307
C30 INTERIOR FINISHES	94,232 SF	55.26	5,207,260
D10 CONVEYING	94,232 SF	8.71	820,601
D20 PLUMBING	94,232 SF	7.00	659,578
D30 HVAC	94,232 SF	49.37	4,651,917
D40 FIRE PROTECTION	94,232 SF	9.00	848,042
D50 ELECTRICAL	94,232 SF	41.09	3,871,838
D60 COMMUNICATION	94,232 SF	14.09	1,327,899
D70 ELECTRONIC SAFETY AND SECURITY	94,232 SF	6.61	623,038
E20 FURNISHINGS	94,232 SF	2.50	235,560
F20 FACILITY REMEDIATION	94,232 SF	10.46	985,488
F30 DEMOLITION	94,232 SF	12.72	1,198,398
02 ALTERNATE 2	***94,232 SF***	***401.84***	***37,865,936***

Estimate Totals

Description	Rate	Amount	Totals	Cost per Unit
Subtotal Direct Cost		*37,865,937*		*401.84 /SF*
Design Contingency	15.00 %	5,679,890		
LEED Premium	2.50 %	1,088,646		
General Conditions	10.00 %	4,463,447		
Construction Contingency	10.00 %	4,909,792		
GC Overhead	5.00 %	2,700,386		
GC Fee	5.00 %	2,835,405		
Performance & Payment Bond	1.00 %	595,435		
Gen Liability Insurance	5.00 %	3,006,947		
Builders Risk Insurance	0.14 %	88,404		
Escalation	6.00 %	3,794,057		
Subtotal Indirect Cost		*29,162,409*		
Total Construction Cost			*67,028,346*	*711.31 /SF*

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The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
02 ALTERNATE 2				
A10 FOUNDATIONS				
A1020 Special Foundations				
Structural bracing foundtion (micro-pile incl cap)	20	loc	35,000.00	700,000
Encased existing column base	36	loc	10,000.00	360,000
Pile foundation, complete - Addition	32,832	GSF	17.50	574,572
A1020 Special Foundations	***94,232***	***SF***	***17.35***	***1,634,572***
A4010 Standard Slab-on-Grade				
Slab on grade, with 6" base - Addition	1,520	sf	10.73	16,316
Patch and repair existing SOG - allowance	5,000	sf	10.73	53,670
Elevator Pit complete incl excavation	3	ea	25,000.00	75,000
A4010 Standard Slab-on-Grade				***144,985***
A9020 Construction Dewatering				
Dewatering allowance	1	ls	150,000.01	150,000
A9020 Construction Dewatering	***94,232***	***SF***	***1.59***	***150,000***
A10 FOUNDATIONS	***94,232***	***SF***	***20.48***	***1,929,557***
B10 SUPERSTRUCTURE				
B1010 Floor Construction				
Concrete fill on metal deck - Addtion	32,832	sf	12.50	410,391
Concrete fill on metal deck - (Floor replacement 6th floor - 25%) - Existing Building	2,558	sf	15.50	39,654
Concrete fill on metal deck - infill shafts/stairs - Existing Building	2,016	sf	15.50	31,249
Structural steel, columns & beams - Addition	246	ton	5,500.00	1,354,320
Structural support for slab replacement 25% of 6th floor - Existing Building	20	ton	7,500.00	150,000
Structural support for slab infill at shaft/stair - Existing Building	15	ton	7,500.00	112,500
Metal floor decking - Addition	32,832	sf	4.73	155,205
Metal floor decking - (Floor replacement 6th floor - 25%) - Existing Building	2,558	sf	6.28	16,068
Metal floor decking - infill shafts/stair - Existing Building	2,016	sf	6.28	12,663
Misc Metals	32,832	sf	2.49	81,770
Misc Metals - Existing Building	61,400	sf	5.50	337,688
Sprayed fireproofing	94,232	sf	3.50	329,866
B1010 Floor Construction	***94,232***	***SF***	***32.17***	***3,031,374***
B1020 Roof Construction				
New roof structure - Existing Building	89	ton	7,478.24	661,824
Allow Penthouse Framing/Dunnage	20	ton	5,500.00	110,000
Metal roof decking, steel - Existing Building	11,800	sf	4.84	57,082
B1020 Roof Construction	***94,232***	***SF***	***8.80***	***828,906***
B1080 Stairs				
Metal stair with railing	24	flt	20,000.00	480,000
B1080 Stairs				***480,000***
B10 SUPERSTRUCTURE	***94,232***	***SF***	***46.06***	***4,340,280***
B20 EXTERIOR VERTICAL ENCLOSURE				
B2010 Exterior Walls				
Exterior scaffolding	29,322	sf	15.00	439,830
Repoint & restore existing brick facade	16,909	sf	50.00	845,444

JACOBS

The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
B2010 Exterior Walls			
Exterior bracing along perimeter - Existing Building	138 ton	7,971.83	1,100,112
Structural steel support for exterior glazing - Existing Building	75 ton	7,971.83	597,887
Exterior caulking	46,754 sf	1.26	58,874
Punched windows	5,892 sf	110.00	648,123
Curtain wall	23,953 sf	165.00	3,952,244
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade	16,909 sf	14.00	236,717
Canopy at Entry Doors, allowance	1 ls	100,000.33	100,000
B2010 Exterior Walls	***94,232 SF***	***84.68***	***7,979,232***
B2050 Exterior Doors & Grilles			
Aluminum/glass door - exterior allowance	6 opng	10,323.67	61,942
B2050 Exterior Doors & Grilles	***94,232 SF***	***0.66***	***61,942***
B20 EXTERIOR VERTICAL ENCLOSURE	***94,232 SF***	***85.33***	***8,041,174***
B30 EXTERIOR HORIZONTAL ENCLOSURE			
B3010 Roof Coverings			
Built-up Roofing System complete	11,800 sf	45.00	531,001
B3010 Roof Coverings	***94,232 SF***	***5.64***	***531,001***
B30 EXTERIOR HORIZONTAL ENCLOSURE	***94,232 SF***	***5.64***	***531,001***
C10 INTERIOR CONSTRUCTION			
C1010 Interior Partitions			
Rough carpentry - building	94,232 sf	1.98	186,101
Misc Caulking & Sealants - Interior building	61,400 sf	0.65	39,910
Interior partition, Orientation Space	6,000 sf	20.00	120,002
Interior partition, NPS Space	17,800 sf	40.00	711,991
Interior partition, USSCM Space	37,600 sf	20.00	752,008
Interior partition, Lease Space	10,432 sf	10.00	104,321
C1010 Interior Partitions	***94,232 SF***	***20.32***	***1,914,333***
C1030 Interior Doors			
Alum Frame/Wood Doors/Hardware	94,232 sf	5.64	531,439
C1030 Interior Doors	***94,232 SF***	***5.64***	***531,439***
C1090 Interior Specialties			
Interior signage	94,232 sf	1.25	117,820
Toilet accessories allowance	61,400 ea	0.50	30,716
C1090 Interior Specialties	***94,232 SF***	***1.58***	***148,535***
C10 INTERIOR CONSTRUCTION	***94,232 SF***	***27.53***	***2,594,307***
C30 INTERIOR FINISHES			
C3010 Wall Finishes			
Orientation space	6,000 sf	5.00	30,003
NPS Space	17,800 sf	5.00	89,009
USSCM Space	60,000 sf	15.00	900,004
Lease Space	10,432 sf	5.00	52,164
C3010 Wall Finishes	***94,232 SF***	***11.37***	***1,071,181***
C3020 Floor Finishes			
Orientation space	6,000 sf	10.50	63,000
NPS Space	17,800 sf	7.50	133,495

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The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
C3020 Floor Finishes				
USSCM Space	60,000	sf	35.00	2,099,994
Lease Space	10,432	sf	35.00	365,119
C3020 Floor Finishes	***94,232***	***SF***	***28.25***	***2,661,608***
C3030 Ceiling Finishes				
Orientation space	6,000	sf	10.00	59,998
NPS Space	17,800	sf	10.00	177,995
USSCM Space	60,000	sf	20.00	1,199,969
Lease Space	10,432	sf	3.50	36,508
C3030 Ceiling Finishes	***94,232***	***SF***	***15.65***	***1,474,471***
C30 INTERIOR FINISHES	***94,232***	***SF***	***55.26***	***5,207,260***
D10 CONVEYING				
D1010 Vertical Conveying System				
Electric traction freight elevators, 5000lb	6	stp	50,000.01	300,000
Electric Traction Passenger Elevators, 3500lb	12	stp	40,050.08	480,601
Passenger Elevator cab finishes allowance	2	ea	20,000.00	40,000
D1010 Vertical Conveying System	***94,232***	***SF***	***8.71***	***820,601***
D10 CONVEYING	***94,232***	***SF***	***8.71***	***820,601***
D20 PLUMBING				
D2010 Plumbing Fixtures				
Plumbing	94,232	sf	7.00	659,578
D2010 Plumbing Fixtures	***94,232***	***SF***	***7.00***	***659,578***
D20 PLUMBING	***94,232***	***SF***	***7.00***	***659,578***
D30 HVAC				
D3020 Heating Systems				
Condensing Boilers	2,830	mbh	40.00	113,200
D3020 Heating Systems	***94,232***	***SF***	***1.20***	***113,200***
D3030 Cooling Systems				
HVAC Piping Systems (CHW/CT/HW)	94,232	sf	10.00	942,295
Chillers	270	tons	500.00	135,000
Cooling tower	270	tons	300.00	81,000
D3030 Cooling Systems	***94,232***	***SF***	***12.29***	***1,158,295***
D3040 Distribution Systems				
Ductwork & Insulation	94,232	lb	14.00	1,319,205
Dampers (Volume/Motorized/Fire)	94,232	sf	0.50	47,087
Exhaust Fans	23,558	cfm	1.50	35,328
Diffusers & Grilles	94,232	sf	1.00	94,179
Air Handling Units	94,232	cfm	8.00	753,804
D3040 Distribution Systems	***94,232***	***SF***	***23.87***	***2,249,604***
D3050 Terminal & Package Units				
Terminal Units (VAV Boxes/Fan Coil Units/Unit Heaters)	94,232	sf	5.00	471,190
D3050 Terminal & Package Units	***94,232***	***SF***	***5.00***	***471,190***
D3060 Controls & Instrumentation				
Controls	94,232	sf	5.00	471,133

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The Hoosac Store Modernization
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Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D3060 Controls & Instrumentation	*94,232 SF*	*5.00*	*471,133*
D3070 System Testing & Balancing			
Commissioning, Assistance, & Start-up	94,232 sf	1.00	94,231
Testing & Balancing	94,232 sf	1.00	94,265
D3070 System Testing & Balancing	*94,232 SF*	*2.00*	*188,496*
D30 HVAC	***94,232 SF***	***49.37***	***4,651,917***
D40 FIRE PROTECTION			
D4010 Fire Suppression			
Fire Suppression System	94,232 sf	9.00	848,042
D4010 Fire Suppression	*94,232 SF*	*9.00*	*848,042*
D40 FIRE PROTECTION	***94,232 SF***	***9.00***	***848,042***
D50 ELECTRICAL			
D5020 Electrical Services and Distribution			
Temporary Light and Power for construction	94,232 sf	0.94	88,106
Building and Equipment Grounding	94,232 sf	0.58	54,748
Motor connections, Electrical Connection including conduit and wire	94,232 sf	1.21	114,208
New Building Transformers	94,232 sf	0.81	76,138
Main Incoming Substation 4000 amp Secondary	1 ea	500,798.83	500,799
New Building Panels	94,232 sf	1.04	97,529
Building Lightning Protection	94,232 sf	0.24	22,662
D5020 Electrical Services and Distribution	*94,232 SF*	*10.13*	*954,189*
D5030 General Purpose Electrical Systems			
New Electrical Feeders and Bus Duct risers	94,232 sf	4.01	377,395
Building Devices (Switches and Receptacles)	94,232 sf	5.03	473,509
Lighting Controls	94,232 sf	2.52	237,838
D5030 General Purpose Electrical Systems	*94,232 SF*	*11.55*	*1,088,742*
D5040 Lighting			
Building Lighting LED Package	94,232 sf	11.45	1,078,943
Museum Lighting Premium	60,000 sf	10.50	629,964
Outdoor Lighting Allow	1 ea	120,000.00	120,000
D5040 Lighting	*94,232 SF*	*19.41*	*1,828,907*
D50 ELECTRICAL	***94,232 SF***	***41.09***	***3,871,838***
D60 COMMUNICATION			
D6020 Voice Communication			
New Building Cable Tray	94,232 sf	0.55	52,204
Telcom and Data System	94,232 sf	7.93	747,249
Wireless Network	94,232 sf	1.04	97,529
Add for specical areas	94,232 sf	1.26	118,919
D6020 Voice Communication	*94,232 SF*	*10.78*	*1,015,901*
D6060 Distributed Communications and Monitoring			
A/V System Rough in, and Wiring Includes Conduit and back boxes, and Cables	94,232 sf	1.87	175,835
New Building Sound Masking System	94,232 sf	1.17	110,062
Add for Dynamic Signage System	94,232 sf	0.28	26,102
D6060 Distributed Communications and Monitoring	*94,232 SF*	*3.31*	*311,999*

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The Hoosac Store Modernization
Alternate 2
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D60 COMMUNICATION	***94,232 SF***	***14.09***	***1,327,899***
D70 ELECTRONIC SAFETY AND SECURITY			
D7050 Detection and Alarm			
Fire Alarm System	94,232 sf	4.02	379,236
D7050 Detection and Alarm	***94,232 SF***	***4.02***	***379,236***
D7090 Electronic Safety & Security Supplimentary Components			
Security and CCTV System	94,232 ea	2.59	243,802
D7090 Electronic Safety & Security Supplimentary Components	***94,232 SF***	***2.59***	***243,802***
D70 ELECTRONIC SAFETY AND SECURITY	***94,232 SF***	***6.61***	***623,038***
E20 FURNISHINGS			
E2050 Furnishings			
Millwork	94,232 SF	2.50	235,560
FF& E - NIC	***ls***		
E2050 Furnishings	***94,232 SF***	***2.50***	***235,560***
E20 FURNISHINGS	***94,232 SF***	***2.50***	***235,560***
F20 FACILITY REMEDIATION			
F2010 Hazardous Materials Remediation			
Hazmat abatement	65,700 sf	15.00	985,488
F2010 Hazardous Materials Remediation	***94,232***	***10.46***	***985,488***
F20 FACILITY REMEDIATION	***94,232 SF***	***10.46***	***985,488***
F30 DEMOLITION			
F3030 Selective Demolition			
Demo existing building interior	65,700 sf	7.50	492,754
Remove existing brick facade	12,413 sf	7.50	93,098
Remove storage items from Existing Building - Allowance	1 ls	100,000.03	100,000
Demo existing roof complete incl structure	10,233 sf	15.00	153,501
Cut opening in structural slab for new elevator - 6 locations	6 loc	7,500.00	45,000
Cut opening in structural slab for new stairs - 12 locations	12 loc	5,000.00	60,000
Cut opening in SOG for new elevator, structral bracing and misc below grade work - assumed 50%	5,117 sf	10.00	51,167
Demo 25% of sixth floor structural slab	2,558 sf	15.00	38,375
Demo existing interior floor to create double-height space	4,300 sf	15.00	64,502
Shoring for structural demo - allowance	1 ls	100,000.32	100,000
F3030 Selective Demolition	***94,232 SF***	***12.72***	***1,198,398***
F30 DEMOLITION	***94,232 SF***	***12.72***	***1,198,398***
02 ALTERNATE 2	***94,232 SF***	***401.84***	***37,865,936***

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The Hoosac Store Modernization
Alternate 3
Conceptual Estimate

Job size **158643 SF**

Estimate Date 02-07-2020

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The Hoosac Store Modernization
Alternate 3
Conceptual Estimate

Date: 02-07-2020

Description	Quantity	Total Cost/Unit	Total Amount
03 ALTERNATE 3			
A10 FOUNDATIONS	158,643 SF	21.05	3,338,805
B10 SUPERSTRUCTURE	158,643 SF	61.05	9,685,836
B20 EXTERIOR VERTICAL ENCLOSURE	158,643 SF	87.21	13,834,445
B30 EXTERIOR HORIZONTAL ENCLOSURE	158,643 SF	6.69	1,060,698
C10 INTERIOR CONSTRUCTION	158,643 SF	24.72	3,921,274
C30 INTERIOR FINISHES	158,643 SF	38.97	6,181,925
D10 CONVEYING	158,643 SF	11.10	1,761,603
D20 PLUMBING	158,643 SF	7.00	1,110,423
D30 HVAC	158,643 SF	49.36	7,831,050
D40 FIRE PROTECTION	158,643 SF	9.00	1,427,710
D50 ELECTRICAL	158,643 SF	35.70	5,663,443
D60 COMMUNICATION	158,643 SF	13.82	2,191,623
D70 ELECTRONIC SAFETY AND SECURITY	158,643 SF	6.61	1,048,907
E20 FURNISHINGS	158,643 SF	2.50	396,574
F20 FACILITY REMEDIATION	158,643 SF	6.21	985,488
F30 DEMOLITION	158,643 SF	7.55	1,198,398
03 ALTERNATE 3	***158,643 SF***	***388.53***	***61,638,201***

Estimate Totals

Description	Rate	Amount	Totals	Cost per Unit
Subtotal Direct Cost		***61,638,200***		***388.53 /SF***
Design Contingency	15.00 %	9,245,730		
LEED Premium	2.50 %	1,772,098		
General Conditions	10.00 %	7,265,603		
Construction Contingency	10.00 %	7,992,163		
GC Overhead	5.00 %	4,395,690		
GC Fee	5.00 %	4,615,474		
Performance & Payment Bond	1.00 %	969,250		
Gen Liability Insurance	5.00 %	4,894,710		
Builders Risk Insurance	0.14 %	143,904		
Escalation	6.00 %	6,175,969		
Subtotal Indirect Cost		***47,470,591***		
Total Construction Cost			***109,108,791***	***687.76 /SF***

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The Hoosac Store Modernization
Alternate 3
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
03 ALTERNATE 3			
A10 FOUNDATIONS			
A1020 Special Foundations			
Pile foundation, complete - New Building/Addition	97,243 GSF	17.50	1,701,788
Structural bracing foundtion (micro-pile incl cap)	20 loc	35,000.00	700,000
Encased existing column base	36 loc	10,000.00	360,000
A1020 Special Foundations	*158,643 SF*	*17.41*	*2,761,788*
A4010 Standard Slab-on-Grade			
Slab on grade, with 6" base - New Building/Addition	13,338 sf	10.73	143,169
Patch and repair existing SOG - allowance	5,000 sf	10.73	53,670
Elevator Pit (New Bldg/Addition)	3 ea	18,392.87	55,179
Elevator Pit complete incl excavation - Existing Building	3 ea	25,000.00	75,000
A4010 Standard Slab-on-Grade	*158,643 SF*	*2.06*	*327,017*
A9020 Construction Dewatering			
Dewatering allowance	1 ls	250,000.04	250,000
A9020 Construction Dewatering	*158,643 SF*	*1.58*	*250,000*
A10 FOUNDATIONS	***158,643 SF***	***21.05***	***3,338,805***
B10 SUPERSTRUCTURE			
B1010 Floor Construction			
Concrete fill on metal deck - New building/Addtion	97,243 sf	12.50	1,215,510
Concrete fill on metal deck - (Floor replacement 6th floor - 25%) - Existing Building	2,558 sf	15.50	39,654
Concrete fill on metal deck - infill shafts/stairs - Existing Building	2,016 sf	15.50	31,249
Structural steel, columns & beams - New building/Addition	729 ton	5,500.00	4,011,260
Structural support for slab replacement 25% of 6th floor - Existing Building	20 ton	7,500.00	150,000
Structural support for slab infill at shaft/stair - Existing Building	15 ton	7,500.00	112,500
Metal floor decking - New building	97,243 sf	4.73	459,691
Metal floor decking - (Floor replacement 6th floor - 25%) - Existing Building	2,558 sf	6.28	16,068
Metal floor decking - infill shafts/stair - Existing Building	2,016 sf	6.28	12,663
Misc Metals (New Bldg & Existing)	97,243 sf	2.49	242,343
Misc Metals - Existing Building	61,400 sf	5.50	337,688
Sprayed fireproofing	97,243 sf	3.50	340,406
B1010 Floor Construction	*158,643 SF*	*43.93*	*6,969,032*
B1020 Roof Construction			
New roof structure	100 ton	5,500.00	550,000
Allow Penthouse Framing/Dunnage	40 ton	5,500.00	220,000
New roof structure - Existing Building	76 ton	7,478.24	568,346
Metal roof decking, steel - New/existing Building	13,338 sf	3.67	48,956
Metal roof decking, steel - Existing Building	10,233 sf	4.84	49,502
B1020 Roof Construction	*158,643 SF*	*9.06*	*1,436,804*
B1080 Stairs			
Metal stair with railing	64 flt	20,000.00	1,280,000
B1080 Stairs	*158,643*	*8.07*	*1,280,000*
B10 SUPERSTRUCTURE	***158,643 SF***	***61.05***	***9,685,836***
B20 EXTERIOR VERTICAL ENCLOSURE			

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The Hoosac Store Modernization
Alternate 3
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
B2010 Exterior Walls				
Exterior scaffolding	101,592	sf	15.00	1,523,880
Repoint & restore existing brick facade	11,348	sf	60.00	680,876
New brick veneer	36,098	sf	45.00	1,624,429
Exterior bracing along perimeter - Existing Building	138	ton	7,971.83	1,100,112
Structural steel support for exterior glazing - Existing Building	56	ton	7,971.83	444,031
Exterior caulking	101,592	sf	1.26	127,927
Punched windows	27,073	sf	110.00	2,978,044
Curtain wall	27,073	sf	165.00	4,467,044
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade - Existing brick	11,348	sf	14.00	158,866
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade - New Brick	36,098	sf	14.00	505,353
Canopy at Entry Doors, allowance	1	ls	100,000.33	100,000
B2010 Exterior Walls	***158,643***	***SF***	***86.42***	***13,710,561***
B2050 Exterior Doors & Grilles				
Aluminum/glass door - exterior allowance	12	opng	10,323.67	123,884
B2050 Exterior Doors & Grilles	***158,643***	***SF***	***0.78***	***123,884***
B20 EXTERIOR VERTICAL ENCLOSURE	***158,643***	***SF***	***87.21***	***13,834,445***
B30 EXTERIOR HORIZONTAL ENCLOSURE				
B3010 Roof Coverings				
Built-up Roofing System complete	23,571	sf	45.00	1,060,698
B3010 Roof Coverings	***158,643***	***SF***	***6.69***	***1,060,698***
B30 EXTERIOR HORIZONTAL ENCLOSURE	***158,643***	***SF***	***6.69***	***1,060,698***
C10 INTERIOR CONSTRUCTION				
C1010 Interior Partitions				
Rough carpentry - building	158,643	sf	1.98	313,308
Misc Caulking & Sealants - Interior building	158,643	sf	0.65	103,118
Interior partition, Orientation Space	6,000	sf	20.00	120,002
Interior partition, NPS Space	17,800	sf	40.00	711,991
Interior partition, USSCM Space	37,600	sf	20.00	752,008
Interior partition, Lease Space	74,843	sf	10.00	748,436
C1010 Interior Partitions	***158,643***	***SF***	***17.33***	***2,748,862***
C1030 Interior Doors				
Alum Frame/Wood Doors/Hardware	158,643	sf	5.64	894,697
C1030 Interior Doors	***158,643***	***SF***	***5.64***	***894,697***
C1090 Interior Specialties				
Interior signage	158,643	sf	1.25	198,353
Toilet accessories allowance	158,643	ea	0.50	79,362
C1090 Interior Specialties	***158,643***	***SF***	***1.75***	***277,715***
C10 INTERIOR CONSTRUCTION	***158,643***	***SF***	***24.72***	***3,921,274***
C30 INTERIOR FINISHES				
C3010 Wall Finishes				
Orientation space	6,000	sf	5.00	30,003
NPS Space	17,800	sf	5.00	89,009
USSCM Space	60,000	sf	15.00	900,004
USSCM Space	37,600	sf	15.00	564,003

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The Hoosac Store Modernization
Alternate 3
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Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
C3010 Wall Finishes			
USSCM Space	37,600 sf	15.00	564,003
Lease Space	74,843 sf	5.00	374,244
C3010 Wall Finishes	***158,643 SF***	***15.89***	***2,521,266***
C3020 Floor Finishes			
Orientation space	6,000 sf	10.50	63,000
NPS Space	17,800 sf	7.50	133,495
USSCM Space	60,000 sf	35.00	2,099,994
Lease Space	74,843 sf	1.50	112,275
C3020 Floor Finishes	***158,643 SF***	***15.18***	***2,408,764***
C3030 Ceiling Finishes			
Orientation space	6,000 sf	10.00	59,998
NPS Space	17,800 sf	10.00	177,997
USSCM Space	37,600 sf	20.00	751,981
Lease Space	74,843 sf	3.50	261,919
C3030 Ceiling Finishes	***158,643 SF***	***7.89***	***1,251,895***
C30 INTERIOR FINISHES	***158,643 SF***	***38.97***	***6,181,925***
D10 CONVEYING			
D1010 Vertical Conveying System			
Electric traction freight elevators, 5000lb	8 stp	50,000.01	400,000
Electric Traction Passenger Elevators, 3500lb	32 stp	40,050.08	1,281,602
Passenger Elevator cab finishes allowance	4 ea	20,000.00	80,000
D1010 Vertical Conveying System	***158,643 SF***	***11.10***	***1,761,603***
D10 CONVEYING	***158,643 SF***	***11.10***	***1,761,603***
D20 PLUMBING			
D2010 Plumbing Fixtures			
Plumbing	158,643 sf	7.00	1,110,423
D2010 Plumbing Fixtures	***158,643 SF***	***7.00***	***1,110,423***
D20 PLUMBING	***158,643 SF***	***7.00***	***1,110,423***
D30 HVAC			
D3020 Heating Systems			
Condensing Boilers	4,760 mbh	40.00	190,400
D3020 Heating Systems	***158,643 SF***	***1.20***	***190,400***
D3030 Cooling Systems			
HVAC Piping Systems (CHW/CT/HW)	158,643 sf	10.00	1,586,388
Chillers	454 tons	500.00	227,000
Cooling tower	454 tons	300.00	136,200
D3030 Cooling Systems	***158,643 SF***	***12.29***	***1,949,587***
D3040 Distribution Systems			
Ductwork & Insulation	158,643 lb	14.00	2,220,930
Dampers (Volume/Motorized/Fire)	158,643 sf	0.50	79,273
Exhaust Fans	39,660 cfm	1.50	59,475
Diffusers & Grilles	158,643 sf	1.00	158,553
Air Handling Units	158,643 cfm	8.00	1,269,056
D3040 Distribution Systems	***158,643 SF***	***23.87***	***3,787,288***

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The Hoosac Store Modernization
Alternate 3
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Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D3050 Terminal & Package Units			
Terminal Units (VAV Boxes/Fan Coil Units/Unit Heaters)	158,643 sf	5.00	793,265
D3050 Terminal & Package Units	***158,643 SF***	***5.00***	***793,265***
D3060 Controls & Instrumentation			
Controls	158,643 sf	5.00	793,169
D3060 Controls & Instrumentation	***158,643 SF***	***5.00***	***793,169***
D3070 System Testing & Balancing			
Commissioning, Assistance, & Start-up	158,643 sf	1.00	158,641
Testing & Balancing	158,643 sf	1.00	158,699
D3070 System Testing & Balancing	***158,643 SF***	***2.00***	***317,340***
D30 HVAC	***158,643 SF***	***49.36***	***7,831,050***
D40 FIRE PROTECTION			
D4010 Fire Suppression			
Fire Suppression System	158,643 sf	9.00	1,427,710
D4010 Fire Suppression	***158,643 SF***	***9.00***	***1,427,710***
D40 FIRE PROTECTION	***158,643 SF***	***9.00***	***1,427,710***
D50 ELECTRICAL			
D5020 Electrical Services and Distribution			
Temporary Light and Power for construction	158,643 sf	0.94	148,329
Building and Equipment Grounding	158,643 sf	0.58	92,170
Motor connections, Electrical Connection including conduit and wire	158,643 sf	1.21	192,273
New Building Transformers	158,643 sf	0.81	128,182
Main Incoming Substation 4000 amp Secondary	1 ea	500,798.83	500,799
New Building Panels	158,643 sf	1.04	164,193
Building Lightning Protection	158,643 sf	0.24	38,153
D5020 Electrical Services and Distribution	***158,643 SF***	***7.97***	***1,264,098***
D5030 General Purpose Electrical Systems			
New Electrical Feeders and Bus Duct risers	158,643 sf	4.01	635,358
Building Devices (Switches and Receptacles)	158,643 sf	5.03	797,169
Lighting Controls	158,643 sf	2.52	400,409
D5030 General Purpose Electrical Systems	***158,643 SF***	***11.55***	***1,832,937***
D5040 Lighting			
Building Lighting LED Package	158,643 sf	11.45	1,816,439
Museum Lighting Premium	60,000 sf	10.50	629,969
Outdoor Lighting Allow	1 ea	120,000.00	120,000
D5040 Lighting	***158,643 SF***	***16.18***	***2,566,408***
D50 ELECTRICAL	***158,643 SF***	***35.70***	***5,663,443***
D60 COMMUNICATION			
D6020 Voice Communication			
New Building Cable Tray	158,643 sf	0.55	87,887
Telcom and Data System	158,643 sf	7.93	1,258,020
Wireless Network	158,643 sf	1.04	164,193
Add for specical areas	158,643 sf	1.26	200,205
D6020 Voice Communication	***158,643 SF***	***10.78***	***1,710,306***

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The Hoosac Store Modernization
Alternate 3
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D6060 Distributed Communications and Monitoring			
A/V System Rough in, and Wiring Includes Conduit and back boxes, and Cables	158,643 sf	1.87	296,024
New Building Sound Masking System	158,643 sf	1.17	185,293
D6060 Distributed Communications and Monitoring	***158,643 SF***	***3.03***	***481,317***
D60 COMMUNICATION	***158,643 SF***	***13.82***	***2,191,623***
D70 ELECTRONIC SAFETY AND SECURITY			
D7050 Detection and Alarm			
Fire Alarm System	158,643 sf	4.02	638,458
D7050 Detection and Alarm	***158,643 SF***	***4.02***	***638,458***
D7090 Electronic Safety & Security Supplimentary Components			
Security and CCTV System	158,643 ea	2.59	410,449
D7090 Electronic Safety & Security Supplimentary Components	***158,643 SF***	***2.59***	***410,449***
D70 ELECTRONIC SAFETY AND SECURITY	***158,643 SF***	***6.61***	***1,048,907***
E20 FURNISHINGS			
E2050 Furnishings			
Millwork	158,643 SF	2.50	396,574
FF& E - NIC	***ls***		
E2050 Furnishings	***158,643 SF***	***2.50***	***396,574***
E20 FURNISHINGS	***158,643 SF***	***2.50***	***396,574***
F20 FACILITY REMEDIATION			
F2010 Hazardous Materials Remediation			
Hazmat abatement	65,700 sf	15.00	985,488
F2010 Hazardous Materials Remediation	***158,643***	***6.21***	***985,488***
F20 FACILITY REMEDIATION	***158,643 SF***	***6.21***	***985,488***
F30 DEMOLITION			
F3030 Selective Demolition			
Demo existing building interior	65,700 sf	7.50	492,754
Remove existing brick facade	12,413 sf	7.50	93,098
Remove storage items from Existing Building - Allowance	1 ls	100,000.03	100,000
Demo existing roof complete incl structure	10,233 sf	15.00	153,501
Cut opening in structural slab for new elevator - 6 locations	6 loc	7,500.00	45,000
Cut opening in structural slab for new stairs - 12 locations	12 loc	5,000.00	60,000
Cut opening in SOG for new elevator, structral bracing and misc below grade work - assumed 50%	5,117 sf	10.00	51,167
Demo 25% of sixth floor structural slab	2,558 sf	15.00	38,375
Demo existing interior floor to create double-height space	4,300 sf	15.00	64,502
Shoring for structural demo - allowance	1 ls	100,000.32	100,000
F3030 Selective Demolition	***158,643 SF***	***7.55***	***1,198,398***
F30 DEMOLITION	***158,643 SF***	***7.55***	***1,198,398***
03 ALTERNATE 3	***158,643 SF***	***388.53***	***61,638,201***

The Hoosac Store Modernization

Alternate 4

Conceptual Estimate

Job size **173507 SF**

Estimate Date 02-07-2020

JACOBS

The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Date: 02-07-2020

Description	Quantity	Total Cost/Unit	Total Amount
04 ALTERNATE 4			
A10 FOUNDATIONS	*173,507 SF*	*20.74*	*3,598,930*
B10 SUPERSTRUCTURE	*173,507 SF*	*62.59*	*10,859,048*
B20 EXTERIOR VERTICAL ENCLOSURE	*173,507 SF*	*75.34*	*13,071,476*
B30 EXTERIOR HORIZONTAL ENCLOSURE	*173,507 SF*	*6.11*	*1,060,698*
C10 INTERIOR CONSTRUCTION	*173,507 SF*	*24.32*	*4,218,781*
C30 INTERIOR FINISHES	*173,507 SF*	*39.07*	*6,778,553*
D10 CONVEYING	*173,507 SF*	*12.46*	*2,161,603*
D20 PLUMBING	*173,507 SF*	*7.00*	*1,214,464*
D30 HVAC	*173,507 SF*	*49.38*	*8,567,714*
D40 FIRE PROTECTION	*173,507 SF*	*9.00*	*1,561,479*
D50 ELECTRICAL	*173,507 SF*	*35.02*	*6,076,888*
D60 COMMUNICATION	*173,507 SF*	*14.09*	*2,445,027*
D70 ELECTRONIC SAFETY AND SECURITY	*173,507 SF*	*6.61*	*1,147,184*
E20 FURNISHINGS	*173,507 SF*	*2.50*	*433,731*
F20 FACILITY REMEDIATION	*173,507 SF*	*5.68*	*985,488*
F30 DEMOLITION	*173,507 SF*	*6.91*	*1,198,398*
04 ALTERNATE 4	***173,507 SF***	***376.81***	***65,379,460***

Estimate Totals

Description	Rate	Amount	Totals	Cost per Unit
Subtotal Direct Cost		***65,379,460***		***376.81 /SF***
Design Contingency	15.00 %	9,806,919		
LEED Premium	2.50 %	1,879,659		
General Conditions	10.00 %	7,706,604		
Construction Contingency	10.00 %	8,477,264		
GC Overhead	5.00 %	4,662,495		
GC Fee	5.00 %	4,895,620		
Performance & Payment Bond	1.00 %	1,028,080		
Gen Liability Insurance	5.00 %	5,191,805		
Builders Risk Insurance	0.14 %	152,639		
Escalation	6.00 %	6,550,833		
Subtotal Indirect Cost		***50,351,918***		
Total Construction Cost			***115,731,378***	***667.01 /SF***

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The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
04 ALTERNATE 4				
A10 FOUNDATIONS				
A1020 Special Foundations				
Pile foundation, complete - New Building/Addition	112,107	GSF	17.50	1,961,913
Structural bracing foundtion (micro-pile incl cap)	20	loc	35,000.00	700,000
Encased existing column base	36	loc	10,000.00	360,000
A1020 Special Foundations	***173,507***	***SF***	***17.42***	***3,021,913***
A4010 Standard Slab-on-Grade				
Slab on grade, with 6" base - New Building/Addition	13,338	sf	10.73	143,169
Patch and repair existing SOG - allowance	5,000	sf	10.73	53,670
Elevator Pit (New Bldg/Addition)	3	ea	18,392.87	55,179
Elevator Pit complete incl excavation - Existing Building	3	ea	25,000.00	75,000
A4010 Standard Slab-on-Grade				***327,017***
A9020 Construction Dewatering				
Dewatering allowance	1	ls	250,000.04	250,000
A9020 Construction Dewatering	***173,507***	***SF***	***1.44***	***250,000***
A10 FOUNDATIONS	***173,507***	***SF***	***20.74***	***3,598,930***
B10 SUPERSTRUCTURE				
B1010 Floor Construction				
Concrete fill on metal deck - New building/Addtion	112,107	sf	12.50	1,401,306
Concrete fill on metal deck - (Floor replacement 6th floor - 25%) - Existing Building	2,558	sf	15.50	39,654
Concrete fill on metal deck - infill shafts/stairs - Existing Building	2,016	sf	15.50	31,249
Structural steel, columns & beams - New building/Addition	841	ton	5,500.00	4,624,400
Structural support for slab replacement 25% of 6th floor - Existing Building	20	ton	7,500.00	150,000
Structural support for slab infill at shaft/stair - Existing Building	15	ton	7,500.00	112,500
Metal floor decking - New building	112,107	sf	4.73	529,956
Metal floor decking - (Floor replacement 6th floor - 25%) - Existing Building	2,558	sf	6.28	16,068
Metal floor decking - infill shafts/stair - Existing Building	2,016	sf	6.28	12,663
Misc Metals New Bldg/Addition	112,107	sf	2.49	279,386
Misc Metals - Existing Building	61,400	sf	5.50	337,688
Sprayed fireproofing	173,507	sf	3.50	607,374
B1010 Floor Construction	***173,507***	***SF***	***46.93***	***8,142,244***
B1020 Roof Construction				
New roof structure	100	ton	5,500.00	550,000
Allow Penthouse Framing/Dunnage	40	ton	5,500.00	220,000
New roof structure - Existing Building	76	ton	7,478.24	568,346
Metal roof decking, steel - New/existing Building	13,338	sf	3.67	48,956
Metal roof decking, steel - Existing Building	10,233	sf	4.84	49,502
B1020 Roof Construction	***173,507***	***SF***	***8.28***	***1,436,804***
B1080 Stairs				
Metal stair with railing	64	flt	20,000.00	1,280,000
B1080 Stairs				***1,280,000***
B10 SUPERSTRUCTURE	***173,507***	***SF***	***62.59***	***10,859,048***
B20 EXTERIOR VERTICAL ENCLOSURE				

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The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
B2010 Exterior Walls			
Exterior scaffolding	86,680 sf	15.00	1,300,200
Repoint & restore existing brick facade	11,348 sf	60.00	680,876
New brick veneer	30,133 sf	45.00	1,356,001
Exterior bracing along perimeter	138 ton	5,500.00	759,000
Structural steel support for exterior glazing - Existing Building	55 ton	5,500.00	302,500
Exterior bracing along perimeter - Existing Building	138 ton	7,971.83	1,100,112
Structural steel support for exterior glazing - Existing Building	56 ton	7,971.83	444,031
Exterior caulking	86,680 sf	1.26	109,149
Punched windows	22,600 sf	110.00	2,486,012
Curtain wall	22,600 sf	165.00	3,728,999
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade - Existing brick	11,348 sf	14.00	158,866
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade - New Brick	30,133 sf	14.00	421,846
Canopy at Entry Doors, allowance	1 ls	100,000.33	100,000
B2010 Exterior Walls	***173,507 SF***	***74.62***	***12,947,592***
B2050 Exterior Doors & Grilles			
Aluminum/glass door - exterior allowance	12 opng	10,323.67	123,884
B2050 Exterior Doors & Grilles	***173,507 SF***	***0.71***	***123,884***
B20 EXTERIOR VERTICAL ENCLOSURE	***173,507 SF***	***75.34***	***13,071,476***
B30 EXTERIOR HORIZONTAL ENCLOSURE			
B3010 Roof Coverings			
Built-up Roofing System complete	23,571 sf	45.00	1,060,698
B3010 Roof Coverings	***173,507 SF***	***6.11***	***1,060,698***
B30 EXTERIOR HORIZONTAL ENCLOSURE	***173,507 SF***	***6.11***	***1,060,698***
C10 INTERIOR CONSTRUCTION			
C1010 Interior Partitions			
Rough carpentry - building	173,507 sf	1.98	342,663
Misc Caulking & Sealants - Interior building	173,507 sf	0.65	112,780
Interior partition, Orientation Space	6,000 sf	20.00	120,002
Interior partition, NPS Space	17,800 sf	40.00	711,991
Interior partition, USSCM Space	37,600 sf	20.00	752,008
Interior partition, Lease Space	89,707 sf	10.00	897,077
C1010 Interior Partitions	***173,507 SF***	***16.93***	***2,936,520***
C1030 Interior Doors			
Alum Frame/Wood Doors/Hardware	173,507 sf	5.64	978,525
C1030 Interior Doors	***173,507 SF***	***5.64***	***978,525***
C1090 Interior Specialties			
Interior signage	173,507 sf	1.25	216,938
Toilet accessories allowance	173,507 ea	0.50	86,797
C1090 Interior Specialties	***173,507 SF***	***1.75***	***303,735***
C10 INTERIOR CONSTRUCTION	***173,507 SF***	***24.32***	***4,218,781***
C30 INTERIOR FINISHES			
C3010 Wall Finishes			
USSCM Space	37,600 sf	15.00	564,003
USSCM Space	37,600 sf	15.00	564,003

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The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
C3010 Wall Finishes				
Orientation space	6,000	sf	5.00	30,003
NPS Space	17,800	sf	5.00	89,009
USSCM Space	60,000	sf	15.00	900,004
Lease Space	89,707	sf	5.00	448,570
C3010 Wall Finishes	***173,507***	***SF***	***14.96***	***2,595,592***
C3020 Floor Finishes				
Orientation space	6,000	sf	10.50	63,000
NPS Space	17,800	sf	7.50	133,495
USSCM Space	60,000	sf	35.00	2,099,994
Lease Space	89,707	sf	1.50	134,573
C3020 Floor Finishes	***173,507***	***SF***	***14.01***	***2,431,062***
C3030 Ceiling Finishes				
Orientation space	6,000	sf	10.00	59,998
NPS Space	17,800	sf	10.00	177,995
USSCM Space	60,000	sf	20.00	1,199,969
Lease Space	89,707	sf	3.50	313,937
C3030 Ceiling Finishes	***173,507***	***SF***	***10.10***	***1,751,900***
C30 INTERIOR FINISHES	***173,507***	***SF***	***39.07***	***6,778,553***
D10 CONVEYING				
D1010 Vertical Conveying System				
Electric traction freight elevators, 5000lb	16	stp	50,000.01	800,000
Electric Traction Passenger Elevators, 3500lb	32	stp	40,050.08	1,281,602
Passenger Elevator cab finishes allowance	4	ea	20,000.00	80,000
D1010 Vertical Conveying System	***173,507***	***SF***	***12.46***	***2,161,603***
D10 CONVEYING	***173,507***	***SF***	***12.46***	***2,161,603***
D20 PLUMBING				
D2010 Plumbing Fixtures				
Plumbing	173,507	sf	7.00	1,214,464
D2010 Plumbing Fixtures	***173,507***	***SF***	***7.00***	***1,214,464***
D20 PLUMBING	***173,507***	***SF***	***7.00***	***1,214,464***
D30 HVAC				
D3020 Heating Systems				
Condensing Boilers	5,210	mbh	40.00	208,400
D3020 Heating Systems	***173,507***	***SF***	***1.20***	***208,400***
D3030 Cooling Systems				
HVAC Piping Systems (CHW/CT/HW)	173,507	sf	10.00	1,735,024
Chillers	500	tons	500.00	250,000
Cooling tower	500	tons	300.00	150,000
D3030 Cooling Systems	***173,507***	***SF***	***12.31***	***2,135,023***
D3040 Distribution Systems				
Ductwork & Insulation	173,507	lb	14.00	2,429,019
Dampers (Volume/Motorized/Fire)	173,507	sf	0.50	86,701
Exhaust Fans	43,380	cfm	1.50	65,054
Diffusers & Grilles	173,507	sf	1.00	173,409
Air Handling Units	173,507	cfm	8.00	1,387,960

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The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
D3040 Distribution Systems	*173,507 SF*	*23.87*	*4,142,143*
D3050 Terminal & Package Units			
Terminal Units (VAV Boxes/Fan Coil Units/Unit Heaters)	173,507 sf	5.00	867,590
D3050 Terminal & Package Units	*173,507 SF*	*5.00*	*867,590*
D3060 Controls & Instrumentation			
Controls	173,507 sf	5.00	867,484
D3060 Controls & Instrumentation	*173,507 SF*	*5.00*	*867,484*
D3070 System Testing & Balancing			
Commissioning, Assistance, & Start-up	173,507 sf	1.00	173,505
Testing & Balancing	173,507 sf	1.00	173,569
D3070 System Testing & Balancing	*173,507 SF*	*2.00*	*347,073*
D30 HVAC	***173,507 SF***	***49.38***	***8,567,714***
D40 FIRE PROTECTION			
D4010 Fire Suppression			
Fire Suppression System	173,507 sf	9.00	1,561,479
D4010 Fire Suppression	*173,507 SF*	*9.00*	*1,561,479*
D40 FIRE PROTECTION	***173,507 SF***	***9.00***	***1,561,479***
D50 ELECTRICAL			
D5020 Electrical Services and Distribution			
Temporary Light and Power for construction	173,507 sf	0.94	162,227
Building and Equipment Grounding	173,507 sf	0.58	100,806
Motor connections, Electrical Connection including conduit and wire	173,507 sf	1.21	210,287
New Building Transformers	173,507 sf	0.81	140,192
Main Incoming Substation 4000 amp Secondary	1 ea	500,798.83	500,799
New Building Panels	173,507 sf	1.04	179,577
Building Lightning Protection	173,507 sf	0.24	41,728
D5020 Electrical Services and Distribution	*173,507 SF*	*7.70*	*1,335,615*
D5030 General Purpose Electrical Systems			
New Electrical Feeders and Bus Duct risers	173,507 sf	4.01	694,888
Building Devices (Switches and Receptacles)	173,507 sf	5.03	871,860
Lighting Controls	173,507 sf	2.52	437,926
D5030 General Purpose Electrical Systems	*173,507 SF*	*11.55*	*2,004,674*
D5040 Lighting			
Building Lighting LED Package	173,507 sf	11.45	1,986,630
Museum Lighting Premium	60,000 sf	10.50	629,969
Outdoor Lighting Allow	1 ea	120,000.00	120,000
D5040 Lighting	*173,507 SF*	*15.77*	*2,736,599*
D50 ELECTRICAL	***173,507 SF***	***35.02***	***6,076,888***
D60 COMMUNICATION			
D6020 Voice Communication			
New Building Cable Tray	173,507 sf	0.55	96,122
Telcom and Data System	173,507 sf	7.93	1,375,890
Wireless Network	173,507 sf	1.04	179,577
Add for specical areas	173,507 sf	1.26	218,963

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The Hoosac Store Modernization
Alternate 4
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
D6020 Voice Communication	*173,507*	*SF*	*10.78*	*1,870,552*
D6060 Distributed Communications and Monitoring				
A/V System Rough in, and Wiring Includes Conduit and back boxes, and Cables	173,507	sf	1.87	323,760
New Building Sound Masking System	173,507	sf	1.17	202,654
Add for Dynamic Signage System	173,507	sf	0.28	48,061
D6060 Distributed Communications and Monitoring	*173,507*	*SF*	*3.31*	*574,475*
D60 COMMUNICATION	***173,507***	***SF***	***14.09***	***2,445,027***
D70 ELECTRONIC SAFETY AND SECURITY				
D7050 Detection and Alarm				
Fire Alarm System	173,507	sf	4.02	698,278
D7050 Detection and Alarm	*173,507*	*SF*	*4.02*	*698,278*
D7090 Electronic Safety & Security Supplimentary Components				
Security and CCTV System	173,507	ea	2.59	448,906
D7090 Electronic Safety & Security Supplimentary Components	*173,507*	*SF*	*2.59*	*448,906*
D70 ELECTRONIC SAFETY AND SECURITY	***173,507***	***SF***	***6.61***	***1,147,184***
E20 FURNISHINGS				
E2050 Furnishings				
Millwork	173,507	SF	2.50	433,731
FF& E - NIC		***ls***		
E2050 Furnishings	*173,507*	*SF*	*2.50*	*433,731*
E20 FURNISHINGS	***173,507***	***SF***	***2.50***	***433,731***
F20 FACILITY REMEDIATION				
F2010 Hazardous Materials Remediation				
Hazmat abatement	65,700	sf	15.00	985,488
F2010 Hazardous Materials Remediation	*173,507*		*5.68*	*985,488*
F20 FACILITY REMEDIATION	***173,507***	***SF***	***5.68***	***985,488***
F30 DEMOLITION				
F3030 Selective Demolition				
Demo existing building interior	65,700	sf	7.50	492,754
Remove existing brick facade	12,413	sf	7.50	93,098
Remove storage items from Existing Building - Allowance	1	ls	100,000.03	100,000
Demo existing roof complete incl structure	10,233	sf	15.00	153,501
Cut opening in structural slab for new elevator - 6 locations	6	loc	7,500.00	45,000
Cut opening in structural slab for new stairs - 12 locations	12	loc	5,000.00	60,000
Cut opening in SOG for new elevator, structral bracing and misc below grade work - assumed 50%	5,117	sf	10.00	51,167
Demo 25% of sixth floor structural slab	2,558	sf	15.00	38,375
Demo existing interior floor to create double-height space	4,300	sf	15.00	64,502
Shoring for structural demo - allowance	1	ls	100,000.32	100,000
F3030 Selective Demolition	*173,507*	*SF*	*6.91*	*1,198,398*
F30 DEMOLITION	***173,507***	***SF***	***6.91***	***1,198,398***
04 ALTERNATE 4	***173,507***	***SF***	***376.81***	***65,379,460***

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The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Job size **175104 SF**

Estimate Date 02-07-2020

JACOBS

The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Date: 02-07-2020

Description	Quantity	Total Cost/Unit	Total Amount
05 ALTERNATE 5			
A10 FOUNDATIONS	*175,104 SF*	*20.89*	*3,658,557*
B10 SUPERSTRUCTURE	*175,104 SF*	*77.12*	*13,503,411*
B20 EXTERIOR VERTICAL ENCLOSURE	*175,104 SF*	*67.00*	*11,732,502*
B30 EXTERIOR HORIZONTAL ENCLOSURE	*175,104 SF*	*6.24*	*1,091,703*
C10 INTERIOR CONSTRUCTION	*175,104 SF*	*26.83*	*4,698,755*
C30 INTERIOR FINISHES	*175,104 SF*	*38.80*	*6,794,526*
D10 CONVEYING	*175,104 SF*	*12.35*	*2,161,603*
D20 PLUMBING	*175,104 SF*	*6.30*	*1,103,188*
D30 HVAC	*175,104 SF*	*44.43*	*7,779,144*
D40 FIRE PROTECTION	*175,104 SF*	*8.10*	*1,418,392*
D50 ELECTRICAL	*175,104 SF*	*34.96*	*6,121,308*
D60 COMMUNICATION	*175,104 SF*	*12.55*	*2,198,050*
D70 ELECTRONIC SAFETY AND SECURITY	*175,104 SF*	*6.61*	*1,157,743*
E20 FURNISHINGS	*175,104 SF*	*2.50*	*437,723*
F20 FACILITY REMEDIATION	*175,104 SF*	*5.63*	*985,488*
F30 DEMOLITION	*175,104 SF*	*3.14*	*550,009*
05 ALTERNATE 5	***173,507 SF***	***376.89***	***65,392,102***

Estimate Totals

Description	Rate	Amount	Totals	Cost per Unit
Subtotal Direct Cost		***65,392,102***		***373.45 /SF***
Design Contingency	15.00 %	9,808,815		
LEED Premium	2.50 %	1,880,023		
General Conditions	10.00 %	7,708,094		
Construction Contingency	10.00 %	8,478,903		
GC Overhead	5.00 %	4,663,397		
GC Fee	5.00 %	4,896,567		
Performance & Payment Bond	1.00 %	1,028,279		
Gen Liability Insurance	5.00 %	5,192,809		
Builders Risk Insurance	0.14 %	152,669		
Escalation	6.00 %	6,552,099		
Subtotal Indirect Cost		***50,361,655***		
Total Construction Cost			***115,753,757***	***661.06 /SF***

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The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
05 ALTERNATE 5			
A10 FOUNDATIONS			
A1020 Special Foundations			
Pile foundation, complete - New Building/Addition	175,104 GSF	17.50	3,064,383
A1020 Special Foundations	***175,104 SF***	***17.50***	***3,064,383***
A4010 Standard Slab-on-Grade			
Slab on grade	21,783 sf	10.73	233,817
Elevator Pit (New Bldg/Addition)	6 ea	18,392.87	110,357
A4010 Standard Slab-on-Grade	***175,104 SF***	***1.97***	***344,174***
A9020 Construction Dewatering			
Dewatering allowance	1 ls	250,000.04	250,000
A9020 Construction Dewatering	***175,104 SF***	***1.43***	***250,000***
A10 FOUNDATIONS	***173,507 SF***	***21.09***	***3,658,557***
B10 SUPERSTRUCTURE			
B1010 Floor Construction			
Concrete fill on metal deck	153,321 sf	12.50	1,916,469
Structural steel, columns & beams	1,313 ton	5,500.00	7,223,040
Metal floor decking - New building	153,321 sf	4.73	724,784
Misc Metals (New Bldg & Existing)	175,104 sf	2.49	436,383
Sprayed fireproofing	175,104 sf	3.50	612,964
B1010 Floor Construction	***175,104 SF***	***62.33***	***10,913,641***
B1020 Roof Construction			
New roof structure	182 ton	5,500.00	1,000,725
Allow Penthouse Framing/Dunnage	40 ton	5,500.00	220,000
Metal roof decking, steel	24,260 sf	3.67	89,045
B1020 Roof Construction	***175,104 SF***	***7.48***	***1,309,770***
B1080 Stairs			
Metal stair with railing	64 flt	20,000.00	1,280,000
B1080 Stairs	***175,104***	***7.31***	***1,280,000***
B10 SUPERSTRUCTURE	***175,104 SF***	***77.12***	***13,503,411***
B20 EXTERIOR VERTICAL ENCLOSURE			
B2010 Exterior Walls			
Exterior scaffolding	85,381 sf	15.00	1,280,715
New brick veneer	34,153 sf	45.00	1,536,903
Exterior bracing along perimeter	138 ton	5,500.00	759,000
Structural steel support for exterior glazing - Existing Building	55 ton	5,500.00	302,500
Exterior caulking	85,381 sf	1.26	107,513
Punched windows	25,614 sf	110.00	2,817,553
Curtain wall	25,614 sf	165.00	4,226,309
Metal Stud Backup w/ Sheathing, insulation and Vapor Barrier to brick facade - New Brick	34,153 sf	14.00	478,124
Canopy at Entry Doors, allowance	1 ls	100,000.33	100,000
B2010 Exterior Walls	***175,104 SF***	***66.30***	***11,608,618***
B2050 Exterior Doors & Grilles			
Aluminum/glass door - exterior allowance	12 opng	10,323.67	123,884

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The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity	Total Cost/Unit	Total Amount
B2050 Exterior Doors & Grilles	*175,104 SF*	*0.71*	*123,884*
B20 EXTERIOR VERTICAL ENCLOSURE	***175,104 SF***	***67.00***	***11,732,502***
B30 EXTERIOR HORIZONTAL ENCLOSURE			
B3010 Roof Coverings			
Built-up Roofing System complete	24,260 sf	45.00	1,091,703
B3010 Roof Coverings	*175,104 SF*	*6.24*	*1,091,703*
B30 EXTERIOR HORIZONTAL ENCLOSURE	***175,104 SF***	***6.24***	***1,091,703***
C10 INTERIOR CONSTRUCTION			
C1010 Interior Partitions			
Rough carpentry - building	175,104 sf	1.98	345,817
Misc Caulking & Sealants - Interior building	175,104 sf	0.65	113,818
Interior partition, Orientation Space	6,000 sf	20.00	120,002
Interior partition, NPS Space	17,800 sf	40.00	711,991
Interior partition, USSCM Space	60,000 sf	20.00	1,200,013
Interior partition, Lease Space	91,304 sf	10.00	913,053
C1010 Interior Partitions	*175,104 SF*	*19.44*	*3,404,693*
C1030 Interior Doors			
Alum Frame/Wood Doors/Hardware	175,104 sf	5.64	987,532
C1030 Interior Doors	*175,104 SF*	*5.64*	*987,532*
C1090 Interior Specialties			
Interior signage	175,104 sf	1.25	218,935
Toilet accessories allowance	175,104 ea	0.50	87,596
C1090 Interior Specialties	*175,104 SF*	*1.75*	*306,531*
C10 INTERIOR CONSTRUCTION	***175,104 SF***	***26.83***	***4,698,755***
C30 INTERIOR FINISHES			
C3010 Wall Finishes			
USSCM Space	37,600 sf	15.00	564,003
USSCM Space	37,600 sf	15.00	564,003
Orientation space	6,000 sf	5.00	30,003
NPS Space	17,800 sf	5.00	89,009
USSCM Space	60,000 sf	15.00	900,004
Lease Space	91,304 sf	5.00	456,555
C3010 Wall Finishes	*175,104 SF*	*14.87*	*2,603,577*
C3020 Floor Finishes			
Orientation space	6,000 sf	10.50	63,000
NPS Space	17,800 sf	7.50	133,495
USSCM Space	60,000 sf	35.00	2,099,994
Lease Space	91,304 sf	1.50	136,969
C3020 Floor Finishes	*175,104 SF*	*13.90*	*2,433,457*
C3030 Ceiling Finishes			
Orientation space	6,000 sf	10.00	59,998
NPS Space	17,800 sf	10.00	177,995
USSCM Space	60,000 sf	20.00	1,199,969
Lease Space	91,304 sf	3.50	319,528
C3030 Ceiling Finishes	*175,104 SF*	*10.04*	*1,757,491*

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The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
C30 INTERIOR FINISHES	***175,104***	***SF***	***38.80***	***6,794,526***
D10 CONVEYING				
D1010 Vertical Conveying System				
Electric traction freight elevators, 5000lb	16	stp	50,000.01	800,000
Electric Traction Passenger Elevators, 3500lb	32	stp	40,050.08	1,281,602
Passenger Elevator cab finishes allowance	4	ea	20,000.00	80,000
D1010 Vertical Conveying System	***175,104***	***SF***	***12.35***	***2,161,603***
D10 CONVEYING	***175,104***	***SF***	***12.35***	***2,161,603***
D20 PLUMBING				
D2010 Plumbing Fixtures				
Plumbing	175,104	sf	6.30	1,103,188
D2010 Plumbing Fixtures	***175,104***	***SF***	***6.30***	***1,103,188***
D20 PLUMBING	***175,104***	***SF***	***6.30***	***1,103,188***
D30 HVAC				
D3020 Heating Systems				
Condensing Boilers	5,260	mbh	36.00	189,358
D3020 Heating Systems	***175,104***	***SF***	***1.08***	***189,358***
D3030 Cooling Systems				
HVAC Piping Systems (CHW/CT/HW)	175,104	sf	9.00	1,575,889
Chillers	500	tons	450.00	225,000
Cooling tower	500	tons	270.00	135,000
D3030 Cooling Systems	***175,104***	***SF***	***11.06***	***1,935,889***
D3040 Distribution Systems				
Ductwork & Insulation	175,104	lb	12.60	2,206,326
Dampers (Volume/Motorized/Fire)	175,104	sf	0.45	78,899
Exhaust Fans	43,776	cfm	1.35	59,108
Diffusers & Grilles	175,104	sf	0.90	157,609
Air Handling Units	175,104	cfm	7.20	1,260,759
D3040 Distribution Systems	***175,104***	***SF***	***21.49***	***3,762,701***
D3050 Terminal & Package Units				
Terminal Units (VAV Boxes/Fan Coil Units/Unit Heaters)	175,104	sf	4.50	787,979
D3050 Terminal & Package Units	***175,104***	***SF***	***4.50***	***787,979***
D3060 Controls & Instrumentation				
Controls	175,104	sf	4.50	787,938
D3060 Controls & Instrumentation	***175,104***	***SF***	***4.50***	***787,938***
D3070 System Testing & Balancing				
Commissioning, Assistance, & Start-up	175,104	sf	0.90	157,592
Testing & Balancing	175,104	sf	0.90	157,687
D3070 System Testing & Balancing	***175,104***	***SF***	***1.80***	***315,279***
D30 HVAC	***175,104***	***SF***	***44.43***	***7,779,144***
D40 FIRE PROTECTION				
D4010 Fire Suppression				
Fire Suppression System	175,104	sf	8.10	1,418,392

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Alternate 5
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Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
D4010 Fire Suppression	*175,104*	*SF*	*8.10*	*1,418,392*
D40 FIRE PROTECTION	***175,104***	***SF***	***8.10***	***1,418,392***
D50 ELECTRICAL				
D5020 Electrical Services and Distribution				
Temporary Light and Power for construction	175,104	sf	0.94	163,720
Building and Equipment Grounding	175,104	sf	0.58	101,734
Motor connections, Electrical Connection including conduit and wire	175,104	sf	1.21	212,223
New Building Transformers	175,104	sf	0.81	141,482
Main Incoming Substation 4000 amp Secondary	1	ea	500,798.83	500,799
New Building Panels	175,104	sf	1.04	181,230
Building Lightning Protection	175,104	sf	0.24	42,112
D5020 Electrical Services and Distribution	*175,104*	*SF*	*7.67*	*1,343,299*
D5030 General Purpose Electrical Systems				
New Electrical Feeders and Bus Duct risers	175,104	sf	4.01	701,284
Building Devices (Switches and Receptacles)	175,104	sf	5.03	879,885
Lighting Controls	175,104	sf	2.52	441,956
D5030 General Purpose Electrical Systems	*175,104*	*SF*	*11.55*	*2,023,125*
D5040 Lighting				
Building Lighting LED Package	175,104	sf	11.45	2,004,915
Museum Lighting Premium	60,000	sf	10.50	629,969
Outdoor Lighting Allow	1	ea	120,000.00	120,000
D5040 Lighting	*175,104*	*SF*	*15.73*	*2,754,884*
D50 ELECTRICAL	***175,104***	***SF***	***34.96***	***6,121,308***
D60 COMMUNICATION				
D6020 Voice Communication				
New Building Cable Tray	175,104	sf	0.55	97,007
Telcom and Data System	175,104	sf	7.93	1,388,554
Wireless Network	175,104	sf	1.04	181,230
D6020 Voice Communication	*175,104*	*SF*	*9.52*	*1,666,791*
D6060 Distributed Communications and Monitoring				
A/V System Rough in, and Wiring Includes Conduit and back boxes, and Cables	175,104	sf	1.87	326,740
New Building Sound Masking System	175,104	sf	1.17	204,519
D6060 Distributed Communications and Monitoring	*175,104*	*SF*	*3.03*	*531,259*
D60 COMMUNICATION	***175,104***	***SF***	***12.55***	***2,198,050***
D70 ELECTRONIC SAFETY AND SECURITY				
D7050 Detection and Alarm				
Fire Alarm System	175,104	sf	4.02	704,705
D7050 Detection and Alarm	*175,104*	*SF*	*4.02*	*704,705*
D7090 Electronic Safety & Security Supplimentary Components				
Security and CCTV System	175,104	ea	2.59	453,037
D7090 Electronic Safety & Security Supplimentary Components	*175,104*	*SF*	*2.59*	*453,037*
D70 ELECTRONIC SAFETY AND SECURITY	***175,104***	***SF***	***6.61***	***1,157,743***
E20 FURNISHINGS				

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The Hoosac Store Modernization
Alternate 5
Conceptual Estimate

Estimate No.
Date: 02-07-2020

Description	Takeoff Quantity		Total Cost/Unit	Total Amount
E2050 Furnishings				
Millwork	175,104	SF	2.50	437,723
FF& E - NIC		***ls***		
E2050 Furnishings	***175,104***	***SF***	***2.50***	***437,723***
E20 FURNISHINGS	***175,104***	***SF***	***2.50***	***437,723***
F20 FACILITY REMEDIATION				
F2010 Hazardous Materials Remediation				
Hazmat abatement	65,700	sf	15.00	985,488
F2010 Hazardous Materials Remediation	***175,104***		***5.63***	***985,488***
F20 FACILITY REMEDIATION	***175,104***	***SF***	***5.63***	***985,488***
F30 DEMOLITION				
F3030 Selective Demolition				
Building demolition, includes 20 mile haul	722,700	cf	0.65	470,008
Demo foundation	1	ls	80,000.30	80,000
F3030 Selective Demolition	***175,104***	***SF***	***3.14***	***550,009***
F30 DEMOLITION	***175,104***	***SF***	***3.14***	***550,009***
05 ALTERNATE 5	***173,507***	***SF***	***376.89***	***65,392,102***

Structural and Geotechnical Report

The Hoosac Building 1 & 2 at the Charlestown Navy Yard in Boston—a six-story warehouse building built in 1895—is proposed to be modernized for commercial and institutional use. Jacobs Engineering Group, Inc. (Jacobs) coordinated with Marble Fairbanks Architects to provide engineering evaluations in conformance with GSA's building design standards and Marble Fairbanks' architectural schemes.

The primary objective of the report is to combine findings from the above investigations and assess whether the existing structure can be utilized to install the program test-fits from the architects.

The Hoosac Stores Modernization

The Hoosac Building 1&2 Structural & Geotechnical Report

Document 4 | Revision 3

February 3, 2020

Marble Fairbanks Architects

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2	12/10/2019	Changed date of report and removed draft	DDC		
3	1/6/2020	Added Structural Sections & change name	CS		
4	2/3/2020	Submission 1 of Feasibility Study	DDC		

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The Hoosac Building 1 & 2 Structural & Geotechnical Report

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The Hoosac Building 1 & 2 Structural & Geotechnical Report

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The Hoosac Building 1 & 2 Structural & Geotechnical Report

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Executive Summary

The Hoosac Building 1 & 2 at the Charlestown Navy Yard in Boston—a six-story warehouse building built in 1895—is proposed to be modernized for commercial and institutional use. Jacobs Engineering Group, Inc. (Jacobs) coordinated with Marble Fairbanks Architects to provide engineering evaluations in conformance with GSA's building design standards and Marble Fairbanks' architectural schemes.

Jacobs performed the following material tests and evaluated the results in order to establish material properties for structural design.

- Masonry exploratory openings and mortar tests.
- Material properties and status of cast iron.
- Wood species, grade and status of wood members.
- Pile capacities for both gravity and lateral loads.
- Conditions assessment of representative connections between members.

Concurrently, the geotechnical report was developed using five soil borings from inside and outside the building. Seismic design parameters are established based on the geotechnical report.

The primary objective of the report is to combine findings from the above investigations and assess whether the existing structure can be utilized to install the program test-fits from the architects. Jacobs used the Tier 1 evaluation and Tier 3 retrofit procedures per ASCE 41-13, *Seismic Evaluation and Retrofit of Existing Buildings*, in developing strategies for structural remediation.

Key Findings:

Material Tests:

Wood: Majority of members are in good condition
Steel: Strength similar to modern-type ASTM A36
Brick: Higher compressive strength than recommended in ASCE 41-13
Mortar: Similar to Modern-type Type O Mortar

Geotechnical Analysis:

Timber piles and pile caps:
- The existing timber piles are expected to last indefinitely while keeping the same vertical (gravity) capacity.
- As-built drawings show loosely stacked granite stone pile caps rendering the existing foundation unable to develop lateral capacity to resist lateral loads.

Soil Condition: Site soil is corrosive and requires the use of micropiles for any new foundation.

Structural Investigation:

- Existing brick walls are in relatively good condition, with deterioration generally consistent with the age of the building. Most of the deterioration is at the exterior wythe due to exposure to weather or water. The bottom 4 feet of brick walls on four sides are heavily corroded at the

exterior wythe due to usage of de-icing salt and snow accumulation.
- Exterior wall assembly is intact at the core wythes;
- Existing members are not adequate in providing diaphragm connections to new seismic braces.
- Existing foundation cannot accommodate lateral loads.

Conclusions and Proposed Remediation:

We have arrived at three main conclusions:

1. The existing structural members above grade (except the roof) can be reused with local modifications and retrofit details.

2. The foundation below grade can be re-used for supporting gravity load from all the proposed program uses.

3. The existing foundation are not adequate to resist seismic or wind loads. We must provide lateral bracing systems.

Jacobs has proposed three conceptual-level lateral bracing systems strategies for consideration by Marble Fairbanks for various architectural alternatives that involve reuse of the building.

- Strategy 1: Interior shear walls around the elevator core.
- Strategy 2: Interior braced frame.
- Strategy 3: Interior braced frame along the exterior walls.

The Hoosac Building 1 & 2 Structural & Geotechnical Report

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1. Introduction

The Hoosac Building 1 & 2 (herein referred to as the Building) is located at 115 Constitution Road outside the entrance of the Boston Navy Yard, and next to the USS Constitution Museum, in the Charlestown neighborhood of Boston, Massachusetts.

The Building is a historic warehouse built in 1895 and currently owned by the National Park Service and is managed as part of the Boston National Historical Park's Navy Yard facilities. Jacobs is contracted with Marble Fairbanks Architects to provide structural and geotechnical recommendations for a feasibility study on the modernization of the Building.

This preliminary geotechnical report presents data from our recent geotechnical investigations at the site and provides the preliminary geotechnical recommendations for the design alternatives currently considered by the Jacobs structural engineer. This report is subject to the limitations contained herein.

2. Existing Conditions

The Building is generally rectangular in plan-view except that its north end is skewed 65.7 degrees. In plan-view, the Building is about 83 feet wide. The length of its northwest side is 112 feet; the length of the southeast side is about 151 feet; the skewed length of the northeast side of the building is about 97 feet. In elevation, the building has six stories including the ground floor (no basement). There is a level parapet above the roof, varying in height from about 1'6" to 3'. Total height from ground surface to top of parapet is approximately 65'-6".

The Building walls (both the exterior and the interior partition walls) and the interior columns are all supported on stone foundations on top of driven timber piles. The length of the timber piles is unknown. The tops of the piles are about 10 ft below the existing grade. See Appendix B for existing site photos and record foundation drawings.

3. Possible Design Alternatives

We understand that Jacobs scope of work will be limited to five possible alternatives, which will be narrowed down to three viable alternatives. The five possible alternatives are as follows:

- Retrofit the existing building
- Retrofit the existing building with rooftop addition
- Retrofit the existing building with new adjacent building
- Demolish existing building and construct a new building on same the footprint
- Demolish existing building and construct a new building on both the original Hoosac site and the adjacent lot

For alternatives involving the retrofit of the existing building, the Jacobs structural engineer has suggested the following methods to bring the building into compliance with current design codes (i.e., for seismic and other lateral loading):

- Adding interior shear walls
- Adding restrained braced frames within building interior
- Adding restrained braced frames along building perimeter

4. Local Geology

According to the USGS Geologic Map of Massachusetts, the site is located in the Cambridge Argillite of Boston Bay Group. The bedrock geologic age is late Proterozoic to earliest Paleozoic. The rock in this area is known to consists mainly of gray argillite and minor quartzite, rare sandstone and conglomerate.

At the Building site, Jacobs borings JB-1 and JB-6 confirmed that bedrock is a fine grained, gray, argillite. Refer to the boring logs in Appendix C for additional rock core sample details. Refer to Section 6.0 for detailed discussions on subsurface conditions at the site.

5. Subsurface Explorations

Recent subsurface explorations were conducted by Jacobs at the Building site and are summarized in Table 1 below. Subsurface exploration locations are shown on Figure 2 of Appendix A and boring logs are provided in Appendix C.

Five test borings (B-1, B-2/B-2A, B-3, B-4 and B-6) were performed in October 2019 by New England Boring Contractors, Inc. Boring B-1 was observed and logged by a representative from Jacobs. The remainder of the borings were logged by the driller.

Borings were drilled using a truck-mounted drill rig (for Borings B-4 and B-6 in the parking lot) or a ATV drill rig (for Boring B-1, B-2/B-2A, and B-3 inside the building) and were advanced using rotary-wash method with casing and standard rock core drilling techniques to depths ranging from approximately 39.6 feet to 94 feet below existing ground surface. In Boring B-1, Standard Penetration Tests (SPTs) and split spoon soil sampling were performed continuously from the bottom of the concrete slab to 10 feet and then performed at five-foot intervals using a 140-pound safety hammer. In the other borings, Standard Penetration Tests (SPTs) and split spoon soil sampling were generally performed at five-foot intervals using a 140-pound safety hammer until glacial till was encountered, then drilled with a roller bit until refusal indicating possible top of bedrock was reached except at Boring B-2 where the boring was terminated about 6 inches in the glacial till layer. In Borings B-1 and B-6, after bedrock was encountered, 10-foot and 9-foot rock cores were performed, respectively.

For additional details regarding the borings refer to the subsurface exploration logs presented in Appendix C.

Table 1: Subsurface Exploration Summary

Exploration No.	Terminated Depth (ft)	Depth to Silty Clay (ft)	Depth to Glacial Till (ft)	Depth to Bedrock (ft)	Groundwater Depth (ft)
B-1	94	19	44	84	10.0
B-2/B-2A	39.6	19	39	N/A[1]	10.0[3]
B-3	83	19	34	83[2]	10.0
B-4	79	19	39	79[2]	9.0
B-6	93	19	49	84	10.0

Notes:
1. N/A = Information Not Available
2. Possible depth to bedrock based on roller bit refusal.
3. Groundwater measured in the borehole upon completion after casing was pulled. All other groundwater readings in casing during drilling or upon completion.
4. Boring B-5 was not performed.

6. Laboratory Testing

6.1 Soil Tests

6.1.1 Soil Classification Testing

Laboratory tests were conducted to confirm visual classification of selected split spoon samples. All laboratory soil classification tests were performed by Thielsch Engineering, of Cranston, RI. The soil tests included natural moisture content (ASTM D-2216), Atterberg Limits (ASTM D-4318) and sieve analysis (ASTM D-6913). The test and soil classification results are summarized in Table 2. Laboratory test reports are presented in Appendix D.

Table 2: Laboratory Soil Classification Summary

Boring No.	Sample No.	Depth (ft)	Material	Water Content (%)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)	LI
B-1	S7A	19.0-21.0	Lean Clay	30.7	-	-	-	40	19	21	0.56
B-2A	S5	19.0-21.0	Lean Clay	31.1	-	-	-	48	22	26	0.35
B-3	S6	29.0-31.0	Lean Clay	32.2	-	-	-	40	20	20	0.61
B-4	S7	29.0-31.0	Lean Clay	24.7	-	-	-	40	20	20	0.24
B-6	S5	19.0-21.0	Lean Clay	34.5	-	-	-	45	22	23	0.54
B-6	S11	49.0-51.0	Silt	10.9	-	-	-	NV	NP	NP	-
B-1	S16	64.0-64.5	Silty Sand with Gravel	10.4	28.9	39.7	31.4	NV	NP	NP	-
B-2A	S4	14.0-16.0	Poorly Graded Sand with Silt and Gravel	10.4	36.8	52.3	10.9	NV	NP	NP	-
B-3	S8	39.0-40.4	Poorly Graded Sand with Silt and Gravel	11.6	34.3	53.7	12.0	NV	NP	NP	-
B-4	S9	39.0-41.0	Silty Sand with Gravel	17.9	22.4	39.0	38.6	NV	NP	NP	-

Notes:
1. NV = None Viscous
2. NP = None Plastic

6.1.2 Soil Corrosivity Testing

Five soil samples collected in the fill at elevations close to the observed groundwater level (between depths of 9 to 11 feet) were tested for corrosivity. The testing suite included:

- Electrical Resistivity
- pH
- Sulfate
- Chloride

The corrosivity results are summarized in Table 3. The tested values of pH, Electrical Resistivity, Chloride, and Sulfate suggest corrosive to very corrosive conditions in the tested soils per FHWA Publication NHI-09-087; and the soil can be considered as indicative of a potential pile deterioration or corrosion situation per AASHTO LRFD Bridge Design Specifications, Article 10.7.5. The complete laboratory test results are presented in Appendix D.

Table 3: Summary of Laboratory Corrosivity Test Results

Boring No.	Sample No.	Sample Depth (ft)	pH	Electrical Resistivity (ohm-cm)	Chlorides (ppm)	Sulfates (ppm)
B-1	S5	9-11	7.08	500	539	215
B-2A	S3	9-11	7.91	300	960	323
B-3	S2	9-10.6	8.51	1,000	217	210
B-4	S3	9-11	7.68	200	1,740	316
B-6	S3	9-11	7.18	800	525	162

6.2 Rock Tests

Three unconfined compression tests were performed on rock samples from borings B-1 and B-6. Test results are summarized in Table 6 below. Detailed test results are presented in Appendix D.

Table 4: Rock Unconfined Compression Test Summary

Boring/Sample Number	Sample Depth (ft)	Length/ Diameter Ratio	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	Undrained Shear Strength (psi)
B-1, C-1	84.5 - 85.1	2.44	169.8	9,104	4,552
B-6, C-2	87.8 - 88.3	2.37	166.9	3,997	1998.5
B-6, C-3	90.9 - 91.4	2.38	170.0	4,001	2,000.5

7. Subsurface Conditions

The following generalized subsurface conditions at the site are inferred from the Jacobs exploration data. The data below is presented with some interpretations. The subsurface exploration logs are included in Appendix C.

The subsurface conditions at the site generally consist of granular fill, followed by Boston Blue Clay overlaying glacial till on top of the bedrock.

7.1 Soil

7.1.1 Fill

Approximately 19 feet of fill was encountered at the site. The fill layer generally consisted of loose to very dense, fine to coarse sand with varying amounts of gravel and silt. In Boring B-4, a layer of cohesive fill mixed with gravels was encountered between 14 and 19 feet. SPT N-values ranged from 6 blows per foot (bpf) to 80 bpf.

7.1.2 Silty Clay (Boston Blue Clay)

A generally stiff to hard Boston Blue Clay layer was encountered below the fill in all borings inside and next to the building (B-1, B-2/B-2A, B-3, and B-4). This silty clay layer is very soft to medium stiff at locations further away from the building (B-6). The thickness of the Blue Clay layer varies from 15 to 30 feet with the thicker silty clay layer at locations further away from the building (i.e., Boring B-6). SPT N-values in this layer ranged from Weight of Hammer (WOH) to more than 100 bpf.

7.1.3 Glacial Till

A layer of glacial till was encountered in all borings directly underneath the Blue Clay at approximately 34 to 49 feet below ground surface. The thickness of the till layer ranged from 35 to 49 feet. The SPT N-values in this layer generally exceed 100 bpf except in B-4 where the SPT N-value varied from 27 to 35 bpf in granular material and in B-6 where the SPT N-value varied from 6 to 12 bpf in cohesive material.

7.2 Bedrock

Bedrock was encountered at 79 to 84 feet below exiting ground surface. The bedrock encountered consists of a hard, moderately to slightly weathered, moderately fractured, fine grained, gray argillite. Recovery was between 65% and 91.7% and the rock quality designations (RQDs) for the core runs were between 0% and 42.7%.

7.3 Groundwater

Groundwater levels were measured in all test borings in casing during drilling or in the borehole (after casing was pulled) upon completion. Based on the boring observations, groundwater is at approximately 10 feet below ground surface. It should be noted that the top of boring elevations for Borings B-4 and B-6, which were in the parking lot, are about 3 feet lower than the top of boring elevations for Borings B-1, B-2/B-2A and B-3, which were inside the building. Therefore, to be conservative, the design depth of groundwater in the parking lot should be 7 feet below grade.

Local or periodic variations of groundwater elevation should be expected as levels may be influenced by tides, season, precipitation, construction activity, and other factors. Therefore, the groundwater elevations presented herein may not be representative of water levels encountered during construction.

8. Seismic Design Parameters

Our work included seismic analyses to determine the appropriate site coefficient for structural design, using information obtained from all Jacobs 2019 test borings. Per Chapter 20 of ASCE 7-10, we recommend using Site Class E for this site.

In accordance with the provisions under Section 1613.3.4 of the 2015 IBC for Site Class E, we recommend that the site's design response spectra be developed using the following coefficients:

$$S_{DS} = 0.362 \text{ g} \quad S_{D1} = 0.161 \text{ g}$$

Where:

S_{DS} is the design spectral acceleration coefficient at 0.2-sec period.

S_{D1} is the design spectral acceleration coefficient at 1.0-sec period.

The proposed structures are defined as Risk Category III (IBC Table 1604.5) and a resulting Seismic Design Category C (IBC Tables 1613.3.5(1) and 1613.3.5(2)). Refer to Appendix E for detailed Seismic Site Class evaluation.

9. Liquefaction Potential

Our work included an analysis of soil liquefaction potential of the existing soils at the Project site. Our analysis utilized the Simplified Method, based on the observed subsurface conditions, worst-case groundwater levels, estimated percentage of fines content, and the recorded SPT N-values at selected borings.

Factors of safety against liquefaction in all borings are no less than 1.3. Therefore, the site is considered not liquefiable.

10. Geotechnical Recommendations

10.1 Existing Timber Piles

The record foundation plan indicates that the top of the timber piles is about 11'-3" below the interior grade. The existing column footings are composed of multiple layers of granite stones with various sizes and thicknesses. Based on the discussions in Section 7.3, it is expected that all the existing timber piles are permanently under the groundwater table. It is generally accepted that foundation timber piles finished below permanent groundwater table will last indefinitely. Therefore, it is expected that the existing footings can still carry the original vertical loads if there is no increase in the vertical loads in the final design.

However, since the granite stones were simply stacked on top of the piles and on top of each other, the existing footings cannot develop much lateral capacity to resist lateral loads (such as wind load and seismic load). Therefore, retrofitting design is required regarding to accommodate lateral loading.

10.2 Foundation for Seismic Retrofit

As discussed in Section 3, Jacobs structural engineer suggested three alternatives regarding to seismic retrofit of the existing structure to bring it into compliance with the current codes. Each of these alternatives will require added foundation piles to support the added structure elements. Due to the overhead space limitation, drilled micropiles are considered the most suitable foundation type.

10.3 Foundation for Building Extension

There is no overhead limitation at the existing parking lot location. Both driven piles (timber piles, precast concrete piles or steel H-piles) and drilled micropiles are feasible foundation types for the new extension structure.

10.4 Foundation for New Building if Existing Structure is Demolished

There would be no overhead limitations if the existing structure is demolished. Both driven piles and drilled micropiles are feasible foundation types for the new structure.

At the existing building location, if the design loads of the proposed new building are higher than the current building loads, additional piles can be added. However, it should be noted that driven piles cannot be added at the existing footing locations, due to the presence of the timber piles and the granite stone footings. Drilled micropiles, however, could drill through the granite blocks and timber piles if needed.

10.5 Foundation and Basement Excavation

Per Section 7.3, it is expected the groundwater depth at the site is between 7 to 10 feet below grade. Any excavation below this level will require a cofferdam and construction dewatering.

Due to proximity to the sidewalk and the roadway, temporary support of excavation may be required if new foundation and basement are to be constructed adjacent to the existing sidewalk.

10.6 Pile Foundation Corrosion Consideration

Per Section 6.1.2, the site soil is corrosive based on the lab test results. Therefore, we recommend that the design of steel pile (drilled micropile or driven H-pile) shall consider a 1/8-inch allowance for corrosion loss.

11. Structural Investigation

The following strategies were formulated based on findings from the Jacobs geotechnical report and the SGH material test report (Appendix G), along with seismic evaluation consisting of Tier 1 and Tier 3 evaluation and retrofit procedures per ASCE 41-13 (Seismic Evaluation and Retrofit of Existing Buildings) (Appendix H).

11.1 Existing Deficiencies

Major structural deficiencies identified per evaluation criteria include:

- Inadequate shear walls (existing brick walls).
- Potentially inadequate diaphragm connections to shear walls.
- Existing Foundation cannot accommodate lateral loads.

11.2 Performance Objectives

Seismic Performance Objective for this building is Tier 1 per Facilities Standards for the Public Buildings Service (PBS-P100). Per this standard, these are three reasons for accepting a somewhat greater risk in existing buildings.

1. The increase in risk is tempered by the recognition that an existing building often has a shorter remaining life than a new building. For example, a new building with a 50 year life has a higher chance of experiencing a large seismic event than an existing building with 30 years remaining in its life. This rationale is less applicable when a retrofit renews the building or is intended to substantially extend its useful life.

2. The cost of retrofitting existing buildings to achieve performance equivalent to new buildings is often disproportionate to the incremental benefit. In some cases it is not realistic to retrofit an existing building to meet new building standards.

3. Accepting performance less than "full code" ensures that recent buildings are not immediately rendered deficient whenever the code changes. report and the recommendations contained herein have been prepared for the exclusive use of Marble Fairbanks Architects and their representatives for the feasibility study of The Hoosac Stores Modernization Project in Charlestown, Boston, MA.

11.3 Structural Evaluation

We have based our structural evaluation on the available as-built drawings that show the original construction, field visit and two reports: Geotechnical Report by Jacobs and Material Testing and Masonry Condition Assessment by SGH (Appendix G), a subconsultant to Jacobs.

11.3.1 Code Categorization

The building as proposed qualifies as Risk Category III for assembly area that contains more than 300 people per IBC 2015 Table 1604.5. The building's target performance level per GSA instruction is Tier 1 Damage Control. The level of seismicity is moderate per local seismic information. Hence, the Scope of Assessment does not need Tier 1 Evaluation for this existing building under BSE-1E per ASCE 41-17 Table 2-2. The building is expected to be retrofitted significantly and the total mass and the final configuration that is needed to be used for Tier 1 Evaluation under BSE-2E is expected to change significantly and they are still pending the final scheme to be accepted by National Park Services and GSA. However, a preliminary evaluation for the existing building systems was still performed to understand the building systems.

11.3.2 Lateral Loads

The existing lateral system per the as-built drawings appears to be 1'-8" thick unreinforced masonry walls (URM), with lower 4'-0" being 2'-0" thick at some locations, supported with timber piles. Note that this is a lateral system forbidden for any building per Massachusetts Building Code 780 CMR 9th Edition. Although it is a permissible system based on ASCE 41 if the seismic shear stress is less than 30 psi, the use of this system is not recommended considering the restriction placed on local building code.

The connections between the diaphragm and URM walls are not shown on as-built drawings. During the site visit it was found the timber beams or timber/steel girders sit on bearing plates embedded in interior wythe of URM walls without any visible connections between bearing plates and walls. Even within the diaphragm composed of wood decking overlaying timber beams, then steel girders, it is not visible that there are any connections from one layer to another beside expected nails.

Among all aspects of lateral system, the foundation system has the most serious deficiency in the lateral resistance. The timber piles stop at about 11 feet below existing grade and columns and URM sit at the grade level over pile caps comprised of multiple layers of granite stones with various sizes and thickness loosely stacked over each other which span about 11 feet of height and have no positive connections shown between layers of stones. Whatever lateral capacity the timber piles may possess, there is no known mechanism that could reliably and positively transfer that to the brick walls or columns. Geotechnical Report Section 10.1 concurs with this conclusion.

11.3.3 Gravity Loads

Surprisingly, the gravity system is stronger than expected based on test results per SGH report. The test results for solid bricks from the almost 150-year-old walls show some rather high compressive strength, the minimum value of 2,640 psi as tested being about twice higher than the minimum of 900 psi as recommended by ASCE 41-17 for bricks in "good condition" multiplied by a factor of 1.3, which yields 1,200 psi. The mortar, by petrographic examination was found to be closely match Type O contemporary mortar per ASTM C270 with higher binder ratio being 1:2 compared to traditional 1:3, which means higher flexural strength than typical Type O. Beside some localized areas of masonry deterioration (e.g., cracked, eroded, spalled, loose brick and mortar), the core of the masonry walls appear to be relatively intact and sound per SGH report.

12. Seismic Rehabilitation Options

With the above findings, we have come to the premise that the retrofitting design based on ASCE 7 and ASCE 41, and ICSSC Recommended Practice (RP) 8 for existing buildings shall require seismic improvements with new foundation systems. In order to complete ASCE 41 checklist methods for seismic improvements, we will require a more definitive architectural design to provide accurate seismic loading calculations. Biggest unknown thus far is the extent of proposed openings in the existing masonry walls. As these are defined, along with removal of any existing floor areas, the design of the structural system can be further defined.

Per ASCE 41 requirements there will be two stages of structural remediation:

- Tier 1 evaluation of structural elements shall be performed at the existing building hazard levels with the proposed architectural schemes.
- Tier 3 seismic retrofit options have been designed to the new building hazard levels because the feasibility study shall include work that will renew the building and substantially extend its useful life.

The following three seismic retrofit options have been provided as a starting point for discussions with the architects and do not represent final resolution for recommended approach. These options are based on the experience of local practice applied to the existing building configuration.

12.1 Strategy 1 – Concrete Shear Wall Core

This Strategy consists of adding four new concrete shear walls between existing building columns. This option provides a dramatic improvement on the torsional behavior of the building, and can be constructed in phases to limit the disruption of the current building configuration.

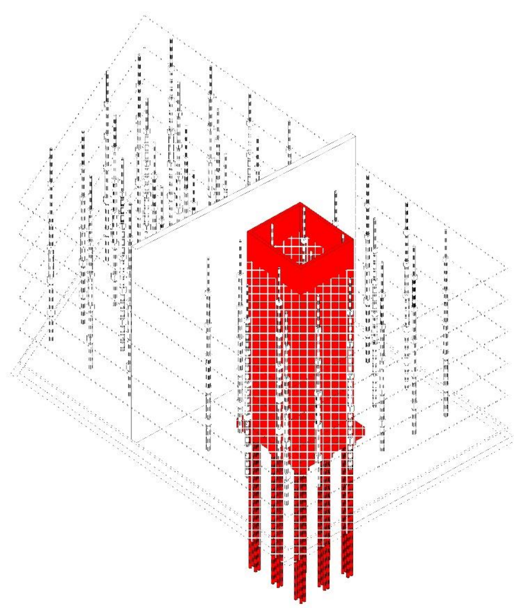

Fig. 12.1 : Strategy 1

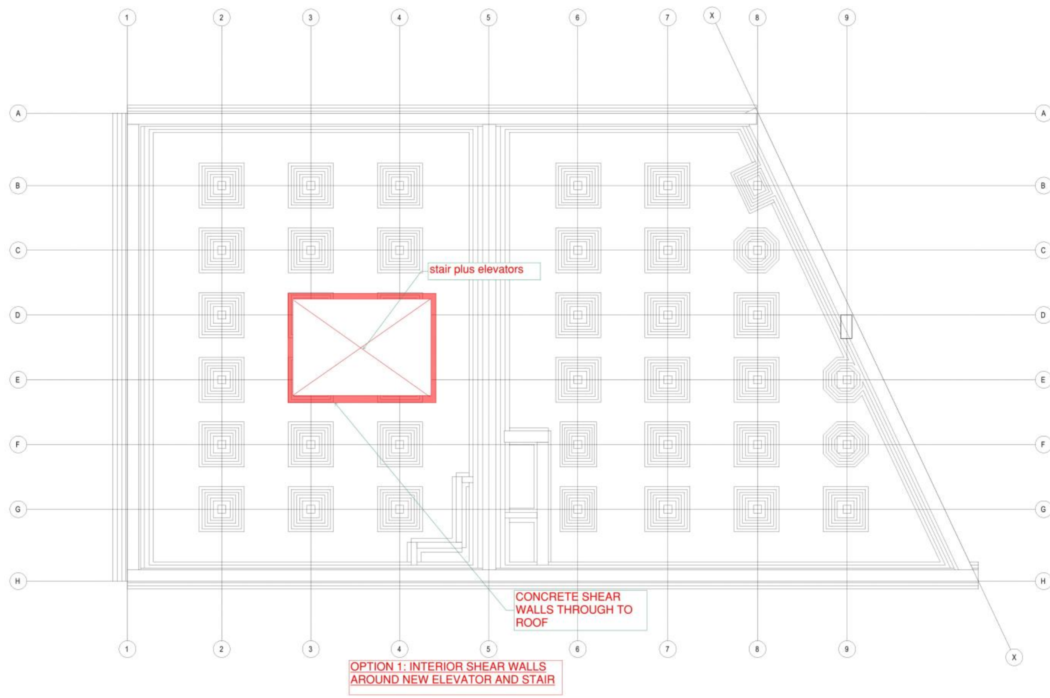

Fig. 12.2 : Strategy 1 plan indicating new interior concrete shear walls around an elevator and stair core.

12.2 Strategy 2 – Braced Frames within the Building Footprint

This strategy consists of positioning the braced frames away from the exterior wall. This can still provide the lateral capacity of the building per appropriate code provisions without impacting the existing foundation.

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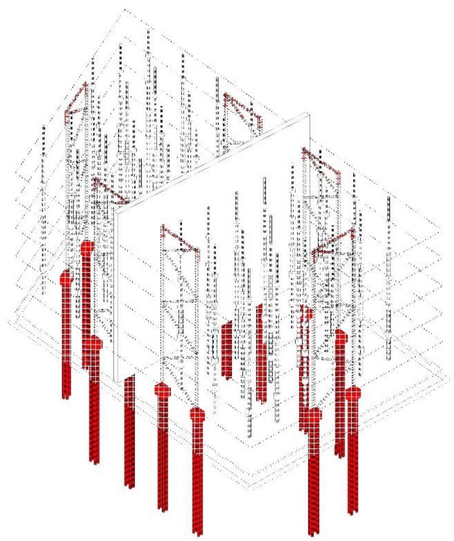

Fig. 12.3 : Strategy 2

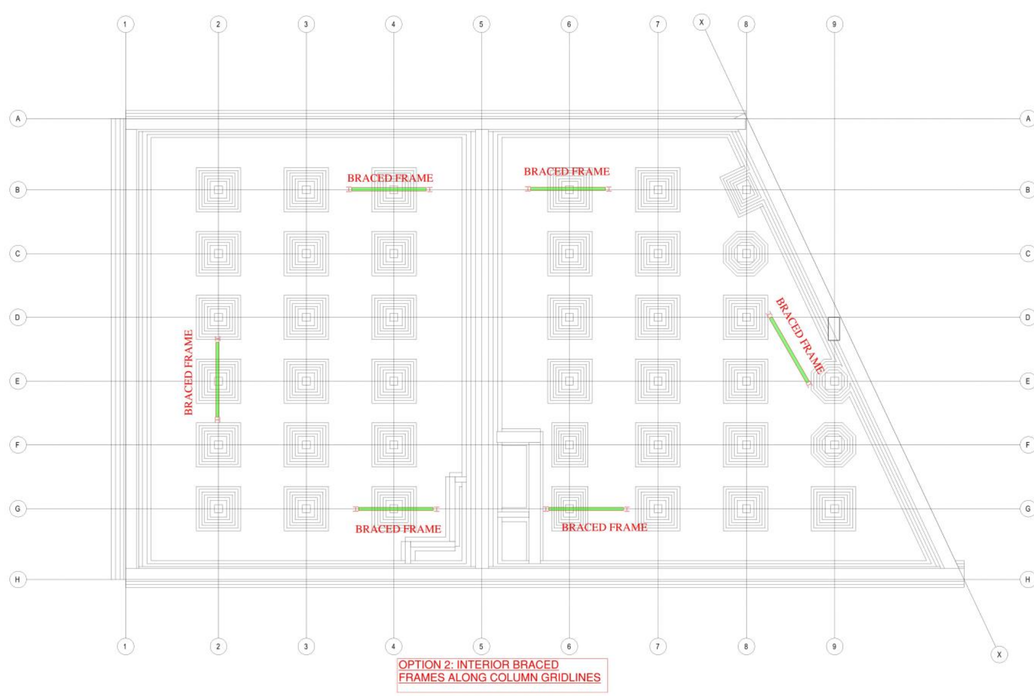

Fig. 12.4 : Strategy 2 plan indicating new braced frame structure inside the existing column grid.

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JACOBS

12.3 Strategy 3 – Braced Frames at Perimeter

This option proposes to add new structural steel braced frames on each of the four sides of the building. The new steel columns will line up with the existing interior face of the exterior brick walls. The new steel columns will be supported at the ground level by new micro-piles that extend to the appropriate soil strata so as to transfer forces from the braced frames into foundation.

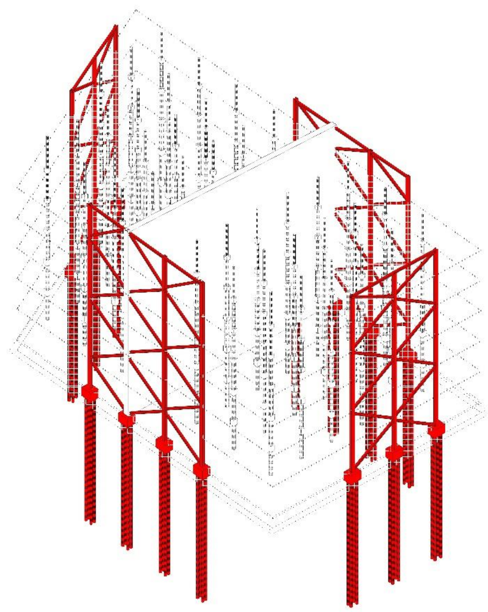

Fig. 12.5 : Strategy 3

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JACOBS

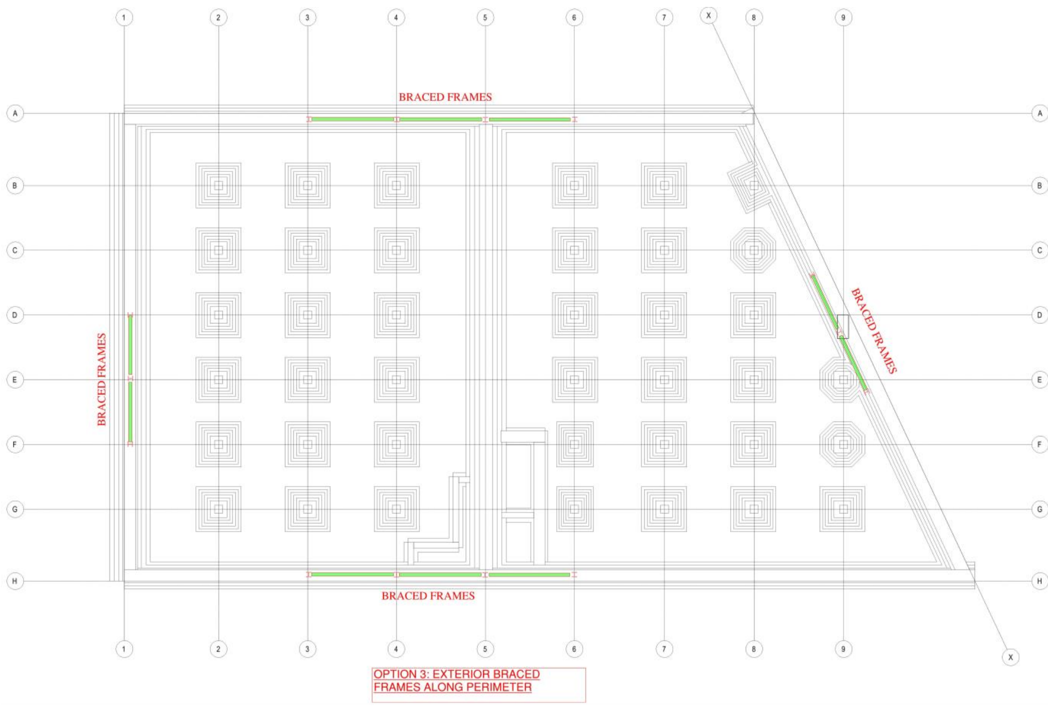


Fig. 12.6 : Strategy 3 plan indicating an exterior braced from along the perimeter of the building.

13. Limitations

This report and the recommendations contained herein have been prepared for the exclusive use of Marble Fairbanks Architects and their representatives for the feasibility study of The Hoosac Stores Modernization Project in Charlestown, Boston, MA.

This report was prepared in accordance with generally accepted engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations, material testing and documents available at the time of this report. Subsurface stratification variations between explorations are anticipated. Material properties may differentiate at location that was not tested or may change after the report is issued. The reported groundwater levels were short-term observations and only represented the water levels at the time of the explorations and as noted on the exploration logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

Appendix A. Figures

JACOBS		NATIONAL PARK SERVICE THE HOOSAC BUILDING FEASIBILITY STUDY GEOTECHNICAL REPORT	LOCUS PLAN	FIGURE 1

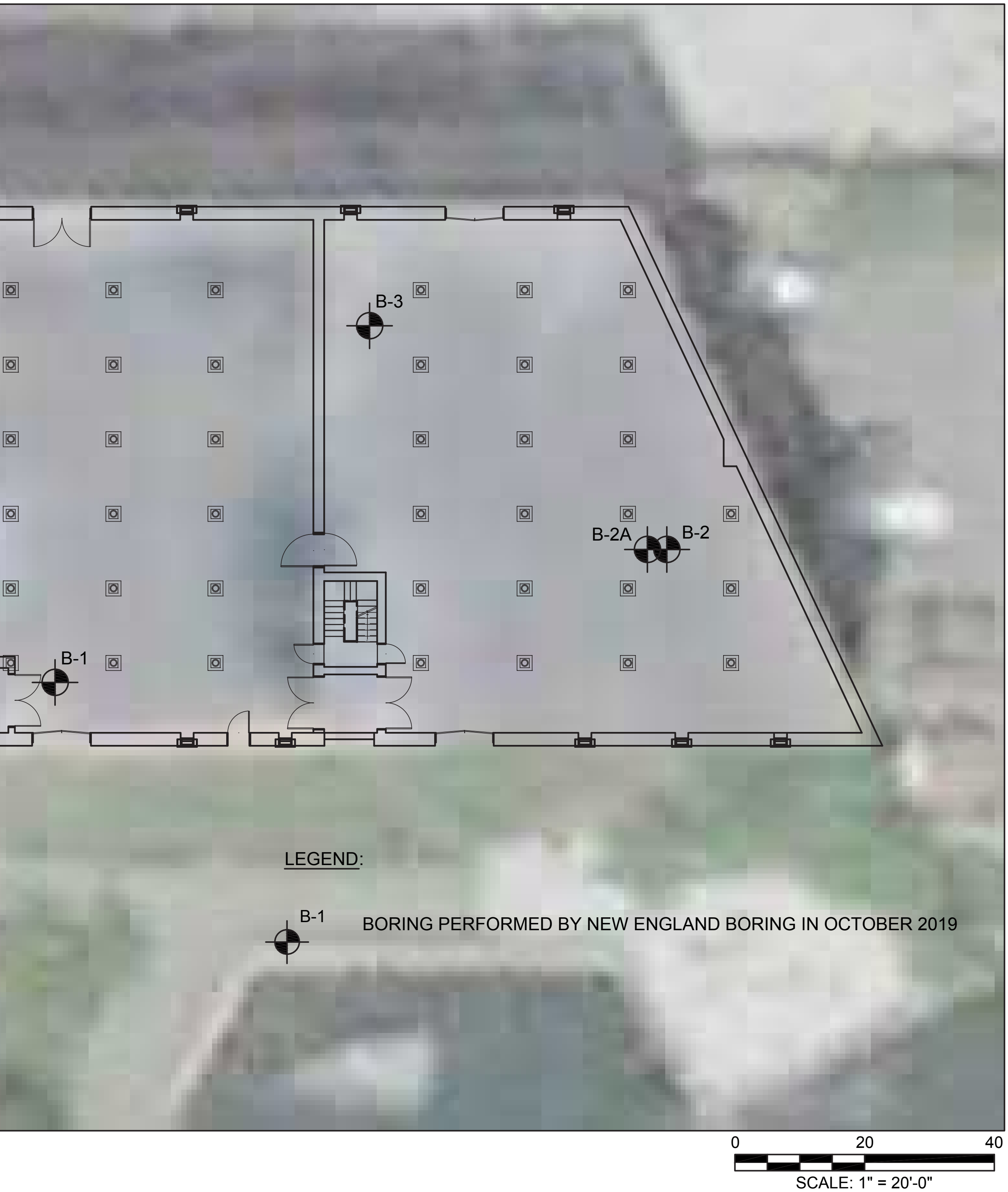
O:\INFRASTRUCTURE\UNDERGROUND\Hoosac Building\700 CAD\Hoosac Building Boring Location Plan.dwg 1 Oct 24, 2019

NOTES:

1. FOR BORING EXPLORATION LOGS SEE GEOTECHNICAL REPORT APPENDIX C.
2. BORING LOCATIONS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENT AND LINE OF SIGHT FROM ORIGINAL STAKED LOCATIONS AND SITE FEATURES AND SHOULD BE CONSIDERED ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED.
3. BORING B-1 WAS OBSERVED AND LOGGED BY JACOBS PERSONNEL. THE OTHER BORINGS WERE LOGGED BY NEW ENGLAND BORING PERSONNEL.

JACOBS™	NATIONAL PARK SERVICE	PREPARED BY: CWB CHECKED BY: DH DATE: OCTOBER 2019	NATIONAL PAR THE HOOSAC BUILDIN GEOTECHNIC

O:\INFRASTRUCTURE\UNDERGROUND\Hoosac Building\700 CAD\Hoosac Building Boring Location Plan.dwg 2 Oct 24, 2019



RK SERVICE

G FEASIBILITY STUDY
AL REPORT

BORING LOCATION PLAN

FIGURE
2

Appendix B. Site Photos and Record Drawings

Figure B1 – Northeast Side of Existing Building

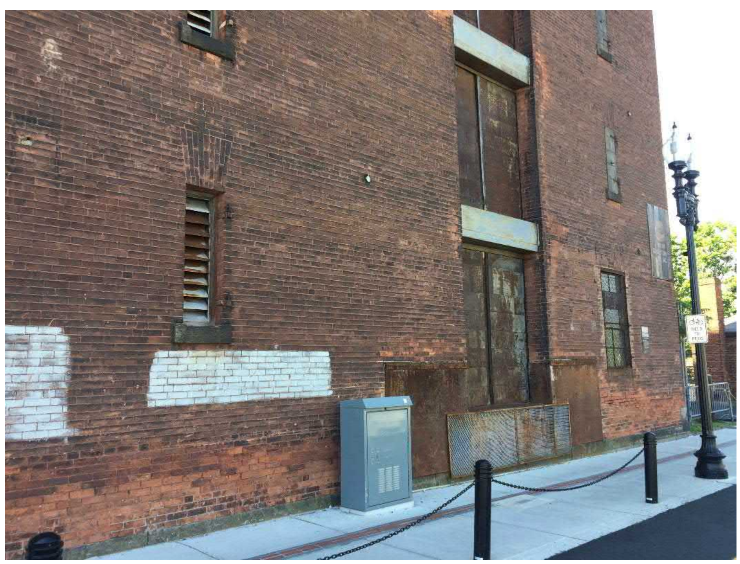


Figure B2 – Northwest Side of Existing Building

Figure B3 – Southwest Side of Existing Building

Figure B4 – Southeast Side of Existing Building

Appendix C. Subsurface Exploration Logs

GrfcText\BORING LOG KEY 4/8/2016 11:34:36 AM

JACOBS

BORING LOG KEY

120 St. James Ave
5th Floor
Boston, Massachusetts
02216

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
1	2	3	4	5	6	7	8	9	10	11

COLUMN DESCRIPTIONS

1 ELEV (feet): Elevation in feet as per datum specified on log.
2 DEPTH (feet): Depth in feet below the ground surface or barge.
3 SAMPLE DATA: Type of soil/rock sample and data collected over the depth interval shown.
4 N-VALUE (Uncorrected): Cumulative number of uncorrected blows for the middle two six-inch intervals (blows/foot).
5 SAMPLE NUMBER: Sample identification number.
6 DEPTH INTERVAL (feet): Depth interval of the soil or rock sample collected.
7 PEN/REC (inch/inch): Soil or rock sample penetration / amount of soil or rock recovered.
8 PID (parts per million): PID reading observed during drilling.
9 LAYER NAME: Inferred name and delineation of subsurface strata.
10 SOIL AND ROCK DESCRIPTION: Description of material encountered.
11 NOTES: Comments/observations regarding drilling/sampling made by driller or field personnel.

BURMISTER SOIL CLASSIFICATION (INORGANIC)

COMPONENT	NAME	PROPORTIONAL TERM	PERCENT BY WEIGHT	GRADATION DESIGNATIONS	PROPORTIONS OF GRANULAR COMPONENT
MAJOR	GRAVEL SAND FINES*	n/a	> 50	fine medium	< 10% coarse & medium < 10% coarse & fine
Minor	Gravel Sand Fines*	and some little trace	35 - 50 20 - 35 10 - 20 0 - 10	fine to medium medium to coarse fine to coarse	< 10% coarse < 10% fine all > 10%

PARTICLE SIZE DEFINITIONS			
SOIL	*FRACTION*	*SIEVE NO.*	*SIEVE SIZE*
Gravel	coarse fine	3 in to 3/4 in 3/4 in to No.4	75mm - 19mm 19mm - 4.75mm
Sand	coarse medium fine	No.4 to No.10 No.10 to No.40 No.40 to No.200	4.75mm - 2.0mm 2.0mm - .43mm 0.43mm - 0.08mm
Silt	n/a	< No.200	< 0.075mm

GRANULAR SOILS		PLASTICITY	PLASTICITY INDEX	FINES*	THREAD DIAMETER	FINE SOILS		
DENSITY	*SPT N-VALUE*					*CONSISTENCY*	*SPT N-VALUE*	*UC STRENGTH*
Very Loose	< 4	Non-Plastic	0	SILT	None	Very Soft	< 2	< 0.25 tsf
Loose	4 - 10	Slight	1 - 5	Clayey SILT	1/4" (6mm)	Soft	2 - 4	0.25 - 0.50 tsf
Medium Dense	10 - 30	Low	5 - 10	SILT & CLAY	1/8" (3mm)	Medium	4 - 8	0.50 - 1.0 tsf
Dense	30 - 50	Medium	10 - 20	CLAY & SILT	1/16" (1.5mm)	Stiff	8 - 15	1.0 - 2.0 tsf
Very Dense	> 50	High	20 - 40	Silty CLAY	1/32" (0.75mm)	Very Stiff	15 - 30	2.0 - 4.0 tsf
		Very High	> 40	CLAY	1/64" (0.4mm)	Hard	> 30	> 4.0 tsf

BURMISTER SOIL CLASSIFICATION (ORGANIC)

Fibrous PEAT - Light weight, spongy, mostly visible organic matter, water squeezes readily from sample. Typically near top of deposit.
Fine Grained PEAT - Light weight, spongy, little visible organic matter, water squeezes readily from sample. Typically below fibrous PEAT.
Organic SILT - Typically gray to dark gray, often has strong H2S odor. Typically contains shells or shell fragment. Light weight. Usually found near coastal regions. May contain wide range of sand fractions.

MASSDOT VISUAL IDENTIFICATION OF SOILS

COMPONENT	NAME	PROPORTIONAL TERM	PERCENT BY WEIGHT
MAJOR	GRAVEL SAND FINES	n/a	> 50
Minor	Gravel Sand Fines	and some trace	40 - 50 10 - 40 < 10

PARTICLE SIZE DEFINITIONS			
SOIL	*FRACTION*	*SIEVE NO.*	*SIEVE SIZE*
Boulders	n/a	> 12 in	> 305mm
Cobbles	n/a	12 in to 3 in	305mm - 75mm
Gravel	coarse medium fine	3 to 1 in 1 in to 3/8 in 3/8 in to No.10	75mm - 25mm 25mm - 9.5mm 9.5mm - 2.0mm
Sand	coarse fine	No.10 to No.40 No.40 to No.200	2.0mm - 0.425mm 0.425mm - 0.075mm
Silt	n/a	< No.200	< 0.075mm

GRANULAR SOILS		FINE SOILS	
DENSITY	*SPT N-VALUE*	*CONSISTENCY*	*SPT N-VALUE*
Very Loose	< 4	Very Soft	< 2
Loose	4 - 10	Soft	2 - 4
Medium Dense	10 - 30	Medium Stiff	4 - 8
Dense	30 - 50	Stiff	8 - 15
Very Dense	> 50	Very Stiff	15 - 30
		Hard	> 30

GRAPHIC SYMBOLS

Split-Spoon Sample (SS) and Blow Counts per 6" REC (in)

Rock Core (RC) and RQD (%) REC (%)

Undisturbed (U) Shelby Tube (P) Piston

Auger Sample (AS)

Jar Sample (JS)

Bag Sample (B)

ABBREVIATIONS

SS = Split Spoon Sampler
U = Undisturbed Sample (Shelby Tube)
P = Piston Sample
WOR = Weight of Rods
WOH = Weight of Hammer
SPT = Stadard Penetration Test (ASTM D2487)
PP = Pocket Penetrometer
PI = Plasticity Index
UC STRENGTH = Unconfined Compressive Strength
PID = Photoionization Detector
ppm = Part Per Million
REC = Recovery
RQD = Rock Quality Designation
Water Level

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-1
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		
JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	S. Mattloob	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3"Casing	10-08-2019 / 7:00 AM	10.0 / Casing at depth 15'			COORD E	
84.0	NX Rock Core	10-11-2019 / 10:00 AM	10.0 / Upon Completion (Casing pulled)			DATE START	10/7/19
94.0	Terminated					DATE END	10/11/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
									(0 - 1') Concrete	
		5 6 4 5	10	S1	1 - 3	24/4			S1: Moist, medium dense, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
		13 6 5 6	11	S2	3 - 5	24/0			S2: No Recovery	1
	5	12 10 9 4	19	S3	5 - 7	24/0 24/6			S3: No Recovery S3R: Similar to S1	2
		9 4 3 8	7	S4	7 - 9	24/4			S4: Wet, loose, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	3
	10	16 14 13 16	27	S5	9 - 11	24/5		FILL	S5: Wet, medium dense, brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	15	22 40 40 30	80	S6	14 - 16	24/6			S6: Wet, very dense, brown, fine to coarse SAND, trace Gravel, trace Silt.	
								19		
	20	16 13 15 22	28	S7	19 - 21	24/20			S7A (Top 14"): Wet, gray, Silty CLAY. PP = 2 tsf. S7B (Bottom 6"): Wet, gray, SILT, some fine Sand.	4
	25	8 9 12 14	21	S8	24 - 26	24/10			S8: Wet, very stiff, gray, Silty CLAY. PP = 1.5 tsf.	
	30	9 7 12 13	19	S9	29 - 31	24/24		CLAY	S9: Wet, very stiff, gray, Silty CLAY. PP = 2 tsf.	
	35	6	30	S10	34 - 36	24/24			S10: Similar to S9	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Piece of gravel at spoon tip.
2. Redrove 3" diameter spoon to collect sample.
3. Piece of gravel at spoon tip.
4. PP indicates pocket penetrometer, the pocket penetrometer estimates unconfined compressive strength in tons per square foot (tsf).

LOG OF TEST BORING

JACOBS			BORING NO.	B-1
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		13 17 34								
	40	37 100/6"	100/6"	S11	39 - 40	12/8			S11: Wet, hard, gray, Silty CLAY. PP = 2 tsf.	5
								44		
	45	100/12"	100/12"	S12	44 - 45	12/2		TILL	S12: Wet, hard, SILT, some fine Sand, some fine to coarse Gravel.	6
	50	100/3"	100/3"	S13	49 - 49.3	3/1			S13: Wet, very dense, gray, fine to coarse GRAVEL, little fine to coarse Sand, little Silt.	7
	55	26 100/7"	100/7"	S14	54 - 55.1	13/2			S14: Wet, very dense, gray, fine to medium SAND and fine to coarse Gravel, little Silt.	
	60	100/3"	100/3"	S15	59 - 59.3	3/3			S15: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little Silt.	
	65	100/6"	100/6"	S16	64 - 64.5	6/6			S16: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, some Silt.	
	70	100/4"	100/4"	S17	69 - 69.3	4/0			S17: No Recovery	8
		100/5"	100/5"	S18	74 - 74.4	5/3				9

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

5. Piece of gravel stuck at spoon tip.
6. Boulder at depth 45' to 47'.
7. Added the drilling mud to the drilling water.
8. Piece of gravel stuck at spoon tip.
9. Piece of gravel stuck at spoon tip.

LOG OF TEST BORING

JACOBS		
PROJECT	The Hoosac Building	BORING NO. B-1
LOCATION	Charlestown, Boston, MA	
OWNER	National Park Service	
JOB NUMBER	FDZE6000	SHEET 3 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75								S18: Wet, very denes, gray, fine to medium SAND, some fine Gravel, some Silt.	
		100/3"	100/3"	S19	79 - 79.3	3/1			S19: Wet, very dense, gray, fine to medium SAND and fine to coarse Gravel, little Silt.	
	80									
		RQD=31.3		C1	84 - 88	48/42		84 BEDROCK	C1: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 6 - 4 - 7 - 8	10
	85									
		RQD=20		C2	88 - 93	60/39			C2: Similar to C1	
	90									
		RQD=0		C3	93 - 94	12/10		94	C3: Moderately hard, moderately to slightly weathered, moderately fractured, amorphous, gray, ARGILLITE with closely spaced, moderately dipping to sub-horizontal fractures. Bottom of Borehole at 94 feet below mudline.	11
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

10. Top of bedrock at 84'.
11. Upon completion, borehole backfilled with cement, bentonite and sand.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-2/B-2A
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 1 OF 2
	JOB NUMBER	FDZE6000		

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3" Casing	10-16-2019 / 9:00 AM	10.0 / Upon Completion (Casing pulled)			COORD E	
39.6	Terminated					DATE START	10/14/19
						DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
									(0 - 1') Concrete	
		5 6 6 6	12	S1	1 - 3	24/12			S1: Moist, medium dense, dark brown, fine to medium SAND and fine to coarse Gravel, trace Silt.	
	5	6 16 17 17	33	S2	4 - 6	24/0			S2: No Recovery	
	10	19 22 23 23	45	S3	9 - 11	24/8		FILL	S3: Moist, dense, dark brown, fine to coarse SAND, some fine Gravel, trace Silt.	1 2
	15	23 28 33 36	61	S4	14 - 16	24/8			S4: Moist, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, little Silt, trace brick fragments.	
								19		
	20	12 13 13 20	26	S5	19 - 21	24/24			S5: Moist, very stiff, gray, Silty CLAY.	
	25	15 13 14 14	27	S6	24 - 26	24/24			S6: Wet, very stiff, gray, Silty CLAY.	
	30	16 15 15 15	30	S7	29 - 31	24/24		CLAY	S7: Similar to S4	
	35	120/6"	120/6"	S8	34 - 34.6	6/4			S8: Wet, hard, gray, CLAY, some fine to medium Gravel, trace Sand.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. At depth 13'; Lost all the drilling water; put casing down and hitted steel. Moved the hole 2'.
2. Upon completion, borehole backfilled with cement, bentonite and sand. Offset hole 2 feet south, redrill, see B-2A.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-2/B-2A
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 2 OF 2
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	40	120/6"	120/6"	S9	39 - 39.6	6/4		39 39.6	S9: Wet, very dense, fine to medium SAND and Silt, some fine to medium Gravel (Till). Bottom of Borehole at 39.6 feet below mudline.	3 4
	45									
	50									
	55									
	60									
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

3. Upon completion, borehole backfilled with cement, bentonite and sand.
4. Boring logged by the driller.

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-3
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		
JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	C. Knight	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	M1	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0	Wash Boring w/3" Casing	10-16-2019 / 2:00 PM	10.0 / Upon Completion (In Casing)			COORD E	
83.0	Terminated					DATE START	10/16/19
						DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	5	22 16 26	42	S1	4 - 5.5	18/4		FILL	S1: Wet, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt, trace brick fragments.	
	10	15 15 15	30	S2	9 - 10.5	18/10		FILL	S2: Wet, dense, dark brown, fine to medium SAND, trace brick fragments.	
	15	17 16 16 20	32	S3	14 - 16	24/10		FILL	S3: Wet, dense, dark brown, fine to medium SAND, and fine to coarse Gravel, some brick fragments.	
								19		
	20	8 10 9 9	19	S4	19 - 21	24/21		CLAY	S4: Wet, very stiff, gray, Silty CLAY.	
	25	13 13 13 13	26	S5	24 - 26	24/24		CLAY	S5: Similar to S4	
	30	15 15 13 15	28	S6	29 - 31	24/24		CLAY	S6: Similar to S5	
								34		
	35	16	54	S7	34 - 35.8	21/20			S7: Wet, hard, gray, Silty CLAY and fine to medium Sand.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS			BORING NO.	B-3
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		16 38 100/3"								
	40	29 33 100/4"	133/10"	S8	39 - 40.3	16/8			S8: Wet, very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little Silt.	1
	45									
	50									
	55									
	60							TILL		
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-3
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 3 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
	80									
								83	Bottom of Borehole at 83 feet below mudline.	2 3 4
	85									
	90									
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Roller bit refusal at 83', possible top of bedrock.
3. Upon completion, borehole backfilled with cement, bentonite and sand.
4. Boring logged by the driller.

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building			BORING NO.	B-4
LOCATION	Charlestown, Boston, MA				
OWNER	National Park Service				
JOB NUMBER	FDZE6000				SHEET 1 OF 3
INSPECTOR N/A	CONTRACTOR NEBC	DRILLER	J. Mientkiewicz	ELEVATION	
METHOD OF DRILLING	GROUNDWATER READINGS	DRILL RIG	D-50 ATV	DATUM	NAVD 88
0.0 Wash Boring w/4" Casing	DATE/TIME / DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID N	
20.0 Wash Boring w/3" Casing	10-14-2019 / 2:00 PM / 9.0 / Upon Completion (In Casing)			COORD E	
79.0 Terminated				DATE START	10/14/19
				DATE END	10/15/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		3 6 100/3"	106/9"	S1	0 - 1.3	15/10		FILL	S1: Dry, very dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	5	13 19 27 75	46	S2	4 - 6	24/12		FILL	S2: Dry, dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	10	8 15 27 33	42	S3	9 - 11	24/10		FILL	S3: Wet, dense, brown, fine to coarse SAND, trace Gravel.	
	15	5 3 3 5	6	S4	14 - 16	24/16		FILL	S4: Wet, medium stiff, gray, Silty CLAY, trace Gravel.	
								19		
	20	3 5 7 5	12	S5	19 - 21	24/12		CLAY	S5: Wet, stiff, gray, Silty CLAY.	
	25	3 4 5 4	9	S6	24 - 26	24/20		CLAY	S6: Similar to S5	
	30	6 5 6 6	11	S7	29 - 31	24/18		CLAY	S7: Similar to S5	
	35	7	12	S8	34 - 36	24/24		CLAY	S8: Similar to S5	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS			BORING NO.	B-4
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		6 6 7								
								39		
	40	12 15 12 27	27	S9	39 - 41	24/10			S9: Wet, medium dense, fine to coarse SAND and SILT, some fine to coarse Gravel.	
	45	4 12 17 20	29	S10	44 - 46	24/10			S10: Wet, medium dense, fine to coarse SAND and fine to coarse Gravel, little Silt.	
	50	17 15 20 25	35	S11	49 - 51	24/12			S11: Wet, dense, brown, fine to coarse SAND and fine to coarse Gravel, little Silt.	1
	55									
	60							TILL		
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-4
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		SHEET 3 OF 3
	JOB NUMBER	FDZE6000		

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
								79	Bottom of Borehole at 79 feet below mudline.	2 3 4
	80									
	85									
	90									
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Roller bit refusal at 79'. Possible top of bedrock.
3. Upon completion, hole backfilled with soil cuttings and sand, asphalt patched/restored.
4. Boring logged by the driller. Some soil descriptions editted by Jacobs.

LOG OF TEST BORING

JACOBS

PROJECT	The Hoosac Building	BORING NO.	B-6
LOCATION	Charlestown, Boston, MA		
OWNER	National Park Service		
JOB NUMBER	FDZE6000		SHEET 1 OF 3

INSPECTOR	N/A	CONTRACTOR	NEBC	DRILLER	J. Mientkiewicz	ELEVATION	
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D-50 ATV	DATUM	NAVD 88
0.0	Wash Boring w/4" Casing	DATE/TIME	DEPTH(ft)	REMARKS / SPT HAMMER	140 lb Safety	GRID	N
20.0	Wash Boring w/3"Casing	10-15-2019 / 3:00 PM	10.0	Upon Completion (In Casing)		COORD	E
84.0	NX Rock Core					DATE START	10/15/19
93.0	Terminated					DATE END	10/16/19

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		9 9 9 5	18	S1	0 - 2	24/10		FILL	S1: Dry, medium dense, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	5	4 2 4 4	6	S2	4 - 6	24/6			S2: Dry, loose, dark brown, fine to coarse SAND and fine to coarse Gravel, trace Silt.	
	10	10 8 8 9	16	S3	9 - 11	24/6			S3: Wet, medium dense, brown, fine to coarse SAND, trace Silt.	
	15	3 3 5 8	8	S4	14 - 16	24/12		19	S4: Wet, loose, brown, fine to coarse SAND, trace Gravel, trace Silt.	
	20	1 2 3 4	5	S5	19 - 21	24/24		CLAY	S5: Wet, medium stiff, gray, Silty CLAY.	
	25	WOH 2 3 2	5	S6	24 - 26	24/24			S6: Similar to S5	
	30	WOH WOH WOH 4	0	S7	29 - 31	24/24			S7: Wet, very soft, gray, Silty CLAY.	
	35	WOH	4	S8	34 - 36	24/24			S8: Wet, soft, gray, Silty CLAY.	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

LOG OF TEST BORING

JACOBS			BORING NO.	B-6
	PROJECT	The Hoosac Building		
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 2 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
		WOH 4 4								
	40	WOH WOH 2 4	2	S9	39 - 41	24/22			S9: Similar to S8	
	45	WOH WOH 6 5	6	S10	44 - 46	24/24			S10: Wet, medium stiff, gray, Silty CLAY and fine Sand.	
								49		
	50	7 3 3 9	6	S11	49 - 51	24/14		TILL	S11: Wet, medium stiff, gray, SILT, trace Gravel.	
	55	6 5 7 8	12	S12	54 - 56	24/12			S12: Wet, stiff, gray, SILT, trace Gravel.	1
	60									
	65									
	70									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Roller bit continued.

LOG OF TEST BORING

JACOBS	PROJECT	The Hoosac Building	BORING NO.	B-6
	LOCATION	Charlestown, Boston, MA		
	OWNER	National Park Service		
	JOB NUMBER	FDZE6000		SHEET 3 OF 3

ELEV. (ft)	DEPTH (ft)	SAMPLE DATA	N-VALUE	SAMPLE NO.	DEPTH INTERVAL (ft)	PEN/REC (in)/(in)	PID (ppm)	LAYER NAME	SOIL AND ROCK DESCRIPTION	NOTES
	75									
	80									
								84		
	85	RQD=0		C1	84 - 86	24/18		BEDROCK	C1: Moderately hard, moderately to slightly weathered, moderately fractured, amorphous, gray, ARGILLITE with closely spaced, moderately dipping to sub-horizontal fractures. Coring Time (mins/ft): 3 - 6	2
		RQD=42.7		C2	86 - 90	48/41		BEDROCK	C2: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 3 - 3 - 5 - 5	
	90	RQD=38.9		C3	90 - 93	36/33		BEDROCK	C3: Hard, moderately to slightly weathered, moderately fractured, fine grained, gray, ARGILLITE, with closely spaced, sub-horizontal to horizontal fractures. Coring Time (mins/ft): 6 - 7 - 6	
								93	Bottom of Borehole at 93 feet below mudline.	3 4
	95									
	100									
	105									
	110									

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

2. Top of Bedrock at 84'.
3. Upon completion, hole backfilled with soil cuttings and sand, asphalt patched/restored.
4. Boring logged by the driller. Some soil descriptions editted by Jacobs.

Appendix D. Laboratory Test Results

THIELSCH ENGINEERING	195 Frances Avenue Cranston RI, 02910 Phone: (401)-467-6454 Fax: (401)-467-2398 thielsch.com *Let's Build a Solid Foundation*	Clie Jack E I Assig Colle

LABORATORY TESTING DATA

Boring ID	Sample No. / Material	Depth (Ft)	Laboratory No.	Identification Tests								
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pc
				D2216	D4318		D6913			D2974	D854	
B-1	S7A	19-21	19-S-2340	30.7	40	19						
B-2A	S5	19-21	19-S-2341	31.1	48	22						
B-3	S6	29-31	19-S-2342	32.2	40	20						
B-4	S7	29-31	19-S-2343	24.7	40	20						
B-6	S5	19-21	19-S-2344	34.5	45	22						
B-6	S11	49-51	19-S-2345	10.9	NV	NP						
B-1	S16	64-64.5	19-S-2346	10.4			28.9	39.7	31.4			
B-2A	S4	14-16	19-S-2347	10.4			36.8	52.3	10.9			
B-3	S8	39-40.4	19-S-2348	11.6			34.3	53.7	12.0			
B-4	S9	39-41	19-S-2349	17.9			22.4	39.0	38.6			

Date Received: *10.22.19*

Reviewed By:

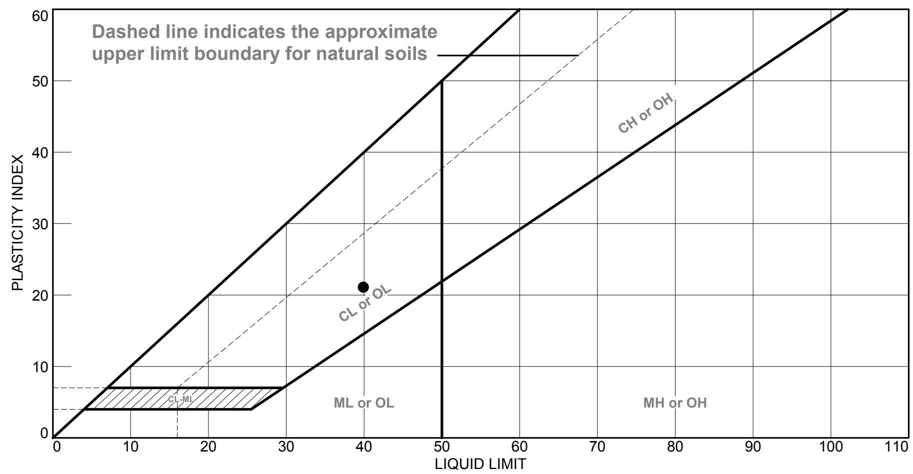
nt Information:	Project Information:	
s Engineering	**Hoosac Building**	
Boston, MA	**Boston, Ma**	
PM: Da Ha	Jacobs Project Number: FDZE6000	
gned By: Da Ha	Summary Page:	1 of 2
cted By: Jacobs	Report Date:	10.30.19

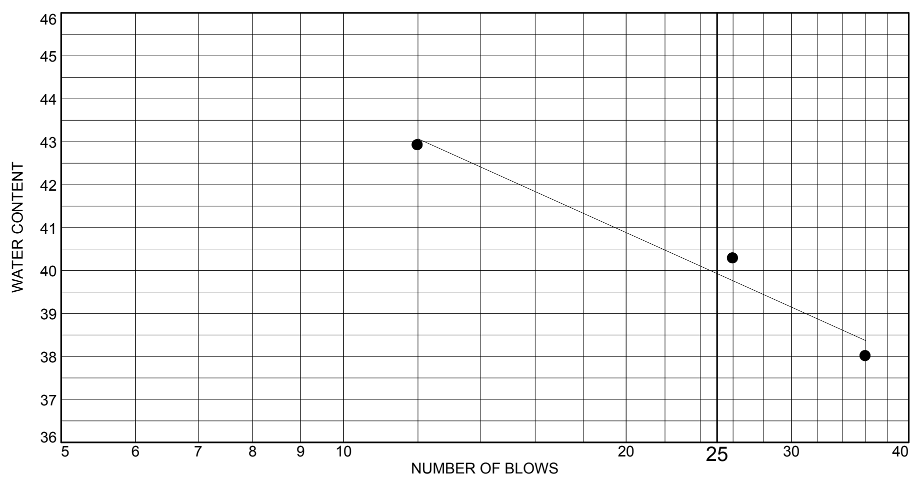
SHEET, Report No.: 7419-K-204

Proctor / CBR / Permeability Tests								
cf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	Laboratory Log and Soil Description
		D1557						
								Gray lean clay
								Gray lean clay
								Gray lean clay
								Gray lean clay
								Gray lean clay
								Gray silt
								Gray silty sand with gravel
								Dark Brown poorly graded sand with silt and gravel
								Gray poorly graded sand with silt and gravel
								Gray silty sand with gravel

Date Reviewed: 10.31.19

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	40	19	21			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-1 **Depth:** 19-21'

Sample Number: S7A

Remarks:

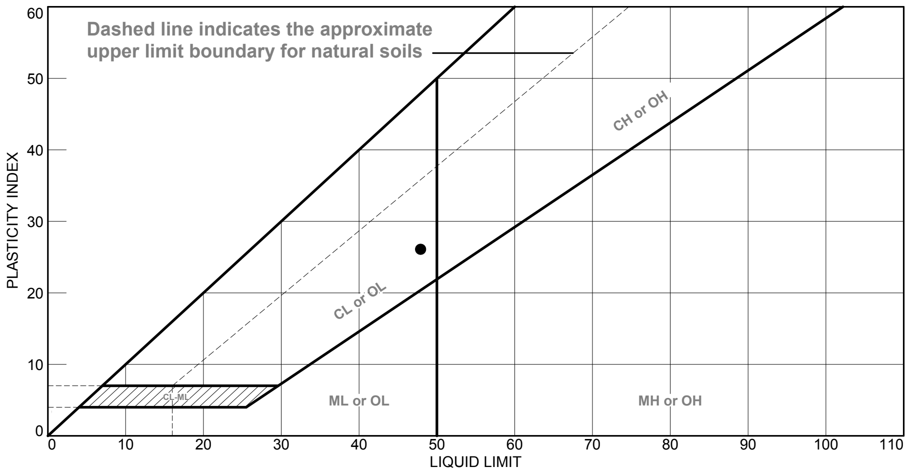
Thielsch Engineering Inc.

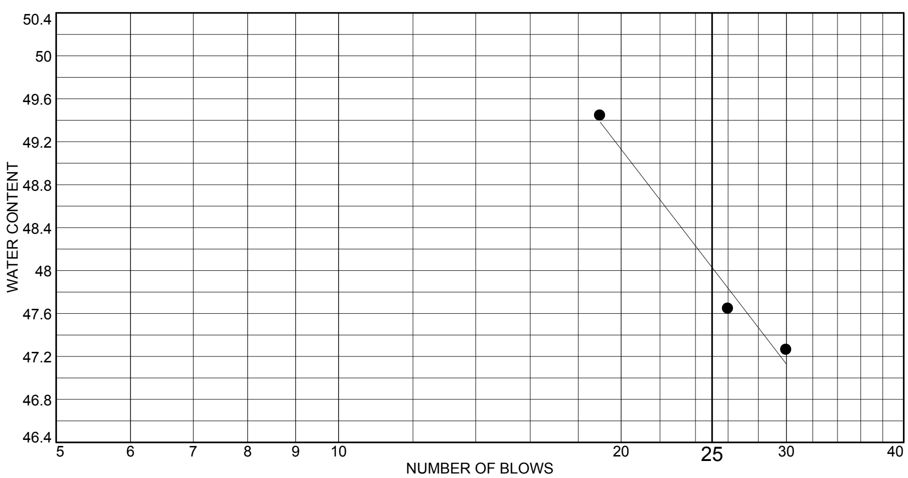
Cranston, RI

Figure 19-L-2340

Tested By: IA **Checked By:** SA

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	48	22	26			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-2A **Depth:** 19-21'

Sample Number: S5

Remarks:

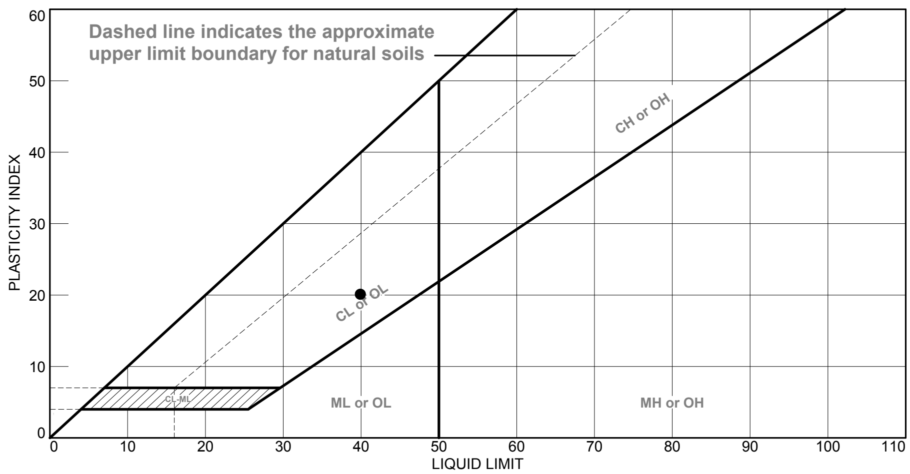
Thielsch Engineering Inc.

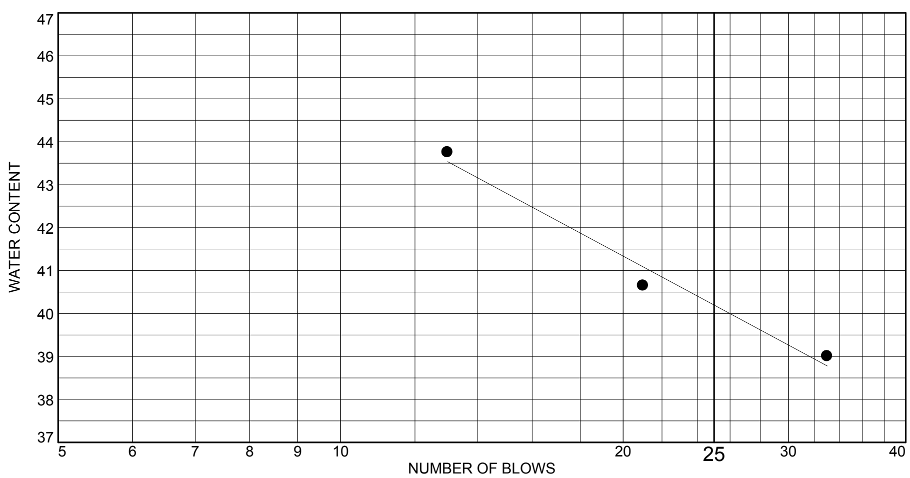
Cranston, RI

Figure 19-L-2341

Tested By: IA **Checked By:** SA

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	40	20	20			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-3 **Depth:** 29-31'

Sample Number: S6

Remarks:

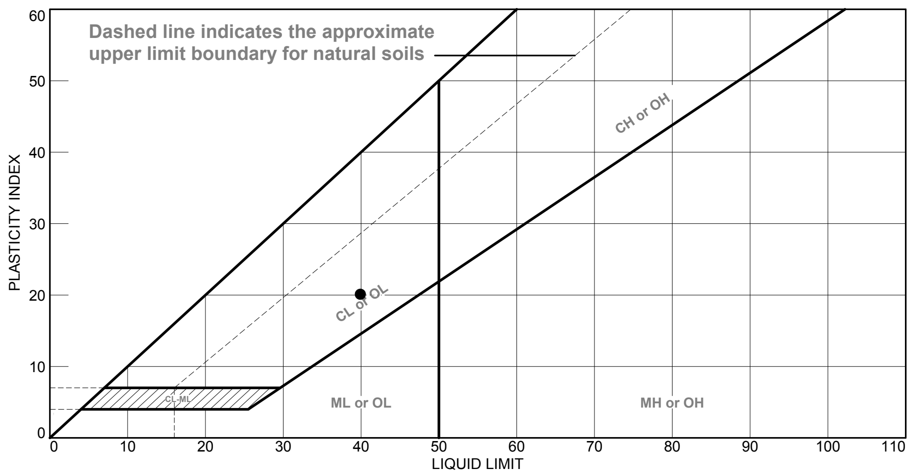
Thielsch Engineering Inc.

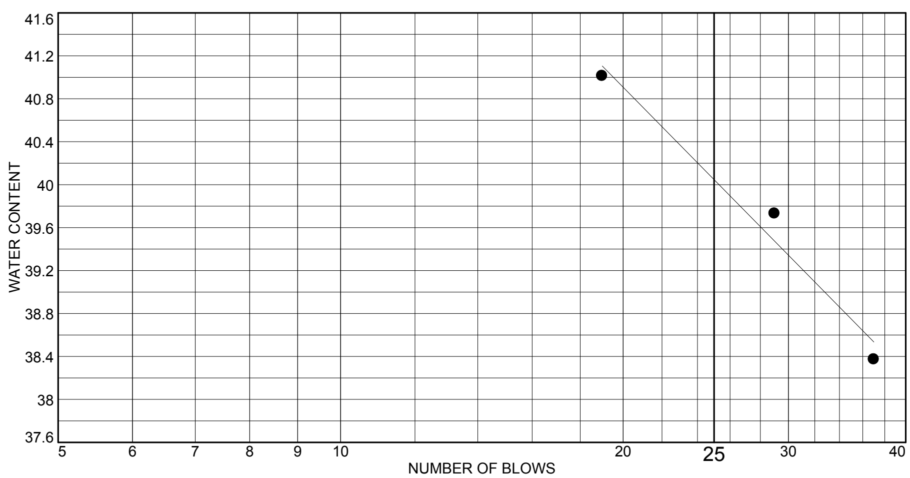
Cranston, RI

Figure 19-L-2342

Tested By: IA **Checked By:** SA

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	40	20	20			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-4 **Depth:** 29-31'

Sample Number: S7

Remarks:

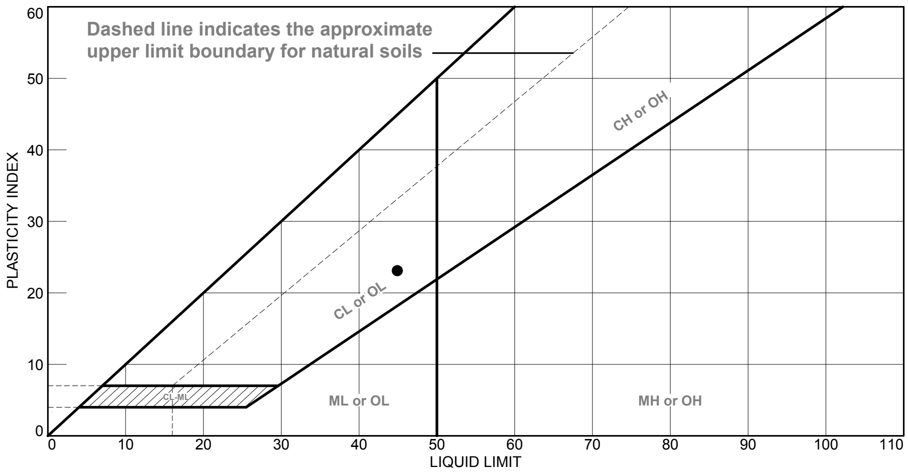
Thielsch Engineering Inc.

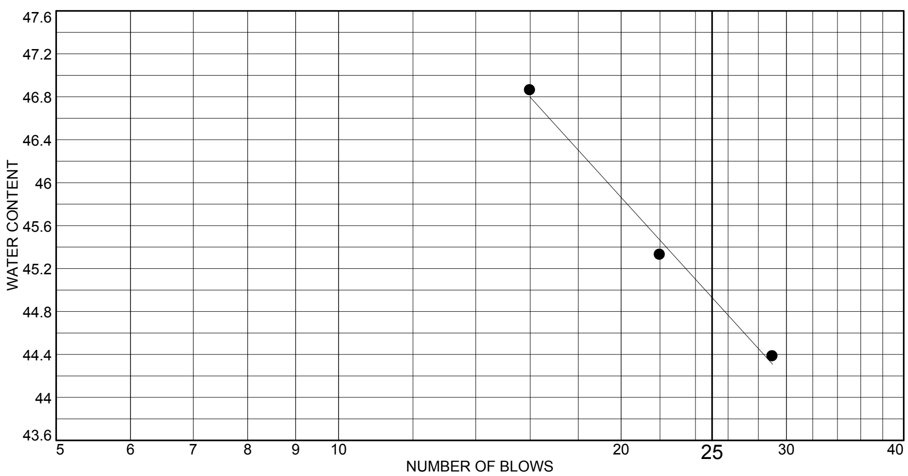
Cranston, RI

Figure 19-L-2343

Tested By: IA **Checked By:** SA

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	45	22	23			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-6 **Depth:** 19-21'

Sample Number: S5

Remarks:

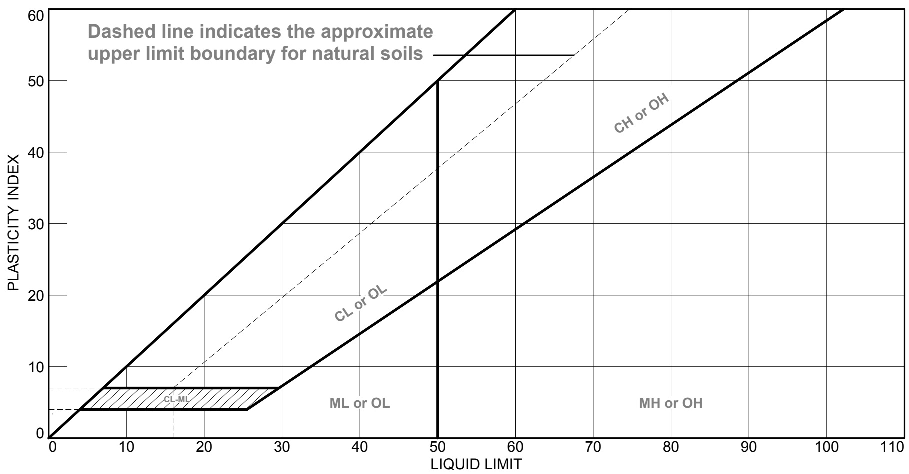
Thielsch Engineering Inc.

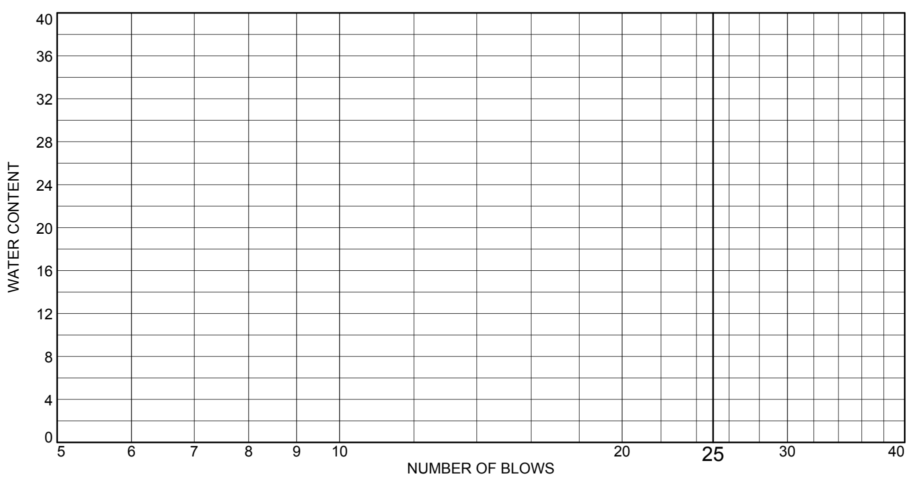
Cranston, RI

Figure 19-L-2344

Tested By: IA **Checked By:** SA

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray silt	NV	NP	NP			

Project No. FDZE6000 **Client:** Jacobs Engineering

Project: Hoosac Building

Boston, MA

Source of Sample: B-6 **Depth:** 49-51'

Sample Number: S11

Thielsch Engineering Inc.

Cranston, RI

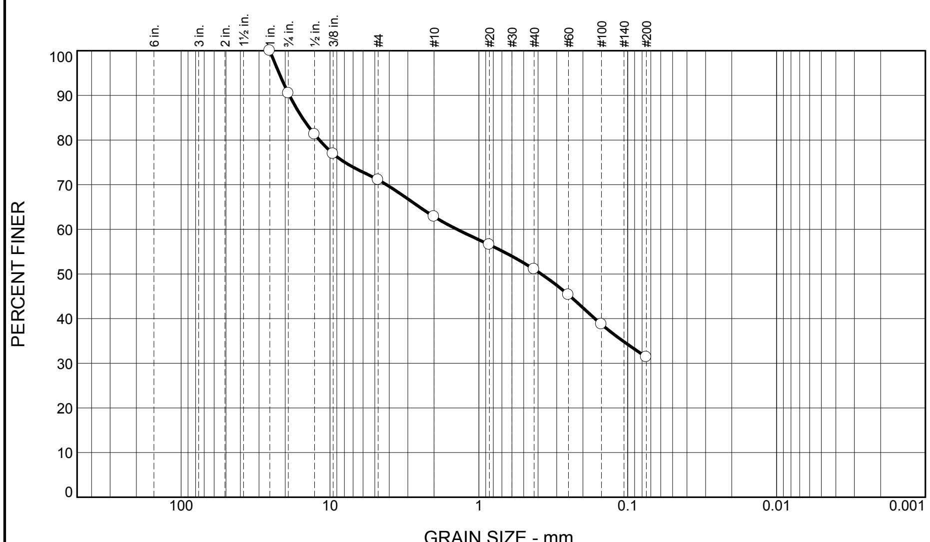
Remarks:

●Sample could not be rolled to a 1/4" diameter.

Figure 19-L-2345

Tested By: IA **Checked By:** SA

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.5	19.4	8.3	11.8	19.6	31.4	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	90.5		
0.5"	81.3		
0.375"	76.9		
#4	71.1		
#10	62.8		
#20	56.5		
#40	51.0		
#60	45.3		
#100	38.7		
#200	31.4		

* (no specification provided)

Material Description

Gray silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 18.7456 D_{85}= 15.3564 D_{60}= 1.4012
D_{50}= 0.3810 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 10.22.19 **Date Tested:** 10.29.19

Tested By: IA / RR / LR

Checked By: Steven Accetta

Title: Laboratory Coordinator

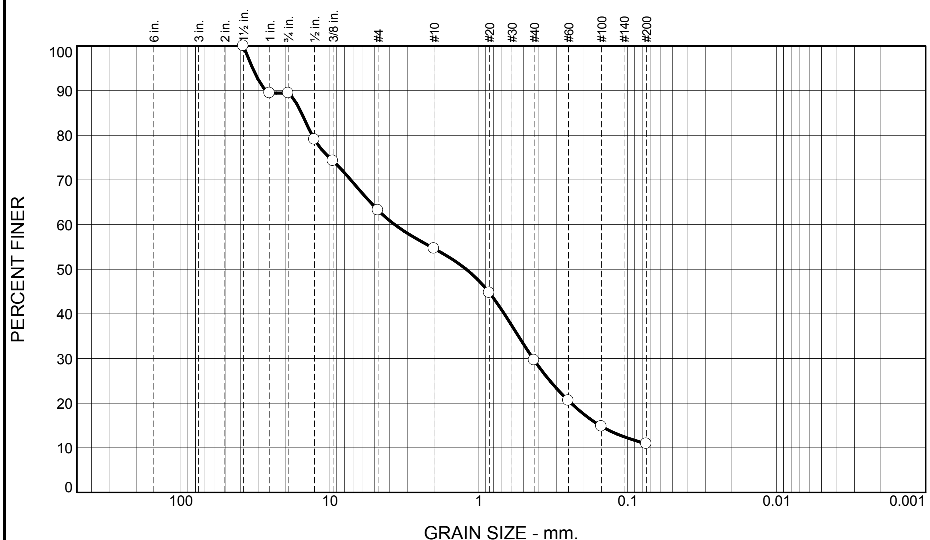
Source of Sample: B-1 **Depth:** 64-64.5' **Date Sampled:**
Sample Number: S16

Thielsch Engineering Inc.

Cranston, RI

Client: Jacobs Engineering
Project: Hoosac Building
Boston, MA
Project No: FDZE6000 **Figure** 19-S-2346

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.5	26.3	8.6	25.0	18.7	10.9	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	89.5		
3/4"	89.5		
1/2"	79.0		
3/8"	74.3		
#4	63.2		
#10	54.6		
#20	44.7		
#40	29.6		
#60	20.6		
#100	14.8		
#200	10.9		

* (no specification provided)

Material Description

Dark Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 26.8338 D_{85}= 15.5373 D_{60}= 3.6710
D_{50}= 1.2158 D_{30}= 0.4328 D_{15}= 0.1536
D_{10}= C_u= C_c=

Remarks

Date Received: 10.22.19 **Date Tested:** 10.29.19

Tested By: IA / RR / LR

Checked By: Steven Accetta

Title: Laboratory Coordinator

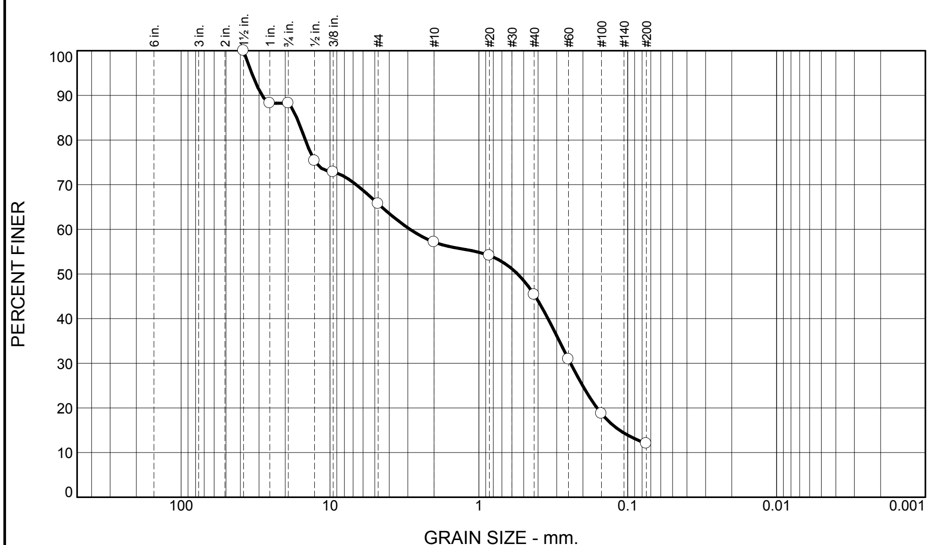
Source of Sample: B-2A **Depth:** 14-16' **Date Sampled:**
Sample Number: S4

Thielsch Engineering Inc.

Cranston, RI

Client: Jacobs Engineering
Project: Hoosac Building
Boston, MA
Project No: FDZE6000 **Figure** 19-S-2347

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.8	22.5	8.6	11.7	33.4	12.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	88.2		
3/4"	88.2		
1/2"	75.4		
3/8"	72.8		
#4	65.7		
#10	57.1		
#20	54.1		
#40	45.4		
#60	30.9		
#100	18.7		
#200	12.0		

* (no specification provided)

Material Description

Gray poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 28.5753 D_{85}= 16.7282 D_{60}= 2.8986
D_{50}= 0.5490 D_{30}= 0.2421 D_{15}= 0.1133
D_{10}= C_u= C_c=

Remarks

Date Received: 10.22.19 **Date Tested:** 10.29.19

Tested By: IA / RR / LR

Checked By: Steven Accetta

Title: Laboratory Coordinator

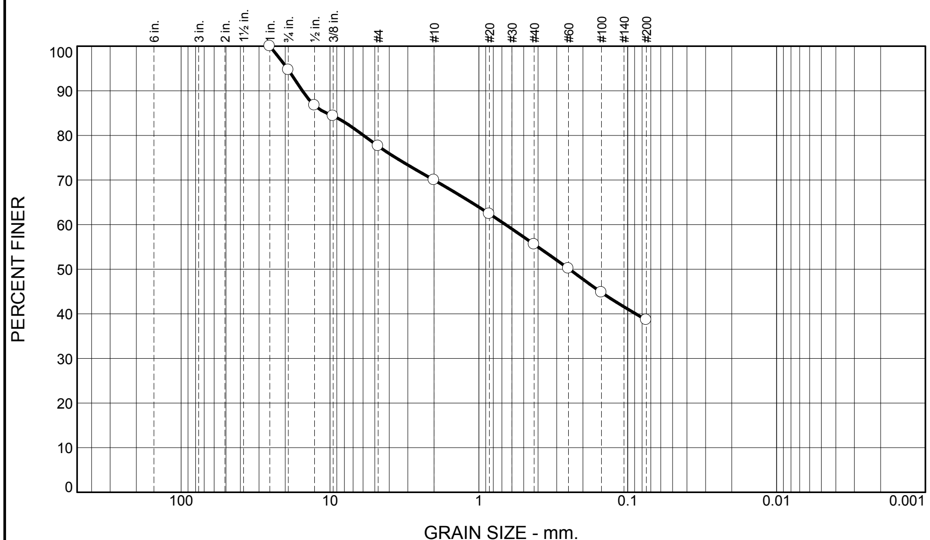
Source of Sample: B-3 **Depth:** 39-40.4' **Date Sampled:**
Sample Number: S8

Thielsch Engineering Inc.

Cranston, RI

Client: Jacobs Engineering
Project: Hoosac Building
Boston, MA
Project No: FDZE6000 **Figure** 19-S-2348

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.3	17.1	7.6	14.4	17.0	38.6	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	94.7		
0.5"	86.7		
0.375"	84.4		
#4	77.6		
#10	70.0		
#20	62.4		
#40	55.6		
#60	50.2		
#100	44.8		
#200	38.6		

* (no specification provided)

Material Description

Gray silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 15.3257 D_{85}= 10.5069 D_{60}= 0.6615
D_{50}= 0.2464 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 10.22.19 **Date Tested:** 10.29.19

Tested By: IA / RR / LR

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: B-4 **Depth:** 39-41' **Date Sampled:**
Sample Number: S9

Thielsch Engineering Inc.

Cranston, RI

Client: Jacobs Engineering
Project: Hoosac Building
Boston, MA
Project No: FDZE6000 **Figure** 19-S-2349

THIELSCH ENGINEERING

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Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

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LABORATORY TESTING DATA

Boring ID	Sample No.	Depth (ft)	Laboratory No.	Identification Tests: As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Resitivity (Mohms-cm)	Sulfate (mg/kg)
				D2216	D4318		D6913				
B-1	S-5	9-11	19-S-2351							0.0005	215
B-2A	S-3	9-11	19-S-2352							0.0003	323
B-3	S-2	9-10.6	19-S-2353							0.001	210
B-4	S-3	9-11	19-S-2354							0.0002	316
B-6	S-3	9-11	19-S-2356							0.0008	162

Date Received: *10.22.19*

Reviewed By:

nt Information:	Project Information:
bs Engineering	**Hoosac Building**
Boston, MA	**Boston, MA**
PM: Da Ha	Jacobs Project Number: FDZE6000
gned By: Da Ha	Summary Page: 2 of 2
ected By: Jacobs	Report Date: 10.31.19

SHEET, Report No.: 7419-K-205

Corrosivity Tests						Laboratory Log and Soil Description
Chloride (mg/kg)	Sulfide (mg/kg)	Redox Potential (mv)	pH	Electrical Resist. As Received Ohm-cm @ 60°F	Electrial Resist. Saturated Ohm-cm @ 60°F	
EPA				G57		
539			7.08			Corrosivity Only
960			7.91			Corrosivity Only
217			8.51			Corrosivity Only
1740			7.68			Corrosivity Only
525			7.18			Corrosivity Only

Date Reviewed: *10.31.19*

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CERTIFICATE OF ANALYSIS

Steve Accetta
Thielsch Engineering, Inc.
195 Frances Avenue
Cranston, RI 02910

RE: Hoosac Building - Jacobs Engineering (FDZE6000)
ESS Laboratory Work Order Number: 19J0831

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering

ESS Laboratory Work Order: 19J0831

SAMPLE RECEIPT

The following samples were received on October 23, 2019 for the analyses specified on the enclosed Chain of Custody Record.

The client did not deliver the samples in a cooler.

Lab Number	Sample Name	Matrix	Analysis
19J0831-01	B-1 S5	Soil	9038, 9045, 9050A, 9250
19J0831-02	B-2A S3	Soil	9038, 9045, 9050A, 9250
19J0831-03	B-3 S-2	Soil	9038, 9045, 9050A, 9250
19J0831-04	B-4 S-3	Soil	9038, 9045, 9050A, 9250
19J0831-05	B-6 S-3	Soil	9038, 9045, 9050A, 9250

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Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering

ESS Laboratory Work Order: 19J0831

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

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BAL LABORATORY

CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering

ESS Laboratory Work Order: 19J0831

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
Client Sample ID: B-1 S5
Date Sampled: 10/23/19 14:00
Percent Solids: 89

ESS Laboratory Work Order: 19J0831
ESS Laboratory Sample ID: 19J0831-01
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Chloride	**WL 539** (33)		9250		1	JLK	10/24/19 20:27	mg/kg dry	CJ92454
Corrosivity (pH)	**7.08** (N/A)		9045		1	CCP	10/23/19 20:49	S.U.	CJ92336
Corrosivity (pH) Sample Temp	**Soil pH measured in water at 20.5 °C.**								
Resistivity	**WL 0.0005** (N/A)		9050A		1	JLK	10/24/19 19:56	Mohms-cm	CJ92457
Sulfate	**WL 215** (56)		9038		1	EEM	10/26/19 15:05	mg/kg dry	CJ92610

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
Client Sample ID: B-2A S3
Date Sampled: 10/23/19 14:00
Percent Solids: 90

ESS Laboratory Work Order: 19J0831
ESS Laboratory Sample ID: 19J0831-02
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Chloride	**WL 960** (33)		9250		1	JLK	10/24/19 20:28	mg/kg dry	CJ92454
Corrosivity (pH)	**7.91** (N/A)		9045		1	CCP	10/23/19 20:49	S.U.	CJ92336
Corrosivity (pH) Sample Temp	**Soil pH measured in water at 20.5 ºC.**								
Resistivity	**WL 0.0003** (N/A)		9050A		1	JLK	10/24/19 19:56	Mohms-cm	CJ92457
Sulfate	**WL 323** (55)		9038		1	EEM	10/26/19 15:05	mg/kg dry	CJ92610

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
Client Sample ID: B-3 S-2
Date Sampled: 10/23/19 14:00
Percent Solids: 85

ESS Laboratory Work Order: 19J0831
ESS Laboratory Sample ID: 19J0831-03
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Chloride	**WL 217** (35)		9250		1	JLK	10/24/19 20:29	mg/kg dry	CJ92454
Corrosivity (pH)	**8.51** (N/A)		9045		1	CCP	10/23/19 20:49	S.U.	CJ92336
Corrosivity (pH) Sample Temp	**Soil pH measured in water at 20.4 °C.**								
Resistivity	**WL 0.001** (N/A)		9050A		1	JLK	10/24/19 19:56	Mohms-cm	CJ92457
Sulfate	**WL 210** (58)		9038		1	EEM	10/26/19 15:05	mg/kg dry	CJ92610

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
Client Sample ID: B-4 S-3
Date Sampled: 10/23/19 14:00
Percent Solids: 89

ESS Laboratory Work Order: 19J0831
ESS Laboratory Sample ID: 19J0831-04
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Chloride	**WL 1740** (67)		9250		2	JLK	10/24/19 20:40	mg/kg dry	CJ92454
Corrosivity (pH)	**7.68** (N/A)		9045		1	CCP	10/23/19 20:49	S.U.	CJ92336
Corrosivity (pH) Sample Temp	**Soil pH measured in water at 20.8 ºC.**								
Resistivity	**WL 0.0002** (N/A)		9050A		1	JLK	10/24/19 19:56	Mohms-cm	CJ92457
Sulfate	**WL 316** (56)		9038		1	EEM	10/26/19 15:05	mg/kg dry	CJ92610

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
Client Sample ID: B-6 S-3
Date Sampled: 10/23/19 14:00
Percent Solids: 86

ESS Laboratory Work Order: 19J0831
ESS Laboratory Sample ID: 19J0831-05
Sample Matrix: Soil

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Chloride	**WL 525** (35)		9250		1	JLK	10/24/19 20:31	mg/kg dry	CJ92454
Corrosivity (pH)	**7.18** (N/A)		9045		1	CCP	10/23/19 20:49	S.U.	CJ92336
Corrosivity (pH) Sample Temp	**Soil pH measured in water at 20.7 °C.**								
Resistivity	**WL 0.0008** (N/A)		9050A		1	JLK	10/24/19 19:56	Mohms-cm	CJ92457
Sulfate	**WL 162** (58)		9038		1	EEM	10/26/19 15:05	mg/kg dry	CJ92610

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering
ESS Laboratory Work Order: 19J0831

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CJ92454 - General Preparation										
Blank										
Chloride	ND	3	mg/kg wet							
LCS										
Chloride	31		mg/L	30.00		105	90-110			
Batch CJ92610 - General Preparation										
Blank										
Sulfate	ND	5	mg/kg wet							
LCS										
Sulfate	10		mg/L	9.988		96	80-120			

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Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering   ESS Laboratory Work Order: 19J0831

Notes and Definitions

Z-10c	Soil pH measured in water at 20.8 ºC.
Z-10b	Soil pH measured in water at 20.7 ºC.
Z-10a	Soil pH measured in water at 20.5 ºC.
Z-10	Soil pH measured in water at 20.4 ºC.
WL	Results obtained from a deionized water leach of the sample.
U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probably Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

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CERTIFICATE OF ANALYSIS

Client Name: Thielsch Engineering, Inc.
Client Project ID: Hoosac Building - Jacobs Engineering

ESS Laboratory Work Order: 19J0831

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: Thielsch Engineering, Inc - ESS/DS

Shipped/Delivered Via: Client

ESS Project ID: 19J0831
Date Received: 10/23/2019
Project Due Date: 10/30/2019
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about __short holds & rushes__?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:

12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	402968	Yes	NA	Yes	Driller Jar	NP	
02	402967	Yes	NA	Yes	Driller Jar	NP	
03	402966	Yes	NA	Yes	Driller Jar	NP	
04	402965	Yes	NA	Yes	Driller Jar	NP	
05	402964	Yes	NA	Yes	Driller Jar	NP	

2nd Review
Were all containers scanned into storage/lab? Initials
Are barcode labels on correct containers? Yes / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Date & Time: 10/23/19 1809
Reviewed By: Date & Time: 10/23/19 1838
Delivered By: 10/23/19 1838

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ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS LAB PROJECT ID 1950831

Reporting Limits -

Turn Time Standard __X__ Rush____ Approved By: ________

State where samples were collected: MA

Is this project for any of the following: (please circle)
MA-MCP CT-RCP RGP DOD Other________

Electonic Deliverable Yes_X__ No___
Format: Excel___ Access___ PDF_X_ Other____

Project Manager: Steven Accetta
Company: Thielsch Engineering
Address: 195 Frances Ave, Cranston, RI 02910

Project # FDZE6000
Project Name/Client Name: Hoosac Building / Jacobs Engineering
Contract Pricing __x___
Special Pricing WO#: ________

ESS Lab Sample ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample Identification	# of Container	pH	SO_4	Chloride	Resistivity							Comment #
1	10.23.19	14:00	G	S	B-1 / S5	1	X	X	X	X							
2	10.23.19	14:00	G	S	B-2A / S3	1	X	X	X	X							
3	10.23.19	14:00	G	S	B-3 / S-2	1	X	X	X	X							
4	10.23.19	14:00	G	S	B-4 / S-3	1	X	X	X	X							
5	10.23.19	14:00	G	S	B-6 / S-3	1	X	X	X	X							
Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_CH_3OH____							1	1	1	1							
Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA							G	G	G	G							

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present _____Yes X No
Seals Intact _____ Yes _____No NA:_____
Cooler Temperature: 21.8 w ice

Sampled by : Jacobs Engineering

Comments: Please send report to: Rroth@thielsch.com, Saccetta@thielsch.com, mcolman@thielsch.com

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]	10.23.19 3:33 PM	[signature] 10/23/19 1705			

Please E-mail all changes to Chain of Custody in writing.

Page ____ of ____

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THIELSCH ENGINEERING

195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

C
J
A
Co

LABORATORY TESTING DATA

Boring No.	Sample No.	Depth (ft)	Laboratory No.	Specimen Data						
				Mohs Hard-ness	Diameter (in)	Length (in)	(1) Unit Weight (PCF)	(2) Wet Density (PCF)	Bulk G_s	(3) Ot Te
B-1	C-1	84.5-85.1	19-S-2356		1.936	4.731	169.8			
Fresh										
B-6	C-2	87.8-88.3	19-S-2357		1.960	4.644	166.9			
Fresh										
B-6	C-3	90.9-91.4	19-S-2358		1.959	4.658	170.0			
Minor break at 1042 psi was along foliati										

(1) Volume Determined By Measuring Dimensions

(2) Determined by Measuring Dimensions and Weight of Saturated Sample

Notes

(3) PLD=Point Load (diametrical),
PLA= Point Load (Axial) ST= Splitting
U= Unconfined Compressive Strength
(4) Taken at Peak Deviator Stress

Date Received: *10.22.19*

Reviewed By

Client Information:	Project Information:	
acobs Engineering	**Hoosac Building**	
Boston, MA	**Boston, MA**	
PM: Da Ha	Jacob's Project Number: FDZE6000	
ssigned By: Da Ha	Summary Page:	1 of 1
ollected By: Jacobs	Report Date:	10.29.19

A SHEET, Report No.: 7419-K-206

Compressive Strength Tests								
3) her sts	(4) Strength PSI	(5) Strain %	(6) E sec PSI EE+06	(7) Poisson's Ratio	$\sigma\tau$ PSI	Is_{50} PSI	(8) S_c PSI	Rock Formation or Description or Remarks
	9104							Slate
break.								
	3997							Slate
break.								
	4001							Slate
on plane. Major break was a fresh break.								

: Tensile	Notes	(5) Strain at Peak Deviator Stress (6) Represents Secant Modulus at 50% of Total Failure Stress (7) Represents Secant Poisson's Ratio at 50% of Total Failure Stress (8) Estimated UCS from Table 1 of ASTM D5731 for NX cores (Is x 24)

r: ________ Date Reviewed: *10.31.19*

Appendix E. Seismic Site Class Evaluation

JACOBS

120 St. James Avenue
Boston, MA 02116

JOB	Hoosac Building		
SUBJECT	Seismic Site Class		
CALCULATED BY	SM	DATE	10/28/2019
CHECKED BY	DH	DATE	10/29/2019

International Building Code (IBC) 2015 - Seismic Site Class Summary

PURPOSE: Determine the seismic site class for Hoosac Building structures in accordance with the 2015 IBC.

SUBSURFACE INFORMATION: SPT borings performed by New England Boring Contractors, Inc and partially observed by Jacobs Engineering Group in October 2019.

APPROACH:

1) Determine Site Class in accordance with Chapter 20 of ASCE 7-10 as specified by IBC 2015

a) Check for three categories of Site Class F requiring site-specific evaluation:
- Peats or highly organic clays greater than 10 feet in thickness
- Thick layers (greater than 25 feet) of high plastic clay (PI > 75)
- Very thick soft/medium stiff clays (greater than 120 feet)

b) Categorize the site using one of the V_s, N and s_u methods.

c) Determine the appropriate Site Class based on the boring-specific results.

2) Determine site coefficients and response parameters in accordance with Section 1613 of the 2015 IBC

SITE CLASS RESULTS PER BORING:

Boring	N_bar	Site Class
B-1	39	D
B-3	53	C
B-4	23	D
B-6	6	E

SITE CLASS: Borings (B-1 and B-4) indicate Site Class D, boring B-3 indicates Site Class C and boring B-6 incidates Site Class E.
Therefore, we recommend the site be classified as Site Class E to be conservative.

Approx. Project Coordinates

Lat 42.372
Long -71.058

Seismic Coefficients (975-Year Return Period) - Per MA State Bldg Code Amendments to IBC- 9th edition

S_S = 0.217 g (Probabilistic Seismic Hazard Deaggregation 0.2-sec period)
S_1 = 0.069 g (Probabilistic Seismic Hazard Deaggregation 1.0-sec period)

Site Coefficient For Site Class E

F_A = 2.5 (See IBC 2015 Table 1613.3.3(1))
F_V = 3.5 (See IBC 2015 Table 1613.3.3(2))

Maximum Spectral Response Acceleration Parameters

$Sm_S = Ss \times F_A$ = 0.543 (IBC 2015 Eq. 16-37)
$Sm_1 = S_1 \times F_V$ = 0.242 (IBC 2015 Eq. 16-38)

Design Spectral Response Acceleration Parameters

$S_{DS} = 2/3\ Sm_s$ = 0.362 (IBC 2015 Eq. 16-39)
$S_{D1} = 2/3\ Sm_1$ = 0.161 (IBC 2015 Eq. 16-40)

Risk Category
III (IBC 2015 Table 1604.5)

Seismic Design Category (SDC)
C (IBC 2015 Tables 1613.3.5(1) and 1613.3.5(2))

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JACOBS

120 St. James Avenue
Boston, MA 02116

JOB	Hoosac Building		
SUBJECT	Seismic Site Class		
CALCULATED BY	SM	DATE	10/28/2019
CHECKED BY	DH	DATE	10/29/2019

ASCE 7-10 Chapter 20

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: —Plasticity index $PI > 20$, —Moisture content $w \geq 40\%$, —Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

2015 IBC - Section 1613

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a [a]

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s.
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_V [a]

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1.
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

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JACOBS

120 St. James Avenue
Boston, MA 02116

JOB	Hoosac Building		
SUBJECT	Seismic Site Class		
CALCULATED BY	SM	DATE	10/28/2019
CHECKED BY	DH	DATE	10/29/2019

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATIONS

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

TABLE 1604.5
RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing elementary school, secondary school or day care facilities with an occupa load greater than 250. • Buildings and other structures containing adult education facilities, such as colleges and universities, with an occupant load greater than 500. • Group I-2 occupancies with an occupant load of 50 or more resident care recipients but not having surgery or emergency treatment facilities. • Group I-3 occupancies. • Any other occupancy with an occupant load greater than 5,000[a]. • Power-generating stations, water treatment facilities for potable water, waste water treatment facilities and other public utility facilities not included in Risk Category IV. • Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released [b].
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Group I-2 occupancies having surgery or emergency treatment facilities. • Fire, rescue, ambulance and police stations and emergency vehicle garages. • Designated earthquake, hurricane or other emergency shelters. • Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures. • Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and Are sufficient to pose a threat to the public if released [b]. • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water storage facilities and pump structures required to maintain water pressure for fire suppression.

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JACOBS

120 St. James Avenue
Boston, MA 02116

JOB	Hoosac Building
SUBJECT	Seismic Site Class
CALCULATED BY	SM
DATE	10/28/2019
CHECKED BY	DH
DATE	10/29/2019

Table 1604.11 - Mass Building Code 9th Edition

	SNOW LOADS		BASIC WIND SPEED, V_{ult} (mph)			SEISMIC PARAMETERS (g)	
City/Town	Ground Snow Load, P_g (psf)	Minimum Flat Roof Snow Load, P_f^1 (psf)	Risk Category I	Risk Category II	Risk Category III or IV	S_s	S_1
Ashfield	50	40	105	115	120	0.170	0.067
Ashland	40	35	116	127	137	0.190	0.066
Athol	60	35	106	117	125	0.183	0.069
Attleboro	35	30	122	132	143	0.181	0.063
Auburn	50	35	114	125	135	0.177	0.065
Avon	35	35	121	131	142	0.196	0.065
Ayer	50	35	111	122	132	0.212	0.071
Barnstable	30	25	132	140	152	0.152	0.055
Barre	50	35	109	120	130	0.180	0.067
Becket[2]	60	40	105	115	120	0.168	0.066
Bedford	50	30	115	125	136	0.221	0.071
Belchertown	40	35	109	119	129	0.173	0.066
Bellingham	40	35	118	129	139	0.181	0.064
Belmont	40	30	117	127	138	0.215	0.070
Berkley	30	30	125	135	146	0.181	0.061
Berlin	50	35	113	124	134	0.193	0.068
Bernardston	60	35	105	115	120	0.176	0.069
Beverly	50	30	117	127	138	0.245	0.073
Billerica	50	30	114	124	135	0.229	0.073
Blackstone	40	35	119	129	140	0.177	0.063
Blandford	50	40	105	116	122	0.171	0.065
Bolton	50	35	113	123	134	0.199	0.069
Boston	40	30	118	128	139	0.217	0.069
Bourne	30	25	130	139	150	0.168	0.058
Boxborough	50	35	113	123	134	0.208	0.070
Boxford	50	30	115	125	136	0.252	0.075
Boylston	50	35	113	123	134	0.191	0.068
Braintree	35	30	120	131	142	0.203	0.066
Brewster	25	25	132	140	152	0.147	0.054
Bridgewater	30	30	124	134	145	0.188	0.063
Brimfield	40	35	112	123	133	0.173	0.065
Brockton	35	30	122	132	143	0.193	0.064
Brookfield	50	35	112	122	132	0.174	0.065
Brookline	40	30	118	128	139	0.211	0.068
Buckland[2]	60	40	105	115	120	0.171	0.068
Burlington	50	30	115	125	136	0.227	0.072
Cambridge	40	30	117	128	139	0.216	0.069
Canton	40	35	120	130	141	0.195	0.065

Proposed 9th Edition of 780 CMR (Base Volume & Special Regulations)

ATTACHMENTS: Refer to the attached calculation sheets for further information.

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JACOBS

Hoosac Building - Seismic Site Class - Nbar.xls

Authored by: SM 10/28/2019
Checked by: DH 10/29/2019

Hoosac Building - Site Class Evaluation

Boring No.	Sample No.	N Value	Di	Di/N_i	N_{bar}
B-1	S-1	10	3	0.30	**39**
	S-2	11	2	0.18	
	S-3	19	2	0.11	
	S-4	7	2	0.29	
	S-5	27	5	0.19	
	S-6	80	5	0.06	
	S-7	28	5	0.18	
	S-8	21	5	0.24	
	S-9	19	5	0.26	
	S-10	30	5	0.17	
	S-11	100	5	0.05	
	S-12	100	5	0.05	
	S-13	100	5	0.05	
	S-14	100	5	0.05	
	S-15	100	5	0.05	
	S-16	100	5	0.05	
	S-17	100	5	0.05	
	S-18	100	5	0.05	
	S-19	100	5	0.05	
	Bedrock	100	16	0.16	
	Total Depth =	100	Σ	2.58	
	Depth to Rock =	84			

N = Σ Di / Σ(Di/Ni) = 100 / 2.58 = **39**

Per Table 9-1-6, 15 ≤ N_{bar} ≤ 50, Site Class D

1 of 1

JACOBS

Hoosac Building - Seismic Site Class - Nbar.xls

Authored by: SM 10/28/2019
Checked by: DH 10/29/2019

Hoosac Building - Site Class Evaluation

Boring No.	Sample No.	N Value	Di	D_i/N_i	N_{bar}
B-3	S-1	42	9	0.21	
	S-2	30	5	0.17	
	S-3	32	5	0.16	
	S-4	19	5	0.26	
	S-5	26	5	0.19	
	S-6	28	5	0.18	
	S-7	54	5	0.09	
	S-8	100	44	0.44	**53**
	Bedrock	100	17	0.17	
	Total Depth =	100	Σ	1.87	
	Depth to Rock =	83			

N = Σ Di / Σ(Di/Ni) = 100 / 1.87 = **53**

Per Table 9-1-6, N_{bar} > 50, Site Class C

1 of 1

JACOBS

Hoosac Building - Seismic Site Class - Nbar.xls

Authored by: SM 10/28/2019
Checked by: DH 10/29/2019

Hoosac Building - Site Class Evaluation

Boring No.	Sample No.	N Value	Di	Di/N_i	N_{bar}
B-4	S-1	100	4	0.04	
	S-2	46	5	0.11	
	S-3	42	5	0.12	
	S-4	6	5	0.83	
	S-5	12	5	0.42	
	S-6	9	5	0.56	
	S-7	11	5	0.45	
	S-8	12	5	0.42	**23**
	S-9	27	5	0.19	
	S-10	29	5	0.17	
	S-11	35	30	0.86	
	Bedrock	100	21	0.21	
	Total Depth =	100	Σ	4.37	
	Depth to Rock =	79			

N = Σ Di / Σ(Di/Ni) = 100 / 4.37 = **23**

Per Table 9-1-6, 15 ≤ N_{bar} ≤ 50, Site Class D

1 of 1

Hoosac Building - Seismic Site Class - Nbar.xls

Authored by: SM 10/28/2019
Checked by: DH 10/29/2019

Hoosac Building - Site Class Evaluation

Boring No.	Sample No.	N Value	Di	D_i/N_i	N_{bar}
B-6	S-1	18	4	0.22	
	S-2	6	5	0.83	
	S-3	16	5	0.31	
	S-4	8	5	0.63	
	S-5	5	5	1.00	
	S-6	5	5	1.00	
	S-7	1	5	5.00	
	S-8	4	5	1.25	**6**
	S-9	2	5	2.50	
	S-10	6	5	0.83	
	S-11	6	5	0.83	
	S-12	12	30	2.50	
	Bedrock	100	16	0.16	
	Total Depth =	100	Σ	17.07	
	Depth to Rock =	84			

N = Σ Di / Σ(Di/Ni) = 100 / 5.86 = **6**

Per Table 9-1-6, 15> N_{bar} Site Class E

1 of 1

The Hoosac Building 1 & 2 Structural & Geotechnical Report

JACOBS

Appendix F. Liquefaction Analysis

Calculated By: SM Date: 10/28/19
Checked by: DH Date 10/29/19

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== B-1
ELEVATION OF BORING GROUND SURFACE ========================= 13.0 FT. (NAVD88, assumed)
DEPTH TO GROUNDWATER - DURING DRILLING ===================== 10.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (PGA_M) == 0.278
EARTHQUAKE MOMENT MAGNITUDE =============================== 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ============== 0.00 FT.
HAMMER EFFICIENCY== 60 %
BOREHOLE DIAMETER== 2.5 to 4.5 IN.
SAMPLING METHOD== 1-3/8 inch ID

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.958**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **831** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.56
Source-To-Site Distance, R (km) = 31.83
Ground Motion Prediction Equations =
PGA = **0.118**

ELEV. OF SAMPLE (FT.)	BORING DATA: BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	CONDITIONS DURING DRILLING: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	CONDITIONS DURING EARTHQUAKE: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
11	2	10		5				0.118	0.236	12.583	12.583	0.137	0.118	0.236	0.236	1.500	**0.401**	1.000	**0.181**	**N.L. (1)**
9	4	11		5				0.119	0.474	12.750	12.750	0.138	0.119	0.474	0.474	1.451	**0.393**	0.999	**0.181**	**N.L. (1)**
7	6	19		5				0.126	0.726	20.325	20.325	0.219	0.126	0.726	0.726	1.373	**0.590**	0.998	**0.181**	**N.L. (1)**
5	8	7		5				0.114	0.954	7.171	7.171	0.089	0.114	0.954	0.954	1.186	**0.207**	0.997	**0.180**	**N.L. (1)**
3	10	27		5				0.130	1.214	27.309	27.309	0.347	0.130	1.214	1.214	1.208	**0.822**	0.996	**0.180**	**N.L. (1)**
-2	15	80		5				0.080	1.614	80.143	80.143	0.567	0.080	1.614	1.926	1.115	**1.239**	0.992	**0.214**	**N.L. (3)**
-7	20	28		75				0.070	1.964	27.074	37.489	-0.014	0.070	1.964	2.588	1.031	**-0.028**	0.986	**0.235**	**N.L. (3)**
-12	25	21		90				0.068	2.304	19.313	28.176	0.376	0.068	2.304	3.240	0.972	**0.715**	0.976	**0.248**	**2.883 (D)**
-17	30	19		90				0.067	2.639	16.542	24.851	0.289	0.067	2.639	3.887	0.931	**0.527**	0.961	**0.256**	**2.059 (D)**
-22	35	30		90				0.071	2.994	24.635	34.561	-1.530	0.071	2.994	4.554	0.876	**-2.623**	0.938	**0.258**	**-10.167 (D)**
-26.5	39.5	100		90				0.083	3.279	78.548	99.257	0.715	0.083	3.279	5.119	0.840	**1.176**	0.911	**0.257**	**N.L. (3)**
-31.5	44.5	100		75				0.083	3.694	73.739	93.487	0.671	0.083	3.694	5.846	0.801	**1.052**	0.875	**0.251**	**N.L. (3)**
-36.2	49.2	100		15				0.083	4.084	69.719	75.570	0.531	0.083	4.084	6.530	0.769	**0.800**	0.838	**0.242**	**N.L. (3)**
-41.6	54.6	100		15				0.083	4.532	65.558	71.209	0.496	0.083	4.532	7.315	0.738	**0.716**	0.797	**0.233**	**N.L. (3)**
-46.2	59.2	100		15				0.083	4.914	62.322	67.818	0.468	0.083	4.914	7.984	0.714	**0.655**	0.767	**0.225**	**N.L. (3)**
-51.3	64.3	100		15				0.083	5.337	59.023	64.360	0.439	0.083	5.337	8.725	0.691	**0.594**	0.742	**0.219**	**N.L. (3)**
-56.2	69.2	100		15				0.083	5.744	56.135	61.333	0.413	0.083	5.744	9.438	0.671	**0.543**	0.688	**0.205**	**N.L. (3)**
-61.2	74.2	100		25				0.083	6.159	53.481	63.920	0.435	0.083	6.159	10.165	0.653	**0.556**	0.681	**0.204**	**N.L. (3)**
-66.2	79.2	100		15				0.083	6.574	51.126	56.083	0.365	0.083	6.574	10.892	0.636	**0.455**	0.674	**0.202**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI ≥ 12 OR w_c/LL ≤ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

10/29/2019 Liquefaction Analysis - Hoosac Building.xls

Calculated By: SM Date: 10/28/19
Checked by: DH Date 10/29/19

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ====================================B-2/B-2A
ELEVATION OF BORING GROUND SURFACE ========================= 13.0 FT. (NAVD88, assumed)
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 10.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (PGA_M) == 0.278
EARTHQUAKE MOMENT MAGNITUDE ================================ 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 0.00 FT.
HAMMER EFFICIENCY== 60 %
BOREHOLE DIAMETER==2.5 to 4.5 IN.
SAMPLING METHOD==1-3/8 inch ID

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.951**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **1057** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.56
Source-To-Site Distance, R (km) = 31.83
Ground Motion Prediction Equations =
PGA = **0.118**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
11	2	12		5				0.120	0.240	15.078	15.078	0.161	0.120	0.240	0.240	1.500	**0.471**	1.000	**0.181**	**N.L. (1)**
8	5	33		5				0.132	0.636	36.300	36.300	-0.171	0.132	0.636	0.636	1.500	**-0.499**	1.000	**0.181**	**N.L. (1)**
3	10	45		5				0.136	1.316	44.313	44.313	0.226	0.136	1.316	1.316	1.210	**0.535**	1.000	**0.181**	**N.L. (1)**
-2	15	61		5				0.078	1.706	59.786	59.786	0.399	0.078	1.706	2.018	1.091	**0.849**	1.000	**0.214**	**N.L. (3)**
-7	20	26		90				0.069	2.051	24.664	34.597	-1.423	0.069	2.051	2.675	1.013	**-2.811**	0.999	**0.236**	**-11.911 (D)**
-12	25	27		90				0.070	2.401	24.344	34.213	-4.441	0.070	2.401	3.337	0.953	**-8.260**	0.999	**0.251**	**-32.908 (D)**
-17	30	30		90				0.071	2.756	25.542	35.651	-0.346	0.071	2.756	4.004	0.902	**-0.610**	0.998	**0.262**	**N.L. (3)**
-21.3	34.3	100		75				0.083	3.113	80.312	101.375	0.731	0.083	3.113	4.629	0.858	**1.223**	0.997	**0.268**	**N.L. (3)**
-26.3	39.3	100		50				0.083	3.528	75.303	95.364	0.685	0.083	3.528	5.356	0.816	**1.090**	0.995	**0.273**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

10/29/2019 Liquefaction Analysis - Hoosac Building.xls

Calculated By: SM Date: 10/28/19
Checked by: DH Date 10/29/19

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== B-3
ELEVATION OF BORING GROUND SURFACE ========================= 13.0 FT. (NAVD88, assumed)
DEPTH TO GROUNDWATER - DURING DRILLING ===================== 10.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (PGA_M) == 0.278
EARTHQUAKE MOMENT MAGNITUDE ================================ 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ============== 0.00 FT.
HAMMER EFFICIENCY=== 60 %
BOREHOLE DIAMETER=== 2.5 to 4.5 IN.
SAMPLING METHOD=== 1-3/8 inch ID

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.951**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **991** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.56
Source-To-Site Distance, R (km) = 31.83
Ground Motion Prediction Equations =
PGA = **0.118**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
8	5	42		5				0.135	0.675	45.640	45.640	0.247	0.135	0.675	0.675	1.500	**0.724**	1.000	**0.181**	**N.L. (1)**
3	10	30		5				0.131	1.330	29.435	29.435	0.433	0.131	1.330	1.330	1.179	**0.995**	0.999	**0.181**	**N.L. (1)**
-2	15	32		5				0.071	1.685	31.519	31.519	0.632	0.071	1.685	1.997	1.088	**1.341**	0.999	**0.214**	**N.L. (3)**
-7	20	19		90				0.067	2.020	18.146	26.776	0.332	0.067	2.020	2.644	1.016	**0.659**	0.998	**0.236**	**2.792 (D)**
-12	25	26		90				0.069	2.365	23.615	33.338	1.752	0.069	2.365	3.301	0.960	**3.279**	0.997	**0.252**	**13.012 (D)**
-17	30	28		90				0.070	2.715	24.026	33.831	6.150	0.070	2.715	3.963	0.910	**10.919**	0.994	**0.263**	**41.517 (D)**
-21.9	34.9	54		50				0.076	2.652	47.251	61.701	0.416	0.076	2.652	4.206	0.914	**0.742**	0.990	**0.284**	**N.L. (3)**
-26.7	39.7	100		5				0.083	3.051	81.764	81.764	0.580	0.083	3.051	4.904	0.865	**0.978**	0.985	**0.286**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI ≥ 12 OR w_c/LL ≤ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Calculated By: SM Date: 10/28/19
Checked by: DH Date 10/29/19

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ====================================== B-4
ELEVATION OF BORING GROUND SURFACE ========================= 10.0 FT. (NAVD88, assumed)
DEPTH TO GROUNDWATER - DURING DRILLING ===================== 7.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 7.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (PGA_M) == 0.278
EARTHQUAKE MOMENT MAGNITUDE ================================ 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ============== 0.00 FT.
HAMMER EFFICIENCY== 60 %
BOREHOLE DIAMETER== 2.5 to 4.5 IN.
SAMPLING METHOD== 1-3/8 inch ID

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.951**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **640** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.56
Source-To-Site Distance, R (km) = 31.83
Ground Motion Prediction Equations =
PGA = **0.118**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
9.3	0.7	100		5				0.147	0.103	127.500	127.500	0.929	0.147	0.103	0.103	1.500	**2.718**	0.999	**0.181**	**N.L. (1)**
5	5	46		5				0.137	0.692	49.724	49.724	0.300	0.137	0.692	0.692	1.500	**0.878**	0.990	**0.179**	**N.L. (1)**
0	10	42		5				0.074	1.062	44.272	44.272	0.226	0.074	1.062	1.249	1.319	**0.581**	0.973	**0.207**	**N.L. (3)**
-5	15	6		90				0.057	1.347	6.423	12.708	0.138	0.057	1.347	1.846	1.119	**0.301**	0.948	**0.235**	**1.281 (C)**
-10	20	12		90				0.063	1.662	12.436	19.924	0.214	0.063	1.662	2.473	1.074	**0.449**	0.912	**0.245**	**1.833 (D)**
-15	25	9		90				0.060	1.962	8.905	15.686	0.167	0.060	1.962	3.085	1.021	**0.333**	0.862	**0.245**	**1.359 (C)**
-20	30	11		90				0.062	2.272	10.307	17.368	0.185	0.062	2.272	3.707	0.981	**0.354**	0.802	**0.237**	**1.494 (C)**
-25	35	12		90				0.063	2.587	10.635	17.763	0.189	0.063	2.587	4.334	0.946	**0.349**	0.737	**0.223**	**1.565 (C)**
-30	40	27		90				0.070	2.937	22.543	32.051	0.746	0.070	2.937	4.996	0.887	**1.290**	0.676	**0.208**	**6.202 (D)**
-35	45	29		15				0.071	3.292	22.868	26.466	0.324	0.071	3.292	5.663	0.863	**0.546**	0.624	**0.194**	**2.814 (D)**
-40	50	35		15				0.072	3.652	26.119	29.874	0.459	0.072	3.652	6.335	0.824	**0.738**	0.586	**0.184**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

10/29/2019 Liquefaction Analysis - Hoosac Building.xls

Calculated By: SM Date: 10/28/19
Checked by: DH Date 10/29/19

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ===================================== B-6
ELEVATION OF BORING GROUND SURFACE ========================= 10.0 FT. (NAVD88, assumed)
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 7.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE =================== 7.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (PGA_M) == 0.278
EARTHQUAKE MOMENT MAGNITUDE =============================== 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ============== 0.00 FT.
HAMMER EFFICIENCY== 60 %
BOREHOLE DIAMETER== 2.5 to 4.5 IN.
SAMPLING METHOD== 1-3/8 inch ID

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.951**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **325** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.56
Source-To-Site Distance, R (km) = 31.83
Ground Motion Prediction Equations =
PGA = **0.118**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
9	1	18		5				0.125	0.125	22.950	22.950	0.256	0.125	0.125	0.125	1.500	**0.750**	0.976	**0.177**	**N.L. (1)**
5	5	6		5				0.113	0.577	6.725	6.725	0.085	0.113	0.577	0.577	1.316	**0.219**	0.874	**0.158**	**N.L. (1)**
0	10	16		5				0.065	0.902	17.649	17.649	0.188	0.065	0.902	1.089	1.270	**0.465**	0.737	**0.161**	**2.888 (D)**
-5	15	8		5				0.059	1.197	8.908	8.908	0.104	0.059	1.197	1.696	1.137	**0.230**	0.606	**0.155**	**1.484 (C)**
-10	20	5		90				0.055	1.472	5.427	11.512	0.127	0.055	1.472	2.283	1.092	**0.270**	0.497	**0.139**	**1.942 (C)**
-15	25	5		90				0.055	1.747	5.195	11.234	0.124	0.055	1.747	2.870	1.047	**0.254**	0.414	**0.123**	**2.065 (C)**
-20	30	1		90				0.043	1.962	1.001	6.202	0.081	0.043	1.962	3.397	1.016	**0.161**	0.356	**0.112**	**1.438 (C)**
-25	35	4		90				0.053	2.227	3.813	9.575	0.109	0.053	2.227	3.974	0.989	**0.211**	0.319	**0.103**	**2.049 (C)**
-30	40	2		90				0.048	2.467	1.826	7.192	0.089	0.048	2.467	4.526	0.968	**0.169**	0.295	**0.098**	**1.724 (C)**
-35	45	6		50				0.057	2.752	5.214	11.256	0.124	0.057	2.752	5.123	0.939	**0.228**	0.280	**0.094**	**2.426 (C)**
-40	50	6		90				0.057	2.850	5.143	11.172	0.124	0.057	2.850	5.533	0.932	**0.225**	0.271	**0.095**	**2.368 (C)**
-45	55	12		90				0.063	3.165	9.753	16.703	0.178	0.063	3.465	6.460	0.874	**0.303**	0.265	**0.090**	**3.367 (C)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

10/29/2019 Liquefaction Analysis - Hoosac Building.xls

10/29/2019 ATC Hazards by Location

ATC Hazards by Location

Search Information

Address: 115 Constitution Rd, Charlestown, MA 02129

Coordinates: 42.372421, -71.05803600000002

Elevation: ft

Timestamp: 2019-10-29T13:19:57.770Z

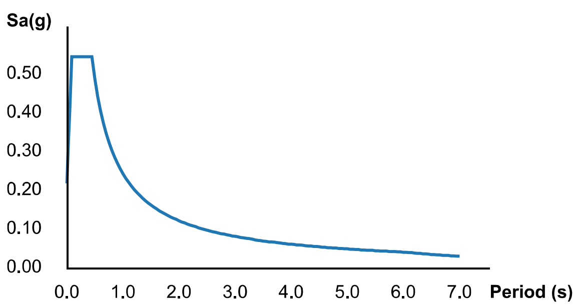
Hazard Type: Seismic

Reference Document: IBC-2015

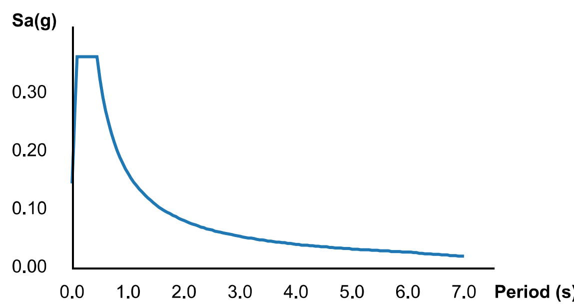
Risk Category: III

Site Class: E

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.218	MCE_R ground motion (period=0.2s)
S_1	0.069	MCE_R ground motion (period=1.0s)
S_{MS}	0.545	Site-modified spectral acceleration value
S_{M1}	0.243	Site-modified spectral acceleration value
S_{DS}	0.363	Numeric seismic design value at 0.2s SA
S_{D1}	0.162	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	C	Seismic design category
F_a	2.5	Site amplification factor at 0.2s
F_v	3.5	Site amplification factor at 1.0s

CR_S	0.891	Coefficient of risk (0.2s)
CR_1	0.9	Coefficient of risk (1.0s)
PGA	0.118	MCE_G peak ground acceleration
F_{PGA}	2.359	Site amplification factor at PGA
PGA_M	0.277	Site modified peak ground acceleration
T_L	6	Long-period transition period (s)
SsRT	0.218	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.245	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.069	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.077	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.6	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (v4.1.

Latitude

Decimal degrees

42.372

Longitude

Decimal degrees, negative values for western longitudes

-71.058

Site Class

760 m/s (B/C boundary)

Spectral Period

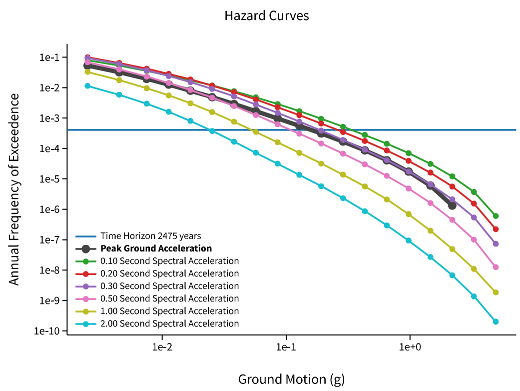
Peak Ground Acceleration

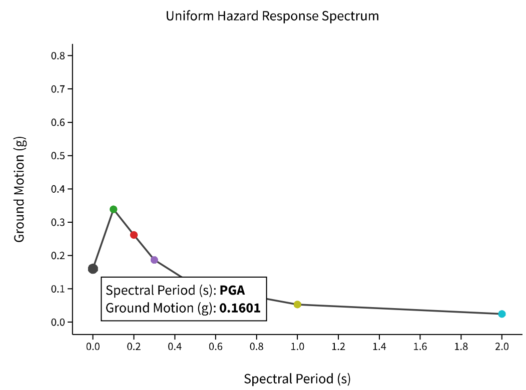
Time Horizon

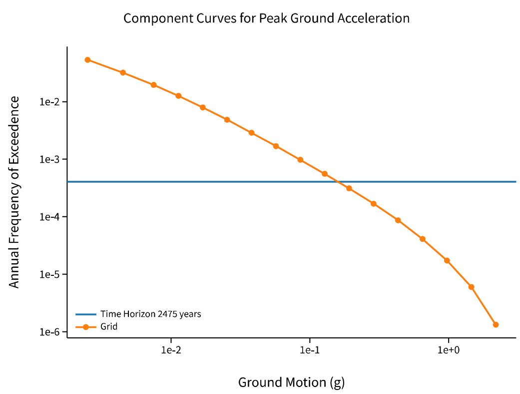
Return period in years

2475

Hazard Curve





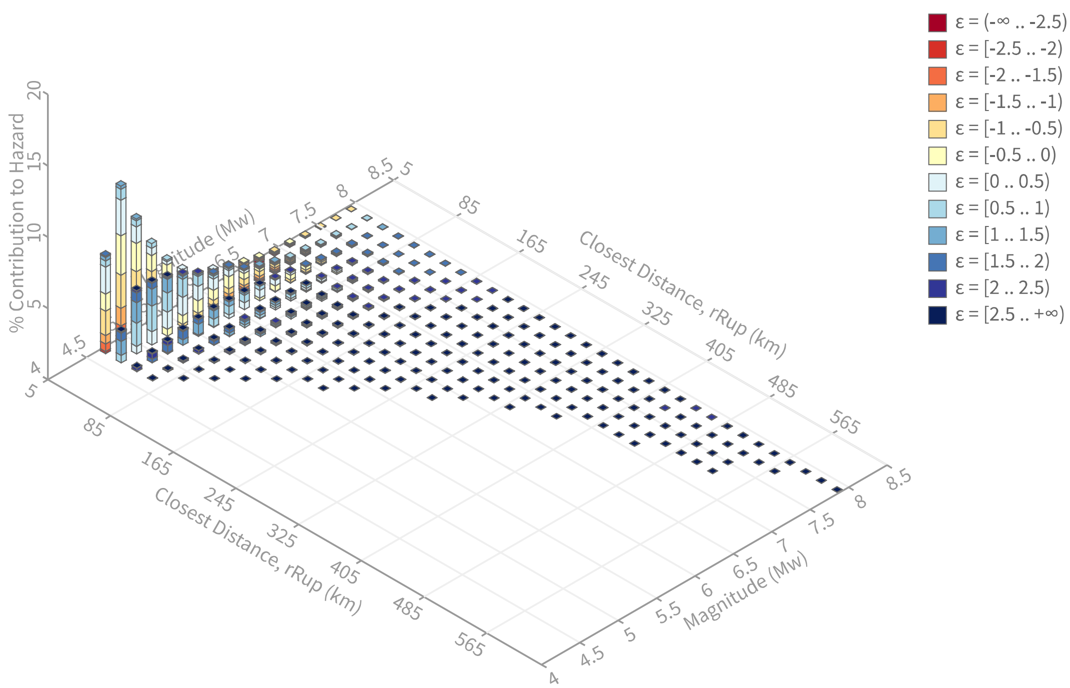


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.16014885 g

Recovered targets

Return period: 2467.5498 yrs
Exceedance rate: 0.00040526031 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 1.23 %

Mean (over all sources)

m: 5.56
r: 31.83 km
ε_0: -0.04 σ

Mode (largest m-r bin)

m: 4.9
r: 12.3 km
ε_0: -0.46 σ
Contribution: 11.12 %

Mode (largest m-r-ε_0 bin)

m: 4.89
r: 13.03 km
ε_0: -0.27 σ
Contribution: 2.75 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
USGS Fixed Smoothing Zone 2 (opt)	Grid							28.80
PointSourceFinite: -71.058, 42.484		13.21	5.23	-0.65	71.058°W	42.484°N	0.00	4.07
PointSourceFinite: -71.058, 42.529		17.78	5.31	-0.24	71.058°W	42.529°N	0.00	3.95
PointSourceFinite: -71.058, 42.439		8.89	5.17	-1.22	71.058°W	42.439°N	0.00	3.91
PointSourceFinite: -71.058, 42.619		27.07	5.50	0.28	71.058°W	42.619°N	0.00	2.84
PointSourceFinite: -71.058, 42.574		22.43	5.40	0.06	71.058°W	42.574°N	0.00	2.78
PointSourceFinite: -71.058, 42.709		36.27	5.71	0.55	71.058°W	42.709°N	0.00	1.72
PointSourceFinite: -71.058, 42.664		31.69	5.60	0.43	71.058°W	42.664°N	0.00	1.66
PointSourceFinite: -71.058, 42.394		5.57	5.14	-1.79	71.058°W	42.394°N	0.00	1.60
PointSourceFinite: -71.058, 42.799		45.38	5.91	0.71	71.058°W	42.799°N	0.00	1.02
SSCn Fixed Smoothing Zone 4 (opt)	Grid							28.77
PointSourceFinite: -71.058, 42.484		13.21	5.23	-0.65	71.058°W	42.484°N	0.00	4.07
PointSourceFinite: -71.058, 42.529		17.78	5.31	-0.24	71.058°W	42.529°N	0.00	3.95
PointSourceFinite: -71.058, 42.439		8.89	5.17	-1.22	71.058°W	42.439°N	0.00	3.91
PointSourceFinite: -71.058, 42.619		27.07	5.50	0.28	71.058°W	42.619°N	0.00	2.84
PointSourceFinite: -71.058, 42.574		22.43	5.40	0.06	71.058°W	42.574°N	0.00	2.78
PointSourceFinite: -71.058, 42.709		36.27	5.71	0.55	71.058°W	42.709°N	0.00	1.72
PointSourceFinite: -71.058, 42.664		31.69	5.60	0.43	71.058°W	42.664°N	0.00	1.66
PointSourceFinite: -71.058, 42.394		5.57	5.14	-1.79	71.058°W	42.394°N	0.00	1.60
PointSourceFinite: -71.058, 42.799		45.38	5.91	0.71	71.058°W	42.799°N	0.00	1.02
USGS Adaptive Smoothing Zone 2 (opt)	Grid							21.04
PointSourceFinite: -71.058, 42.484		13.21	5.23	-0.65	71.058°W	42.484°N	0.00	2.75
PointSourceFinite: -71.058, 42.529		17.78	5.31	-0.24	71.058°W	42.529°N	0.00	2.69
PointSourceFinite: -71.058, 42.619		27.07	5.50	0.28	71.058°W	42.619°N	0.00	2.40
PointSourceFinite: -71.058, 42.439		8.89	5.17	-1.22	71.058°W	42.439°N	0.00	2.02
PointSourceFinite: -71.058, 42.709		36.27	5.71	0.55	71.058°W	42.709°N	0.00	1.58
PointSourceFinite: -71.058, 42.574		22.43	5.40	0.06	71.058°W	42.574°N	0.00	1.52
PointSourceFinite: -71.058, 42.664		31.69	5.60	0.43	71.058°W	42.664°N	0.00	1.10
PointSourceFinite: -71.058, 42.394		5.57	5.14	-1.79	71.058°W	42.394°N	0.00	1.04
SSCn Adaptive Smoothing Zone 4 (opt)	Grid							21.02
PointSourceFinite: -71.058, 42.484		13.21	5.23	-0.65	71.058°W	42.484°N	0.00	2.75
PointSourceFinite: -71.058, 42.529		17.78	5.31	-0.24	71.058°W	42.529°N	0.00	2.69
PointSourceFinite: -71.058, 42.619		27.07	5.50	0.28	71.058°W	42.619°N	0.00	2.40
PointSourceFinite: -71.058, 42.439		8.89	5.17	-1.22	71.058°W	42.439°N	0.00	2.02
PointSourceFinite: -71.058, 42.709		36.27	5.71	0.55	71.058°W	42.709°N	0.00	1.58
PointSourceFinite: -71.058, 42.574		22.43	5.40	0.06	71.058°W	42.574°N	0.00	1.52
PointSourceFinite: -71.058, 42.664		31.69	5.60	0.43	71.058°W	42.664°N	0.00	1.10
PointSourceFinite: -71.058, 42.394		5.57	5.14	-1.79	71.058°W	42.394°N	0.00	1.04

Liquefaction Analysis

This design guide illustrates the Department's recommended procedures for analyzing the liquefaction potential of soil during a seismic event considering Article 10.5.4.2 of the 2009 Interim Revisions for the AASHTO LRFD Bridge Design Specifications and various research. The phenomenon of liquefaction and how it should be evaluated continues to be the subject of considerable study and debate. It is expected that enhancements will evolve and modify how liquefaction should be evaluated and accounted for in design. This design guide outlines the Department's current recommended procedure for identifying potentially liquefiable soils. Also included are recommendations for characterizing the properties and behavior of liquefiable soils so that substructure stiffness and embankment response to seismic loading can be modeled.

Liquefaction Description and Design

Saturated loose to medium dense cohesionless soils and low plasticity silts tend to densify and consolidate when subjected to cyclic shear deformations inherent with large seismic ground motions. Pore-water pressures within such layers increase as the soils are cyclically loaded, resulting in a decrease in vertical effective stress and shear strength. If the shear strength drops below the applied cyclic shear loadings, the layer is expected to transition to a semi fluid state until the excess pore-water pressure dissipates.

Embankments and foundations are particularly susceptible to damage, depending on the location and extent of the liquefied soil layers. Such soils may adequately carry everyday loadings, however once liquefied, retain insufficient capacity for such loads or additional seismic forces. Substructure foundations shall either be designed to withstand the liquefaction or ground improvement techniques shall be used to achieve the IDOT performance objectives of no loss of life or loss of span. End slopes and roadway embankments on liquefiable soils require an analysis to determine the likely extent of pavement/slope damage so that the cost of ground improvement techniques can be compared to alternatives such as re-routing traffic around the damaged lanes or quickly effecting emergency repairs.

The stiffness of liquefiable soils supporting foundations is anticipated to degrade over the duration of the seismic event and reduces the lateral stiffness of the substructure. The reduced stiffness results in increased deflection and moment arm, concern for buckling, and potentially additional loading on adjacent substructures. The lateral stiffness, moments and forces carried by such foundations supported by liquefiable soils is best determined using programs such as COM624 or LPILE. The liquefied soil layers can be modeled in these programs with reduced strength parameters or the p-y curves can be modified to reflect the residual strength of the liquefied layers. Note that the estimated fixity depths indicated in Design Guide 3.15 (Seismic Design) should not be used for analyzing substructures with liquefiable soils.

Vertical ground settlement should be expected to occur following liquefaction. As such, spread footings should not be specified at sites expected to liquefy unless ground improvement techniques are employed to mitigate liquefaction. For driven pile and drilled shaft foundations, the vertical settlement will result in a loss of skin friction capacity and an added negative skin friction (NSF) downdrag load when the liquefiable layers are overlain by non-liquefiable soils. Geotechnical losses from liquefaction and any liquefaction induced NSF loadings shall only be considered with the Extreme Event I limit state group loading, since the strength limit state group loadings represent the conditions prior to, not after a seismic event.

Since liquefaction may or may not fully occur while the peak seismic bridge loadings are applied, structures at sites where liquefaction is anticipated must be analyzed and designed to resist the seismic loadings with nonliquefied conditions as well as a configuration that reflects the locations, extent and reduced strength of the liquefiable layers. However, the design spectra used for both configurations shall be the spectra determined for the nonliquefied configuration.

Embankments and bridge cones are susceptible to lateral movements in addition to vertical settlement during a seismic event. When the seismic slope stability factor of safety approaches 1.0, slope deformations become likely and when liquefaction is expected, these movements can be substantial. The ability of embankments and bridge cones to resist such failures when liquefiable soils are present should be investigated using the slope geometry and static stresses along with residual strength properties for the liquefied soils as described later in the design guide. A new AGMU Memo 10.3 (Slope Stability Design Criteria for Bridges and Roadways) is expected to be issued this year to provide further guidance on the seismic analysis of embankments.

Liquefaction Analysis Criteria

All sites located in Seismic Performance Zones (SPZ) 3 and 4 as well as sites located in SPZ 2 with a peak seismic ground surface acceleration, A_S (PGA modified by the zero-period site factor, F_{pga}), equal to or greater than 0.15, require liquefaction analysis. The exception to this is when the all liquefaction susceptible soils at a site have corrected standard penetration test (SPT) blow counts $(N_1)_{60}$ above 25 blows/ft. or the anticipated groundwater is not within 50 ft of the ground surface. The groundwater elevation used in the analysis should be the seasonally averaged groundwater elevation for the site which may not be equal to that encountered during the soil boring drilling.

Low plasticity silts and clays may experience pore-water pressure increases, softening, and strength loss during earthquake shaking similar to cohesionless soils. Fine-grained soils with a plasticity index (PI) less than 12 and water content (w_c) to liquid limit (LL) ratio greater than 0.85 are considered potentially liquefiable and require liquefaction analysis. While PI is regularly investigated for pavement subgrades, it has rarely been considered in the past for structure soil borings. However, in order to investigate liquefaction susceptibility of fine-grained soils, the plasticity of such soils should be examined when conducting structure soil borings. Drillers should inspect and describe the plasticity of fine-grained soil samples. Low plasticity fine-grained soils, particularly loams and silty loams, should be retained for the Atterberg Limit testing with the results indicated on the soil boring log.

For typical projects, liquefaction analysis shall be limited to the upper 60 ft of the geotechnical profile measured from the existing or final ground surface (whichever is lower). This depth encompasses a significant number of past liquefaction observations used to develop the simplified liquefaction analysis procedure described below. If the liquefaction analysis indicates that the factor of safety (FS) against liquefaction is greater than or equal to 1.0, no further concern for liquefaction is necessary. However, if soil layers are present indicating a FS less than 1.0, the potential for these layers to liquefy and the effect on the slope or foundation but be further evaluated.

Liquefaction Analysis Procedure

The method described below is provided to assist Geotechnical Engineers in facilitating liquefaction analysis for typical or routine projects. For simplicity, numerical expressions or directions are provided for determining values of the variables necessary to conduct the liquefaction analysis for such projects. Non-linear site response analysis programs can be used to determine more exacting values for some of the variables, however this should only be considered necessary for large or unique projects where a more refined liquefaction analysis is desired.

The “Simplified Method” described by Youd et al. (2001) as well as refinements suggested by Cetin et al. (2004) shall be used to estimate liquefaction potential as contained herein. The simplified method compares the resistance of a soil layer against liquefaction (Cyclic Resistance Ratio, CRR) to the seismic demand on a soil layer (Cyclic Stress Ratio, CSR) to estimate the FS of a given soil layer against triggering liquefaction. The FS for each soil sample should be computed to allow thin, isolated layers to be discounted and the specific locations and extent of those determined liquefiable to be indicated in the SGR and accounted for in design.

An Excel spreadsheet that performs these calculations has been prepared to assist Geotechnical Engineers with conducting a liquefaction analysis and may be downloaded from IDOT’s website.

$$FS = \frac{CRR}{CSR}$$

Where:

$$CRR = CRR_{7.5} K_{\sigma} K_{\alpha} MSF$$

$$CSR = 0.65 A_S \left(\frac{\sigma_{vo}}{\sigma'_{vo}} \right) r_d$$

$CRR_{7.5}$ = cyclic resistance ratio for magnitude 7.5 earthquake

$$= \frac{1}{34 - (N_1)_{60cs}} + \frac{(N_1)_{60cs}}{135} + \frac{50}{[10(N_1)_{60cs} + 45]^2} - \frac{1}{200}$$

K_σ = overburden correction factor

$$= \left(\frac{\sigma'_{vo}}{2.12}\right)^{(f-1)} \text{ and } 1.5 \le K_\sigma \le 9^{(f-1)}$$

f = soil relative density factor

$$= 0.831 - \frac{(N_1)_{60cs}}{160} \text{ and } 0.6 \le f \le 0.8$$

K_α = sloping ground correction factor

= 1.0 for generally level ground surfaces or slopes flatter than 6 degrees. See the following discussions for liquefaction evaluation of slopes and embankments.

MSF = magnitude scaling factor

= $87.2(M_w)^{-2.215}$

M_w = earthquake moment magnitude.

A_S = peak horizontal acceleration coefficient at the ground surface

= F_{pga} PGA

F_{pga} = site amplification factor for zero-period spectral acceleration (LRFD Article 3.10.3.2)

PGA = peak seismic ground acceleration on rock.

σ_{vof} = total vertical soil pressure for final condition (ksf)

σ'_{vof} = effective vertical soil pressure for final condition (ksf)

σ_{vof}, σ'_{vof}, and σ'_{voi} may be calculated using the following correlations for estimating the unit weight of soil (kcf):

Above water table: $\gamma_{granular} = 0.095 N_m^{0.095}$

$\gamma_{cohesive} = 0.1215 Q_u^{0.095}$

Below water table: $\gamma_{granular} = 0.105 N_m^{0.07} - 0.0624$

$\gamma_{cohesive} = 0.1215 Q_u^{0.095} - 0.0624$

Fill soils being modeled for the final condition may be assumed to have unit weights of 0.120 kcf and 0.058 kcf above and below the water table.

r_d = soil shear mass participation factor

$$= \frac{\left[1+\frac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(-d+0.0785V^*_{s,40'}+24.888\right)}}\right]}{\left[1+\frac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(0.0785V^*_{s,40'}+24.888\right)}}\right]} \text{ for d < 65 ft}$$

$$= \frac{\left[1+\frac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(-65+0.0785V^*_{s,40'}+24.888\right)}}\right]}{\left[1+\frac{-23.013-2.949A_S+0.999M_w+0.016V^*_{s,40'}}{16.258+0.201e^{0.104\left(0.0785V^*_{s,40'}+24.888\right)}}\right]} - 0.0014(d-65) \text{ for } d \geq 65 \text{ ft}$$

$V^*_{s,40'}$ = average shear wave velocity within the top 40 ft of the finished grade (ft/sec).

$$= \frac{40}{\sum_{i=1}^{n}\frac{d_i}{v_{si}}}$$

v_{si} = shear wave velocity of individual soil layer (ft/sec)

$$= 169N_m^{0.516}$$

Fill soils may be assumed to have a shear wave velocity of 600 ft/sec.

d_i = thickness of individual soil layer (ft)

d = depth of soil sample below finished grade (ft)

$(N_1)_{60cs}$ = $(N_1)_{60}$ adjusted to an equivalent clean sand value (blows/ft)

$$= \alpha + \beta(N_1)_{60}$$

α = clean sand adjustment factor coefficient

= 0 for $FC \leq 5\%$

$$= e^{\left(1.76-\frac{190}{FC^2}\right)} \text{ for } 5\% < FC < 35\%$$

= 5 for $FC \geq 35\%$

β = clean sand adjustment factor coefficient

= 1.0 for $FC \leq 5\%$

$$= 0.99 + \frac{FC^{1.5}}{1000} \text{ for } 5\% < FC < 35\%$$

= 1.2 for $FC \geq 35\%$

FC = % passing No. 200 sieve

$(N_1)_{60}$ = corrected SPT blow count (blows/ft)

= $N_m C_N C_E C_B C_R C_S$

N_m = field measured SPT blow count recorded on the boring logs (blows/ft)

C_N = overburden correction factor

$$= \frac{2.2}{\left(1.2 + \frac{\sigma'_{voi}}{2.12}\right)} \leq 1.7$$

σ'_{voi} = effective vertical soil pressure during drilling (ksf)

C_E = hammer energy rating correction factor

= $\frac{ER}{60}$; ER = hammer efficiency rating (%)

C_B = borehole diameter correction factor

= 1.0 for boreholes approximately $2\frac{1}{2}$ to $4\frac{1}{2}$ inches in diameter

= 1.05 for boreholes approximately 6 inches in diameter

= 1.15 for boreholes approximately 8 inches in diameter

C_R = rod length correction factor

$$= (-2.1033 \times 10^{-11})\ell^6 + (7.9025 \times 10^{-9})\ell^5 - (1.2008 \times 10^{-6})\ell^4 + (9.4538 \times 10^{-5})\ell^3$$
$$- (4.0911 \times 10^{-3})\ell^2 + (9.3996 \times 10^{-2})\ell + 0.0615 \text{ and } 0.75 \leq C_R \leq 1.0$$

C_S = split-spoon sampler lining correction factor

= 1.0 for samplers with liners

= $1 + \frac{C_N N_m}{100}$ for samplers without liners where $1.1 \leq C_S \leq 1.3$

ER = hammer efficiency rating (%)

Unless more exacting information is available, use 73% for automatic type hammers and 60% for conventional drop type hammers.

ℓ = drill rod length (ft) measured from the point of hammer impact to tip of sampler. ℓ may be estimated as the depth below the top of boring for the soil sample under consideration plus 5 ft to account for protrusion of the drill rod above the top of borehole.

For soils explorations conducted by IDOT, boreholes are typically advanced using hollow stem augers that are 8 inches in diameter or using wash boring methods with a cutting bit that results in approximately a 4½ inch diameter borehole. The diameter and methods of advancing the borehole can vary between Districts and Consultants performing soils explorations for IDOT. As such, it is recommended that the borehole diameter be included on the soil boring log in addition to the drilling procedure (hollow stem auger, mud rotary, etc.). Geotechnical engineers conducting a liquefaction analysis and calculating the borehole diameter correction factor (C_B) should inquire with the soils exploration provider if the borehole diameter is not provided.

SPT tests are generally conducted in accordance with AASHTO T 206 and the split-spoon samplers are designed to accept a metal or plastic liner for collecting and transporting soil samples to the laboratory. Omitting the liner provides an enlarged internal barrel diameter that reduces friction between the soil sample and interior of the sampler, resulting in a reduced SPT blow count. Past experience indicates that interior liners are seldom used and the AASHTO T 206 specification indicates that the use of liners is to be noted on the penetration record. Thus, it shall be assumed in the calculation of the split-spoon sampler lining correction factor (C_S) that liners were not used unless otherwise indicated the soil boring log.

The field measured SPT blow count values obtained in Illinois commonly use an automatic type hammer which typically offer hammer efficiency (ER) values greater than the standard 60% associated with drop type hammers. For soils exploration conducted with automatic type hammers, an ER of 73% may be assumed unless more exacting information is available.

Liquefaction resistance improves with increased fines content. As such, sieve analysis should be conducted for low plasticity fine-grained loams and silts below the anticipated groundwater elevation and within the upper 60 ft when the $(N_1)_{60}$ is less than or equal to 25 blows/ft to determine percent passing a No. 200 sieve (Fines Content, FC). These data should be included in the SGR and/or reported on the soil boring log.

M_w and PGA Values for Liquefaction Analysis

The spectral accelerations for the 0.0 second, 0.2 second and 1.0 second structure period are typically used by the structural engineer to conduct a pseudo-static seismic analysis and design of the bridge and foundation elements. These are commonly obtained from U.S. Geological Survey (USGS) maps which were developed using a probabilistic seismic hazard analysis (PSHA). PSHA estimates the likelihood that various seismic accelerations will be exceeded at a given site, over a future specific period of time, by analyzing various potential seismic sources, earthquake magnitudes, site to source distances, and estimated rates of occurrence. With this methodology, as the desired probability of exceedance is decreased (or design return period is increased), the corresponding spectral accelerations increase. The 0.0 second spectral acceleration is commonly considered as the PGA (hereafter referred to as the PSHA PGA) for the structure's design return period.

In addition to PGA, duration of shaking is a key factor in triggering liquefaction and is represented in the liquefaction analysis procedure by the earthquake Moment Magnitude (Mw). In the past, IDOT used the PSHA PGA with the Mean Earthquake Moment Magnitude ($\overline{M_W}$) provided by the USGS for the site location and design return period. However, this PGA and Mw combination will not properly indentify a site's liquefaction potential for the design return period. Portions of Illinois considered multi-modal, meaning that there are multiple earthquake scenarios that have a significant contribution to the overall hazard, require liquefaction potential be checked for multiple PGA and Mw pairs to determine the controlling values. Multi-modal conditions are often characterized by a distant seismic source, capable of producing a large Mw with a smaller PGA, and a near-site source capable of producing a smaller Mw with a larger PGA. The distant seismic source will almost always be the New Madrid seismic zone (NMSZ). The near-site source will typically be the "background seismicity" sources gridded by the USGS, although the Wabash Valley seismic zone (WVSZ) will control the near-site source for some sites in southeastern Illinois. Sites near the southern most portion of the state become less multi-modal and are solely controlled the NMSZ. The PGA and Mw values to be checked must be determined using the USGS 2008 PSHA deaggregation data, located at: http://geohazards.usgs.gov/deaggint/2008/, which summarizes the contribution of various earthquake scenarios to the hazard.

The distant seismic source (NMSZ) is typically represented by the Modal source-site distance (R*) and magnitude (M_w*) values provided at the base of the deaggregation, which reflect the largest contribution to the overall site hazard. The PGA to be used with this source must be calculated using the R*, M_w* and the ground motion prediction equations (GMPE's) used by the USGS for the NMSZ. The USGS uses a weighted average of 8 different ground GMPE's for the NMSZ, which due to their complexity, are not presented herein. They are provided in IDOT's Liquefaction Analysis Excel spreadsheet and used to compute the distant seismic source PGA with input of R*, M_w*, and selecting "NMSZ" for the proper ground motion prediction equations.

The R and M_w values representing the near-site sources can be identified by evaluating the "ALL_EPS" and source-site distance "DIST(KM)" columns of the deaggregation data. The ALL_EPS column indicates the percent contribution each earthquake scenario adds to the overall hazard. Scenarios contributing more than 5% to the hazard with a source-site distance not extending to the NMSZ should be selected as near-site sources to be investigated. The PGA to be used with each selected near-site R and M_w pair shall be calculated using the USGS ground motion prediction equations for the Central Eastern United States (CEUS). The USGS uses a weighted average of 7 different GMPE's to for the CEUS. These GMPE's are also programmed into the IDOT Liquefaction Analysis spreadsheet to provide near-site PGA values for each selected R, and M_w when the "CEUS" is input as the proper ground motion prediction equations.

Two examples for interpreting the deaggregation data and determining the PGA and M_w pairs to be used for the liquefaction analysis are included at the end of the design guide.

Liquefaction Analysis Procedure for Slopes and Embankments

The liquefaction resistance of dense granular materials under low confining stress (dilative soils) tends to increase with increased static shear stresses. Such static shear stresses are typically the result of ground surface inclinations associated with slopes and embankments. Conversely, the liquefaction resistance of loose soils under high confining stress (contractive soils) tends to decrease with increased static shear stresses. Such soils are susceptible to undrained strain softening. The effects of sloping ground and static shear stresses on the liquefaction resistance of soils is accounted for in the previously described Simplified Procedure by use of the sloping ground correction factor, K_α.

K_α is a function of the static shear stress to effective overburden pressure ratio and relative density of the soil. Graphical curves have been published that correlate K_α with these variables (Harder and Boulanger 1997). With the exception of earth masses of a constant slope, the ratio of the static shear stress to effective overburden pressure will vary at different points under an embankment, and most slopes, making it difficult to determine an appropriate K_α. Researchers that developed the Simplified Procedure have indicated that there is a wide range of proposed K_α values indicating a lack of convergence and need for additional research. It is recommended that the graphical curves that have been published for establishing K_{α} not be used by nonspecialists in geotechnical earthquake engineering or in routine engineering practice.

Olson and Stark (2003) have presented an alternative approach for analyzing the effects of static shear stress due to sloping ground on the liquefaction resistance of soils. A detailed description of the method is not included herein and Geotechnical Engineers should obtain a copy of the reference document for further information.

The method provides a numerical relationship for determining whether soils are contractive or dilative. If soils are determined to be contractive, an additional analysis should be conducted to investigate the effects of static shear stress on the liquefaction resistance of soils. The additional analysis is an extension of a traditional slope stability analysis typically performed with commercial software, and can be readily facilitated with the use of a spreadsheet and data obtained from the slope stability software. If the additional analysis indicates soil layers with a FS < 1.0 against liquefaction, a post-liquefaction slope stability analysis should be conducted with residual shear strengths assigned to the soil layers expected to liquefy. While Olson and Stark (2003) present one acceptable method for estimating the residual shear strength of liquefied soil layers, there are also a number of other methods presented in various reference documents concerning liquefaction.

The Department's Liquefaction Analysis spreadsheet that estimates liquefaction resistance of soil using the Simplified Method described above also estimates whether soils are contractive or dilative based upon the relationship provided by Olson and Stark (2003). As the classification of contractive or dilative soils is affected by overburden pressure, the presence of such soils should be assessed considering a soil column that starts at the top of the embankment/slope and another soil column that begins at the base of the embankment/slope.

Note that the method provided by Olson and Stark (2003) also includes an equation for estimating the seismic shear stress on a soil layer (Eq. 3a in the reference document). The variable C_M included in the referenced equation shall be replaced with the variable MSF and both variables MSF and r_d shall be calculated using the equations outlined above for the Simplified Method.

Examples for Determining M_w and PGA Values

The first of two examples is for a location near Grayville, Illinois and the corresponding deaggregation data, obtained from the USGS website, is provided in below in Figure 1. In this case, the five earthquake scenarios highlighted in the figures have an "ALL_EPS" contribution to the total hazard greater than 5%.

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2008 version ***
PSHA Deaggregation. %contributions. site: Grayville,_IL long:  88.015 W., lat: 38.257 N.
 Vs30(m/s)= 760.0 CEUS atten. model site cl BC(firm) or A(hard).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 975   yrs. Exceedance PGA =0.2147   g. Weight * Computed_Rate_Ex 0.104E-02
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02123
#This deaggregation corresponds to Mean Hazard w/all GMPEs
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
   11.6     4.60    3.493     0.343    1.627    1.385    0.139    0.000    0.000
   28.5     4.61    0.589     0.466    0.123    0.000    0.000    0.000    0.000
   12.1     4.80    7.215     0.564    3.247    2.915    0.488    0.000    0.000
   29.2     4.81    1.674     1.065    0.609    0.000    0.000    0.000    0.000
   12.6     5.03    6.111     0.365    2.177    2.831    0.738    0.000    0.000
   30.0     5.04    2.112     0.981    1.129    0.002    0.000    0.000    0.000
   55.8     5.05    0.086     0.086    0.000    0.000    0.000    0.000    0.000
   13.0     5.21    2.627     0.130    0.780    1.338    0.378    0.001    0.000
   30.6     5.21    1.205     0.427    0.731    0.047    0.000    0.000    0.000
   57.6     5.21    0.081     0.081    0.000    0.000    0.000    0.000    0.000
   13.4     5.39    4.419     0.189    1.130    2.343    0.735    0.022    0.000
   31.1     5.40    2.638     0.692    1.677    0.269    0.000    0.000    0.000
   58.8     5.40    0.262     0.262    0.000    0.000    0.000    0.000    0.000
   13.7     5.61    2.434     0.089    0.532    1.315    0.473    0.024    0.000
   31.9     5.62    1.959     0.336    1.190    0.434    0.000    0.000    0.000
   59.7     5.62    0.288     0.267    0.020    0.000    0.000    0.000    0.000
   13.9     5.80    2.291     0.077    0.459    1.152    0.562    0.042    0.000
   32.3     5.81    2.234     0.289    1.267    0.678    0.000    0.000    0.000
   60.1     5.81    0.395     0.313    0.082    0.000    0.000    0.000    0.000
   88.4     5.82    0.052     0.052    0.000    0.000    0.000    0.000    0.000
   12.9     6.01    1.740     0.050    0.301    0.757    0.569    0.063    0.000
   32.6     6.01    2.166     0.196    1.036    0.911    0.023    0.000    0.000
   61.2     6.01    0.434     0.252    0.182    0.000    0.000    0.000    0.000
   88.5     6.01    0.078     0.078    0.000    0.000    0.000    0.000    0.000
   12.5     6.21    1.725     0.047    0.279    0.700    0.619    0.080    0.000
   34.1     7.39    0.999     0.031    0.183    0.461    0.314    0.010    0.000
   59.4     7.40    0.369     0.020    0.120    0.222    0.007    0.000    0.000
   85.0     7.38    0.168     0.017    0.101    0.050    0.000    0.000    0.000
  120.6     7.39    0.144     0.027    0.113    0.004    0.000    0.000    0.000
  155.1     7.44    5.773     1.406    3.581    0.786    0.000    0.000    0.000
   14.4     7.59    0.060     0.001    0.008    0.021    0.021    0.008    0.000
   34.3     7.59    0.158     0.005    0.027    0.068    0.055    0.003    0.000
   62.2     7.59    0.062     0.003    0.018    0.038    0.004    0.000    0.000
  155.1     7.70   15.821     2.080    7.962    5.779    0.000    0.000    0.000
  155.1     8.00    7.989     0.623    3.017    3.584    0.765    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):  100.0
 Mean src-site R=   64.9 km; M= 6.33; eps0=   0.12. Mean calculated for all sources.
Modal src-site R=  155.1 km; M= 7.70  eps0=   0.67 from peak (R,M) bin
 MODE R*= 155.1km; M*= 7.70; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.=  7.962

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                   % contr.  R(km)     M   epsilon0 (mean values).
New Madrid SZ no clustering          29.53   155.1   7.73    0.63
CEUS gridded                         70.47    27.1   5.75   -0.09
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                           % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
New Madrid FZ, midwest                2.91   155.9   7.73    0.63    -139.1
New Madrid FZ, central               21.22   153.6   7.73    0.61    -143.6
New Madrid FZ, mideast                2.80   158.3   7.73    0.66    -146.9
#*********End of deaggregation corresponding to Mean Hazard w/all GMPEs  *********#
```

Figure 1. Grayville Deaggregation Data.

Three of the five sites have source-to-site distances indicative of the NMSZ and thus, the Modal source-site distance (R*) and magnitude (M_w*) values can be used to represent the distant seismic source. The remaining two earthquake scenarios are considered near-site sources which both requiring further investigation. The PGA for each of the three earthquake scenarios is then calculated using the indicated R and M_w values with selection of the proper GMPE model programmed in the IDOT Liquefaction Analysis spreadsheet.

- EQ Scenario #1, Dist. (R) = 155.1 km, M_w = 7.70 → PGA = 0.115 (NMSZ Model)
- EQ Scenario #2, Dist. (R) = 12.1 km, M_w = 4.80 → PGA = 0.175 (CEUS Model)
- EQ Scenario #3, Dist. (R) = 12.6 km, M_w = 5.03 → PGA = 0.209 (CEUS Model)

In this instance, it is clear that EQ Scenario #3 will control over EQ Scenario #2 and as such, EQ Scenario #2 does not require further consideration for the liquefaction analysis. The PGA and M_w pairs for EQ Scenario's #1 and #3 serve as an example of the potential multi-modal nature of some locations.

There will be many instances where the deaggregation data indicates that there are no near-site sources that contribute at least 5% to the hazard that need to be considered for liquefaction analysis. In such cases, the hazard is likely dominated by the NMSZ and only the Modal combination needs to be considered.

The second example is for a location near Cairo, Illinois and the site deaggregation data is provided in below in Figure 2.

There are three highlighted earthquake scenarios where the “ALL_EPS” contribution is greater than 5%.

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2008 version ***
PSHA Deaggregation. %contributions. site: Cairo,_IL long:  89.181 W., lat: 37.005 N.
 Vs30(m/s)= 760.0 CEUS atten. model site cl BC(firm) or A(hard).
NSHMP 2007-08  See USGS OFR 2008-1128. dM=0.2 below
Return period: 975   yrs. Exceedance PGA =1.1619   g. Weight * Computed_Rate_Ex 0.101E-02
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.04009
#This deaggregation corresponds to Mean Hazard w/all GMPEs
DIST(KM) MAG(MW) ALL_EPS EPSILON>2  1<EPS<2 0<EPS<1 -1<EPS<0 -2<EPS<-1 EPS<-2
    6.9     4.61    0.075    0.046    0.029    0.000    0.000    0.000    0.000
    7.6     4.80    0.203    0.114    0.090    0.000    0.000    0.000    0.000
    8.5     5.04    0.238    0.117    0.121    0.000    0.000    0.000    0.000
    9.2     5.21    0.132    0.064    0.068    0.000    0.000    0.000    0.000
   10.0     5.40    0.287    0.135    0.137    0.015    0.000    0.000    0.000
   11.1     5.62    0.218    0.083    0.110    0.024    0.000    0.000    0.000
   11.8     5.81    0.258    0.089    0.134    0.035    0.000    0.000    0.000
   11.7     6.02    0.315    0.079    0.169    0.067    0.000    0.000    0.000
   11.4     6.22    0.423    0.087    0.206    0.130    0.000    0.000    0.000
   12.4     6.42    0.377    0.065    0.184    0.128    0.000    0.000    0.000
   12.2     6.59    0.257    0.036    0.120    0.101    0.000    0.000    0.000
   12.1     6.79    0.404    0.038    0.187    0.178    0.001    0.000    0.000
   31.0     6.76    0.070    0.049    0.021    0.000    0.000    0.000    0.000
   14.0     7.00    0.370    0.035    0.168    0.164    0.003    0.000    0.000
   14.7     7.19    0.223    0.019    0.100    0.101    0.003    0.000    0.000
   11.4     7.42   31.476    1.447    8.511   17.760    3.758    0.000    0.000
   29.8     7.39    0.271    0.079    0.192    0.000    0.000    0.000    0.000
   11.5     7.70   48.171    2.025   12.040   27.292    6.814    0.000    0.000
   29.4     7.70    0.708    0.115    0.471    0.121    0.000    0.000    0.000
   11.5     8.00   14.768    0.594    3.535    8.424    2.215    0.000    0.000
   27.0     8.00    0.593    0.047    0.237    0.309    0.000    0.000    0.000

Summary statistics for above PSHA PGA  deaggregation, R=distance, e=epsilon:
Contribution from this GMPE(%):  100.0
 Mean src-site R=   11.8 km; M= 7.59; eps0=  -0.24. Mean calculated for all sources.
Modal src-site R=   11.5 km; M= 7.70; eps0=  -0.32 from peak (R,M) bin
 MODE R*=  11.4km; M*= 7.70; EPS.INTERVAL: 0 to 1 sigma  % CONTRIB.= 27.292

Principal sources (faults, subduction, random seismicity having > 3% contribution)
Source Category:                   % contr.  R(km)    M   epsilon0 (mean values).
New Madrid SZ no clustering          95.65    11.7   7.66   -0.28
CEUS gridded                          4.35    13.5   6.24    0.76
Individual fault hazard details if its contribution to mean hazard > 2%:
Fault ID                           % contr.   Rcd(km)  M   epsilon0 Site-to-src azimuth(d)
New Madrid FZ, midwest                7.47    17.4   7.68   -0.02      -50.3
New Madrid FZ, central               74.16    10.3   7.65   -0.35      -47.2
New Madrid FZ, mideast                9.94    12.1   7.66   -0.29      132.6
New Madrid FZ, east                   2.63    22.5   7.69    0.33      131.2
#*********End of deaggregation corresponding to Mean Hazard w/all GMPEs  *********#
```

Figure 2. Cairo Deaggregation Data.

By inspection, they all have source-to-site distances indicative of the NMSZ and can be represented by a single check of the Modal R and M combination. With no near-site scenarios contributing more than 5% to the hazard, only the single distant seismic source need be investigated.

- EQ Scenario #1, Dist. (R) = 11.5 km, M_w = 7.70 $\rightarrow$ PGA = 1.528 (NMSZ Model)

Similar to Example #1, the PGA value for the earthquake scenario has been determined using the IDOT Liquefaction Analysis Excel spreadsheet and the indicated GMPE model.

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Appendix G. SGH Material Testing Report

Hoosac Building Material Testing and Masonry Condition Assessment

Charlestown, MA
10 December 2019

SGH Project 191468

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

PREPARED FOR:

Mr. David Duhahn Choi
JACOBS Project Management Co.
120 St. James Avenue, 5th Floor
Boston, MA 02116

PREPARED BY:

Simpson Gumpertz & Heger Inc.
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SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

10 December 2019

Mr. David Duhahn Choi
JACOBS Project Management Co.
120 St. James Avenue, 5th Floor
Boston, MA 02116

Project 191468 – Condition Assessment and Material Testing, Hoosac Building, Charlestown Navy Yard, Charlestown, MA

Dear Mr. Choi:

As you requested, Simpson Gumpertz & Heger Inc. (SGH) completed a masonry condition assessment and representative material testing of various structural elements at the above-named building. This letter summarizes our findings and general recommendations.

Sincerely yours,

Matthew B. Bronski, P.E.
Principal
MA License No. 52573

Pedro F. Sifre, P.E.
Senior Principal
MA License No. 47204

Helena M. Currie
Senior Consulting Engineer

Michael J. Richard
Consulting Engineer

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Encls.

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EXECUTIVE SUMMARY

The Hoosac Building is located at the Charlestown Navy Yard in the Charlestown neighborhood of Boston, Massachusetts. The six-story building was constructed around 1875, with four-to-five wythe thick load-bearing mass masonry exterior walls, cast iron columns and steel girders at the first and second levels, and timber columns and girders at the third level and above. The building was originally built and used for ice storage and was used as a warehouse for miscellaneous storage up until the 1960s, at which time the building was closed and abandoned. The building was listed on the National Register of Historic Places in 1985. The National Park Service (NPS) currently owns the building and wishes to adaptively reuse and convert the building into a museum and/or visitor center, which requires structural analysis of the existing building systems. Thus, NPS enlisted Marble Fairbanks, with JACOBS Project Management Co. (JACOBS) as a subconsultant, to evaluate the existing structure for this purpose.

JACOBS enlisted the services of Simpson Gumpertz & Heger Inc. (SGH) to assist their structural engineering team by assessing the structural properties and condition of the historic structural materials. We understand from conversations with JACOBS that this information will be used by JACOBS in their preliminary structural analysis of the existing building and of various rehabilitation design options. As such, SGH's tasks consist primarily of the following:

- Perform a visual condition assessment of the exterior masonry (brick and mortar) walls, which includes documentation of the approximate location and type of existing deficiencies (e.g., missing, loose, eroded, or otherwise deteriorated masonry) that require repair to restore the original integrity and performance of the exterior walls.
- Coordinate and review exploratory openings in the mass masonry walls to evaluate concealed conditions.
- Collect representative samples and conduct material testing of brick, mortar, timber framing, and steel girder samples to measure existing material properties.
- Review the condition and dimensions of cast iron columns at the first and second levels and recommend, based in part on our historic literature review, estimated material properties for JACOBS to consider including in their structural analysis of the building.

This report summarizes our findings and general recommendations.

Table of Contents

APPENDIX

1. INTRODUCTION

1.1 Background

The Hoosac Building is a six-story mass masonry building constructed circa 1875, is currently owned by the National Park Service (NPS), and is located at the Charlestown Navy Yard in the Charlestown neighborhood of Boston, Massachusetts (Photos 1 – 4). The structural framing system consists of load-bearing brick mass masonry exterior walls, timber columns and beams at upper levels, and cast iron columns and cast steel girders at lower levels (Levels 1 and 2). The building was originally built and used for ice storage, and then was used as a warehouse for miscellaneous storage up until the 1960s, at which time, the building was closed and abandoned. The Hoosac Building was listed on the National Register of Historic Places in 1985.

We understand through conversations with JACOBS that the NPS wishes to evaluate the feasibility of converting the Hoosac Building into a museum and/or visitors center. Thus, NPS enlisted Marble Fairbanks, with JACOBS as a subconsultant, to evaluate the existing structure for this purpose. The existing condition of and material properties for the structural materials (e.g., load-bearing brick mass masonry exterior walls, the cast iron and timber columns, the steel girders, and the timber beams) at the Hoosac Building are unknown. JACOBS anticipates that the building conversion will require analysis of the structure to accommodate new operations, programming and architectural modifications, to evaluate existing deterioration, and to meet modern day building code requirements (e.g., improvements to the building's lateral-load resistance). Thus, JACOBS requested that SGH assess the condition of the mass masonry exterior walls and perform laboratory testing of various structural elements to provide estimated technical properties of the existing historic structural materials (e.g., brick masonry, cast iron columns, steel girders, and timber framing) to better the structural analysis and design.

1.2 Objective and Approach

The objective of SGH's involvement is two-fold: 1) to provide reasonable material property value recommendations for the existing masonry, steel girders, cast iron columns, and timber framing that are appropriate for use in a preliminary structural evaluation of the existing building and of various rehabilitation options, and 2) to provide general repair recommendations to address existing deterioration of the mass brick masonry exterior walls (e.g., cracked, loose, missing, spalled, or otherwise deteriorated masonry).

To determine reasonable material properties for this purpose, we selected a representative number of samples throughout the building to capture the range of conditions present and compared measured values for various technical properties to current and past industry standards (refer to Section 2.2. below).

We also provide recommendations for repairs to brick mass masonry exterior walls that are required to apply the material properties provided herein and to rehabilitate the facade. We do not factor existing deterioration into our recommendations for preliminary material property values, but rather anticipate in-kind repairs and a comprehensive restoration will be completed to address deterioration that would otherwise compromise the integrity and capacity of the structural elements.

Our assessment did not include visual review or evaluation of the roof structure or roofing assembly, as we understand those elements are slated for replacement. Thus, visual observations related to the existing roofing pertain only to water infiltration and/or drainage issues that adversely affect the condition of the structural elements slated to remain (e.g., the load-bearing masonry walls). We understand from conversations with JACOBS that roof replacement and strengthening would likely be required for any of the building rehabilitation options.

1.3 Scope of Work

Per our proposal dated 14 June 2019, our scope of work includes the following:

Task 1 – Field Investigation

- **Task 1A – Visual Condition Assessment:** Conduct a visual condition assessment of the load-bearing brick masonry walls from the ground using binoculars and from the interior, where the masonry is exposed to assess the general condition, and to identify areas of current damage or deterioration that may require repair.
- **Task 1B – Masonry Cores:** Document and collect twelve cores through the full thickness of the exterior brick masonry walls that are representative and capture the range of the existing conditions.
- **Task 1C – Masonry Exploratory Openings:** Document openings and collect brick and mortar samples at twelve exploratory openings in the exterior masonry walls.
- **Task 1D – Timber Samples:** Collect three timber samples for laboratory identification.

- **Task 1E – Timber Grading:** After laboratory identification of the prevalent timber species, visually review in situ and grade representative members (i.e., about 10%) of the existing timber framing.

- **Task 1F – Steel Girder Coupon Samples and Literature Review:** Collect two steel girder coupon samples for laboratory testing and evaluation.

- **Task 1G – Cast Iron Column Dimensions and Material Properties:** Measure the typical existing dimensions of the cast iron columns on the first and second levels of the building and conduct a literature review of historic documents to estimate reasonable material properties.

Task 2 – Laboratory Testing

- **Task 2A – Brick Compressive Strength and Durability Testing:** Conduct laboratory testing of twenty-four brick samples in general accordance with ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile to determine the compressive strength, absorption, and bulk density of each brick sample.

- **Task 2B – Mortar Testing:** Conduct petrographic analysis of four samples of mortar to determine the proportional breakdown of primary components. We will examine the mortar following ASTM C1324 – Standard Test Method for Examination and Analysis of Hardened Masonry Mortar for the composition and relative proportions of each constituent ingredient, and the closest contemporary mortar proportions (e.g., ASTM C270 Types M, S, N, and O) to historic mortar.

- **Task 2C – Timber Testing:** Conduct microscopic review of the wood structure and characteristics of up to three timber samples to identify the species of wood, which is required to visually grade the timber.

- **Task 2D – Steel Testing:** Conduct tensile testing of two steel girder coupon samples in general accordance with ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products, to determine the yield and ultimate tensile strength, compared with the technical properties listed in various historic standards/guidelines for the steel fabrication information (e.g., manufacturer name, etc.) stamped on the steel members, if any.

Task 3 – Information Synthesis and Summary Report

- **Task 3 –** Provide an illustrated report summarizing our key findings, recommendations for masonry, steel girder, cast iron columns, and timber framing material properties that are appropriate for use in a structural evaluation of the building and various rehabilitation options, as well as general repair recommendations for the structural systems included in our review.

2. DOCUMENT REVIEW

2.1 Existing Building Drawings

We reviewed the existing building model and associated drawing sheets, dated 9 September 2019 and provided by JACOBS. The building model provides the following relevant information:

- The Hoosac building is a six-story mass masonry building constructed on wood piles and concrete pile caps.
- Floor framing consists of timber beams and columns at Levels 3 – 6 and cast iron columns and steel girders at Levels 1 and 2.
- Each level of the building is about 11 ft tall.
- The east and west elevations contain few openings in the mass brick masonry exterior walls (i.e., no openings at the east elevation and openings constitute less than 5% of the total area at the west elevation).
- Multiple door and window openings are present at the north and south elevations, at all levels. Two large bays of doors mirror each other on every level at the north and south elevations.
- The roof is pitched to drain toward the south elevation, where there is a gutter with four down leaders.
- A parapet wall is present at the perimeter of the roof at the east, north, and west elevations.

2.2 Relevant Industry Documents

We reviewed the following documents with respect to masonry material properties:

2.2.1 Brick Masonry Material Properties

- **ASCE/SEI 41-13 Standard for Seismic Rehabilitation of Existing Buildings (ASCE/SEI 41-13, as referenced in the International Existing Building Code, 2015 edition)**
  Chapter 11-Masonry (ASCE/SEI 41-13).
- ASCE/SEI 41-13 (ASCE 41-13) provides guidance for solid or hollow clay-unit masonry and outlines the lower-bound masonry properties acceptable for use in linear structural analysis when the existing materials properties are unknown and are likely to significantly differ from those specified in current codes. Table 11-2(a) of the standard (Figure 1) provides the default lower value strengths for unreinforced masonry. Note that the table erroneously refers to TMS 402 (also known as the ACI 530 code) Section 3.2.4 for determining the lower bound shear strengths. ASCE 41-13 references TMS 402-13, but the referenced Section 3.2.4 is from TMS 402-11. The corresponding section in TMS 402-13 is Section 9.2.6.

Table 11-2(a). Default Lower-Bound Unreinforced Masonry Strengths

Material	Solid Units	Hollow Concrete Units
Compressive strength[a]	1,000 lb/in.^{2} × 0.6	1,350 lb/in.^{2} × 0.6
Flexural tensile strength	75 lb/in.^{2} × 0.6	48 lb/in.^{2}[b] (158 lb/in.^{2})[c] × 0.6
Shear strength	[d]	[d]

[a]Clay f'_m is based on 2,100 lb/in.^{2} unit compressive strength and Type N mortar. Hollow concrete f'_m is based on 1,900 lb/in.^{2} unit net compressive strength and Type N mortar on face shells only.
[b]Ungrouted hollow concrete blocks.
[c]Solid grouting of hollow concrete blocks; may be interpolated for partial grouting based on net area.
[d]Strength shall be taken as 80% of shear strength values determined in accordance with Section 3.2.4 of TMS 402.

Figure 1 – Excerpt from ASCE 41-13, Table 11-2, indicates default lower-bound technical properties for brick masonry depending on the condition category.

Table 11-1. Factors to Translate Lower-Bound Masonry Strengths to Expected Strengths

Strength	Factor
Compressive strength (f_{me})	1.3
Flexural tensile strength	1.3
Shear strength	1.3

Figure 2 – Excerpt from ASCE/SEI 41-13, Table 11-1, indicates factors to convert lower-bound technical properties to expected strength masonry properties.

We use the previous edition of this standard, ASCE/SEI 41-06 (ASCE 41-06), as an additional reference. ASCE 41-06 also provides guidance for solid or hollow clay-unit masonry and outlines the lower-bound masonry properties acceptable for use in linear structural analysis. Lower-bound properties provided in ASCE 41-06 correspond to condition categories, such as "good," "fair," or "poor," (Figure 3), which is based on the type of component, the anticipated mode of inelastic behavior, and the nature and extent of the damage or deterioration. The Commentary in ASCE 41-06 states that default lower-bound values for masonry compressive strength, flexural tensile strength, and masonry shear strength "shall be determined by multiplying lower-bound values by an appropriate factor taken from Table 7-2" (Figure 4), and that the default lower-bound values are generally lower than those provided in the International Building Code for more modern building materials.

Table 7-1. Default Lower-Bound Masonry Properties

Property	Masonry Condition[1] Good	Fair	Poor
Compressive Strength (f'_m)[2]	900 psi	600 psi	300 psi
Elastic Modulus in Compression	$550f'_m$	$550f'_m$	$550f'_m$
Flexural Tensile Strength[3]	20 psi	10 psi	0
Shear Strength[4]			
Masonry with a Running Bond Lay-Up	27 psi	20 psi	13 psi
Fully Grouted Masonry with a Lay-Up Other Than Running Bond	27 psi	20 psi	13 psi
Partially Grouted or Ungrouted Masonry with a Lay-Up Other Than Running Bond	11 psi	8 psi	5 psi

Figure 3 – Excerpt from ASCE/SEI 41-06, Table 7-1, indicates default lower-bound technical properties for brick masonry depending on the condition category.

Table 7-2. Factors to Translate Lower-Bound Masonry Properties to Expected Strength Masonry Properties[1]

Property	Factor
Compressive Strength (f_{me})	1.3
Elastic Modulus in Compression[2]	—
Flexural Tensile Strength	1.3
Shear Strength	1.3

[1]See Chapter 6 for properties of reinforcing steel
[2]The expected elastic modulus in compression shall be taken as $550f_{me}$ where f_{me} is the expected masonry compressive strength.

Figure 4 – Excerpt from ASCE/SEI 41-06, Table 7-2, indicates factors to convert lower-bound technical properties to expected strength masonry properties.

2.2.2 Cast Iron Material Properties

We reviewed the following relevant, historical cast iron and steel standards for structural construction applications:

- **1920 Carnegie Steel Company Pocket Companion (1920 Pocket Companion) and 1993 Building Officials and Code Administrators (BOCA) National Building Code**

  The 1920 Pocket Companion is an historic publication that would have been commonly used by engineers and builders in the early twentieth century. The 1993 BOCA National Building Code is a more modern standard and is the latest version of a model code to prescribe cast iron allowable compressive stress values. Both standards, despite being published decades apart, recommend using an allowable cast iron compressive stress of 9,000 pounds per square inch (psi), less 40 psi, and multiplied by the ratio of column length to radius of gyration (l/r).

- **The Building Law of the City of Boston (published circa 1900)**

  This historic publication provides a table to determine the allowable cast iron compressive stress for columns based on column length and diameter (Figure 5).

ACTS, 1892. — CHAP. 419. 15

Cast Iron.

Stresses in Pounds per Square Inch.

Extreme fibre stress, tension, ... 2,500
Extreme fibre stress, compression, . . . 8,000

For Columns.

The stresses given in the following table, in which L = length of column in feet, D = external diameter, or at least side of rectangle in inches, and S = stress in pounds per square inch. **Stresses of materials.**

	ROUND COLUMNS.			RECTANGULAR COLUMNS.		
$\frac{L}{D}$	S Square Faced Bearings.	S Round and Faced Bearings.	S Round Bearings.	S Square Faced Bearings.	S Round and Faced Bearings.	S Round Bearings.
1.0	8,480	7,870	7,350	8,810	8,320	7,870
1.1	8,210	7,540	6,970	8,600	8,030	7,540
1.2	7,940	7,200	6,590	8,380	7,740	7,200
1.3	7,670	6,870	6,220	8,140	7,450	6,870
1.4	7,390	6,540	5,860	7,910	7,160	6,540
1.5	7,120	6,220	5,530	7,670	6,870	6,220
1.6	6,850	5,910	5,200	7,430	6,590	5,910
1.7	6,580	5,620	4,900	7,190	6,310	5,620
1.8	6,320	5,330	4,620	6,960	6,040	5,330
1.9	6,060	5,060	4,350	6,730	5,780	5,060
2.0	5,810	4,810	4,100	6,490	5,530	4,810
2.1	5,580	4,570	3,870	6,270	5,280	4,570
2.2	5,340	4,340	3,650	6,050	5,050	4,340
2.3	5,120	4,120	3,440	5,830	4,830	4,120
2.4	4,910	3,910	3,250	5,620	4,620	3,910
2.5	4,710	3,720	3,080	5,420	4,410	3,720
2.6	4,510	3,540	2,910	5,230	4,220	3,540
2.7	4,330	3,370	2,760	5,040	4,040	3,370
2.8	4,150	3,210	2,620	4,860	3,870	3,210
2.9	3,980	3,060	2,480	4,680	3,700	3,060
3.0	3,820	2,920	2,360	4,520	3,540	2,920
3.1	3,660	2,780	2,240	4,350	3,390	2,780
3.2	3,520	2,660	2,130	4,200	3,250	2,660
3.3	3,380	2,540	2,030	4,050	3,120	2,540
3.4	3,250	2,430	1,940	3,910	2,990	2,430

Figure 5 – Excerpt from "The Building Law of the City of Boston" indicates the cast iron allowable compressive stresses for various column geometries.

2.2.3 Steel Girder Material Properties Literature Review

- **The Building Law of the City of Boston (published circa 1900)**

  This historic publication provides tabulated allowable stresses for steel (Figure 6) with an ultimate tensile strength (F_u) of 60,000 – 68,000 psi and a yield strength (F_y) of no less than 35,000 psi.

- **Pencoyd Iron Works' Steel in Construction (1898)**

  This historic publication refers to Pencoyd Iron Works (Pencoyd, also known as A. & P. Roberts Company) and lists a range of ultimate tensile strength for steel girders from 54,000 psi to 68,200 psi and corresponding yield strengths from 32,500 psi to 41,000 psi. Pencoyd is a mill that operated from 1852 through the 1940s. It produced both wrought iron and steel during the 1880s and 1890s time. The Pencoyd publication also provides dimensions and weights for typical "Pencoyd beams" (Figure 7).

Wrought Iron and Steel.

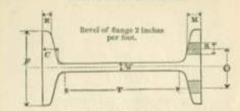
Stresses in Pounds per Square Inch.

Stresses of materials.

	W. I.	Steel
Extreme fibre stress, rolled beams, and shapes,	12,000	16,000
Tension,	12,000	15,000
Compression in flanges of built beams,	10,000	12,000
Shearing,	9,000	10,000
Direct bearing, including pins and rivets,	15,000	18,000
Bending on pins,	18,000	22,500

Figure 6 – Excerpt from “The Building Law of the City of Boston” indicates allowable stresses for wrought iron and steel.

PENCOYD BEAMS.



Dimensions in inches.

Section Number.	Size of Beam.	Weight Pounds per Foot.	Area of Section.	W.	F.	C.	E.	O.	R.	M.	T.
240B	24	80.0	23.53	.50	7.00	1.14	.60	4.50		.81	20.70
241B	24	85.0	25.00	.56	7.06	1.14	.60	4.50		.81	20.70
242B	24	90.0	26.47	.56	7.42	1.21	.64	4.50		.88	20.48
243B	24	95.0	27.92	.62	7.48	1.21	.64	4.50		.89	20.48
244B	24	100.0	29.42	.68	7.54	1.21	.64	4.50		.89	20.48
200B	20	65.0	19.12	.50	6.25	1.03	.55	4.00		.74	16.92
201B	20	70.0	20.59	.56	6.31	1.03	.55	4.00		.74	16.92
202B	20	75.0	22.06	.64	6.39	1.03	.55	4.00		.75	16.92
203B	20	80.0	23.53	.63	6.75	1.12	.61	4.25		.82	16.52
204B	20	85.0	25.00	.70	6.82	1.12	.61	4.25		.82	16.52
205B	20	90.0	26.47	.78	6.90	1.12	.61	4.25		.83	16.52
206B	20	95.0	27.94	.74	7.24	1.25	.68	4.50		.92	15.86
207B	20	100.0	29.41	.81	7.31	1.25	.68	4.50		.93	15.86
180B	18	55.0	16.18	.46	6.00	.92	.46	3.75		.65	15.19
181B	18	60.0	17.65	.54	6.08	.92	.46	3.75		.65	15.19
182B	18	65.0	19.12	.63	6.17	.92	.46	3.75	[illegible] to [illegible]	.66	15.19
183B	18	70.0	20.59	.62	6.50	1.01	.52	4.00		.73	14.76
184B	18	75.0	22.06	.71	6.58	1.01	.52	4.00		.74	14.76
185B	18	80.0	23.53	.79	6.66	1.01	.52	4.00		.74	14.76
186B	18	85.0	25.00	.74	7.00	1.16	.61	4.50		.83	14.04
187B	18	90.0	26.47	.82	7.08	1.16	.61	4.50		.84	14.04
150B	15	42.0	12.35	.41	5.50	.83	.41	3.25		.60	12.47
151B	15	45.0	13.23	.46	5.54	.83	.41	3.25		.60	12.47
152B	15	50.0	14.70	.48	5.82	.90	.46	3.50		.65	12.21
153B	15	55.0	16.18	.58	5.92	.90	.46	3.50		.66	12.21
154B	15	60.0	17.65	.55	6.17	1.04	.57	3.75		.77	11.82
155B	15	65.0	19.12	.65	6.27	1.04	.57	3.75		.78	11.82
156B	15	70.0	20.58	.63	6.43	1.17	.69	4.00		.89	11.41
157B	15	75.0	22.06	.73	6.53	1.17	.69	4.00		.90	11.41
158B	15	80.0	23.53	.83	6.63	1.17	.69	4.00		.91	11.41

PENCOYD BEAMS.

Dimensions in inches.

Section Number.	Size of Beam.	Weight Pounds per Foot.	Area of Section.	W.	F.	C.	E.	O.	R.	M.	T.
120B	12	31.5	9.26	.35	5.00	.74	.35	3.00	[illegible] to [illegible]	.52	9.76
121B	12	35.0	10.29	.42	5.07	.74	.35	3.00	[illegible] to [illegible]	.52	9.76
122B	12	40.0	11.76	.42	5.25	.88	.48	3.25	[illegible] to [illegible]	.65	9.35
123B	12	45.0	13.23	.54	5.37	.88	.48	3.25	[illegible] to [illegible]	.66	9.35
124B	12	50.0	14.70	.55	5.68	.98	.56	3.50	[illegible] to [illegible]	.74	9.04
125B	12	55.0	16.18	.56	5.75	1.10	.67	3.50	[illegible] to [illegible]	.86	8.68
126B	12	60.0	17.65	.68	5.87	1.10	.67	3.50	[illegible] to [illegible]	.87	8.68
127B	12	65.0	19.12	.80	5.99	1.10	.67	3.50	[illegible] to [illegible]	.88	8.68
100B	10	25.0	7.35	.31	4.66	.67	.31	2.75	[illegible]	.47	7.96
101B	10	30.0	8.82	.44	4.79	.67	.31	2.75	[illegible]	.48	7.96
102B	10	35.0	10.29	.44	5.00	.81	.43	3.00	[illegible]	.60	7.47
103B	10	40.0	11.76	.59	5.15	.81	.43	3.00	[illegible]	.61	7.47
90B	9	21.0	6.18	.29	4.33	.63	.29	2.50	[illegible]	.44	7.09
91B	9	25.0	7.35	.39	4.43	.63	.29	2.50	[illegible]	.45	7.09
92B	9	30.0	8.82	.56	4.60	.63	.29	2.75	[illegible]	.45	7.09
93B	9	35.0	10.29	.72	4.76	.63	.29	2.75	[illegible]	.46	7.09
80B	8	18.0	5.29	.27	4.00	.58	.27	2.25	[illegible]	.42	6.21
81B	8	20.5	6.03	.34	4.07	.58	.27	2.25	[illegible]	.42	6.21
82B	8	23.0	6.76	.41	4.17	.58	.27	2.50	[illegible]	.41	6.21
83B	8	25.5	7.50	.53	4.26	.58	.27	2.50	[illegible]	.42	6.21

PENCOYD BEAMS.

Dimensions in inches.

Section Number.	Size of Beam.	Weight Pounds per Foot.	Area of Section.	W.	F.	C.	E.	O.	R.	M.	T.
70B	7	15.0	4.41	.25	3.66	.53	.25	2.00	[illegible]	.39	5.34
71B	7	17.5	5.15	.34	3.75	.53	.25	2.00	[illegible]	.39	5.34
72B	7	20.0	5.88	.45	3.86	.53	.25	2.25	[illegible]	.38	5.34
60B	6	12.25	3.60	.23	3.33	.49	.23	1.75	[illegible]	.36	4.46
61B	6	14.75	4.34	.34	3.44	.49	.23	1.75	[illegible]	.37	4.46
62B	6	17.25	5.07	.46	3.56	.49	.23	2.00	[illegible]	.38	4.46
50B	5	9.75	2.87	.21	3.00	.44	.21	1.75	[illegible]	.31	3.59
51B	5	12.25	3.60	.34	3.13	.44	.21	1.75	[illegible]	.32	3.59
52B	5	14.75	4.34	.49	3.28	.44	.21	2.00	[illegible]	.32	3.59
40B	4	7.50	2.20	.19	2.66	.40	.19	1.50	[illegible]	.29	2.72
41B	4	8.50	2.50	.24	2.71	.40	.19	1.50	[illegible]	.29	2.72
42B	4	9.50	2.79	.32	2.79	.40	.19	1.75	[illegible]	.28	2.72
43B	4	10.50	3.09	.39	2.86	.40	.19	1.75	[illegible]	.28	2.72
30B	3	5.50	1.62	.17	2.33	.35	.17	1.25	[illegible]	.26	1.85
31B	3	6.50	1.91	.24	2.40	.35	.17	1.25	[illegible]	.27	1.85
32B	3	7.50	2.20	.34	2.50	.35	.17	1.50	[illegible]	.25	1.85
63B	6	32.3 to 37.4	9.49 to 10.99	.50	4.88	.87	.50	3.00	[illegible] to [illegible]	.66	3.00
67B	6	41.0 to 46.1	12.06 to 13.56	.63	5.25	1.05	.52	3.25	[illegible] to [illegible]	.81	2.60

Figure 7 – Excerpt from “Pencoyd Iron Works’ Steel in Construction (1898)” indicates typical Pencoyd beam dimensions and weights.

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3. FIELD INVESTIGATION

Helena M. Currie, Andrew N. Gillis, Holbrook C. Phelan, Michael J. Richard, and Matthew D. Roll of SGH visited the Hoosac Building (Photos 1 – 4) between 1 and 16 October to document the existing construction and condition of the exterior masonry walls via binoculars and aerial lift, to collect masonry cores and samples, and to review exploratory masonry openings made by the assisting contractor, Riggs Construction. We also collected steel girder coupon samples, documented cast iron column geometry at Levels 1 and 2, collected timber species identification samples, and visually graded representative timber framing. Below is a summary of our key observations.

3.1 Exterior Masonry Wall Construction

We observed twelve masonry cores through the full-depth of the exterior load-bearing masonry walls and reviewed concealed conditions at twelve masonry openings (Photo 5) at the interior to confirm the thickness of the wall and extract brick and mortar samples from the interior and middle wythes for laboratory testing (refer to Sections 4.1 and 4.2). We collected a mortar sample from the collar joint between the inner and middle wythe at each masonry opening. Masonry core and exploratory opening locations are indicated on Sheets A1 – A4 (exterior elevations) and Sheets A18 – A21 (interior elevations) on Appendix A (attached).

From the full-thickness masonry cores, we determined that the exterior walls are five wythes thick at Levels 1 – 5 and transition to four wythes thick at Level 6 on each of the elevations. Brick coursing is a running bond with headers located about every eight courses. Mortar within the cores at collar joints between wythes is generally intact (i.e., non-friable). Mortar at the exterior is about 1/4 in. to 1/2 in. deep and tinted red, whereas the mortar at all interior and middle wythes is off-white. The condition of the red and off-white mortars are similar (i.e., generally intact and non-friable) and are consistent at all openings (i.e., does not significantly vary based on the level, coordinal direction, and/or severity of deterioration of the exterior wythe at the exploratory opening). The brick at the inner, outer, and middle wythes is reddish-orange and fairly consistent in color. Where brick was removed by the assisting contract, new or salvaged brick was installed with new mortar to provide a reasonable match to the existing adjacent masonry, in general accordance with our letter dated 2 October 2019.

3.2 Visual Condition Assessment Observations

We performed a visual survey of the exterior load-bearing masonry (i.e., brick and mortar) walls from the ground using binoculars and from an aerial lift at representative areas along the upper levels. We performed a visual condition assessment of the interior face of the load-bearing masonry walls at all levels and elevations where safe access was provided (i.e., where flooring was not heavily stained or rotted and where materials were not stockpiled up against the exterior wall) and where the masonry was exposed (i.e., not covered with drywall or concealed by stored materials). Refer to Appendix B for key exterior masonry observations made during our visual condition assessment.

The masonry within 4 ft of grade is typically eroded at all elevations, and erosion is most severe at the north elevation, where the building is adjacent to a public sidewalk (Photos 6 and 7). There are several locations where the outer wythe of brick is missing at or near grade. Eroded brick and mortar joints are also present on all elevations well above from grade, particularly at the south elevation (Photo 8). Eroded and face-spalled brick is bright orange in color where it's lost its fire-skin and surface soiling.

We observed several locations where brick masonry is displaced out-of-plane (i.e., bulged outward) with respect to the adjacent masonry, particularly adjacent to openings at the north and south elevations (Photos 9 and 10, respectively). Eroded and displaced brick masonry is also typically present below the roof level (i.e., at the parapet on the east, north, and west elevations, and below the gutter at the south elevation; Photo 11). Brick masonry adjacent to doors at the east and west elevations is previously rebuilt in many locations (i.e., the brick and/or mortar does not match the color and texture of the surrounding masonry). In many locations, bulged brick masonry is present at previously rebuilt areas (Photo 10).

We observed cracked brick and mortar joints at all elevations, within the field of the wall at the east elevation (Photo 12), above window heads (Photo 13), and at brick opening returns (Photo 14) at the north and south elevations. Miscellaneous steel is embedded through the masonry walls, such as corroded steel hinges at all brick returns at doors at the north and south elevation (Photo 14).

We also conducted a survey of the interior side of the exterior load-bearing masonry walls where those walls are visible and could be readily accessed (i.e., not concealed by drywall, stored materials, and/or paint). Mortar joint deterioration, bulged brick, and cracking is typically present within the vicinity of full-depth openings in the walls (i.e., windows, doors; Photos 15 – 17), at corroded bearing plates beneath timber beams and corroded steel girders and at window heads

(Photos 18 and 19, respectively), and directly below the roof level. We observed deteriorated mortar joints at the east elevation at Level 6 for virtually the entire length of the wall.

3.3 Timber Grading Observations

We conducted limited grading of certain timber framing elements in the building. Our timber grading was localized and limited as follows:

- We did not grade existing timber decking material.
- We did not grade existing roof purlins or decking per client request as we understand that the existing roof will likely be replaced during future building renovations.
- Of the timber elements that we did visually survey and grade, per your request our work was limited to representative members, and did not include 100%of those timber elements throughout the existing building.
- Additionally, of the timber elements that we did grade, we did not visually grade any existing timbers, which were partially obstructed, heavily painted, and/or inaccessible at the time of SGH's site visits.

On 15 and 18 October 2019, using the results of SGH's limited timber species identification (refer to Section 4.3), SGH conducted a limited visual grading survey of select existing heavy timber beams and timber columns within the building. We visually graded exposed timber surfaces at a limited number of existing heavy timber beams, and columns at each level, using the 2014 Standard Grading Rules for Southern Pine Lumber by the Southern Pine Inspection Bureau (SPIB). The results of our timber grading are summarized in Appendix C.

While not the focus of our visual grading and evaluation, we also observed that the timber framing is stained at masonry pockets near beam ends (i.e., where the wood is in direct contact with the masonry) and at the wood roof decking (Photo 20).

3.4 Cast Iron Column Observations

We performed exploratory holes at drilled through the full depth of two cast iron columns at Levels 1 and 2 to determine the outer diameter and wall thickness of each column (refer to Appendix A). We obtained the following column dimensions:

- Column at the first floor (Grid Location E-2): Outer diameter of 13-1/4 in. ± with a wall thickness of 1-1/2 in.
- Column at the second floor (Grid Location C-2): Outer dimension of 12-1/2 in. ± with a wall thickness of 1-1/4 in.

Most columns are wrapped in fireproofing, and conditions beyond those exposed at exploratory locations are unknown.

3.5 Steel Girders

The steel girders consist of S-shapes (or the closest historical equivalent to S-shapes) that are wrapped in fireproofing, and thus, our observations are limited to areas where the girders are exposed. We observed at least one location where a girder is stamped “PENCOYD” on the interior face of a second-floor framing girder, near Column Line H-4 (Photo 21), which is an iron and steel manufacturer based out of the Philadelphia, Pennsylvania area. The outer surface of the girder exhibits surface corrosion, but we observed no areas with obvious section loss.

4. LABORATORY TESTS

4.1 Brick Compressive Strength and Durability Testing

We conducted brick compressive strength and durability testing in accordance with ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile to determine the compressive strength, absorption, and bulk density of twenty-four brick samples (refer to Appendix D for complete ASTM 67 results). The average brick compressive strength 4,645 psi, the maximum recorded strength is 8,020 psi, and the minimum recorded strength is 2,640 psi.

4.2 Mortar Testing

We conducted chemical analyses and petrographic examinations on four existing masonry mortar samples, one from each elevation, to determine the general composition and proportions of the constituents in the historic masonry mortar. We conducted petrographic examination in accordance with ASTM C1324 – Standard Test Method for Examination and Analysis of Hardened Masonry Mortar. The petrographic examination indicates the mortar at all elevations is the closest match to contemporary mortar ASTM C270 Type O in terms of cement-to-lime ratio; however, the higher 1:2 binder to aggregate ratio of the mortar at Hoosac would tend to result in a stronger mortar than if the more traditional 1:3 binder to aggregate ratio were used. Refer to Appendix E for summary of petrographic results.

4.3 Wood Species Identification

We made gross and microscopic visual examinations of five (5) wood samples collected on site to identify the species of wood. We concluded that the heavy timber beam and column samples are most likely southern pine or southern yellow pine *(Pinus spp.)*. We determined that the existing wood decking sample is most likely eastern spruce *(Picea spp.)* or less likely larch (*Larix spp.)* Refer to Appendix F for results of our microscopic observations.

4.4 Steel Girder Coupon Testing

We extracted steel coupons (approximately 1-1/2 in. by 10 in.) from the top flanges of two girders near exterior walls. We extracted Sample S1 from the Level 2 framing steel near H-6, and Sample S2 from the Level 3 framing steel near A-2 (refer to Appendix A for sample locations). We machined these coupon test specimens and tested them in direct tension per ASTM A370, and recorded the following results:

Specimen ID	Cross-Sectional Area (in.²)	Yield Strength (ksi)	Strain at Yield (%)	Modulus of Elasticity (psi)	Ultimate Tensile Strength (ksi)	Elongation After Break (%)
S1	0.148	33.7	0.33	28,867,483	54.6	31.3
S2	0.147	39.5	0.33	29,777,252	62.8	37.4

Table 1 – ASTM 370 Steel Tension Test Results

5. DISCUSSION AND CONCLUSIONS

5.1 Load-Bearing Masonry Walls

The solid masonry exterior walls at the Hoosac Building are almost 150 yrs old, and despite localized areas of masonry deterioration (e.g., cracked, eroded, spalled, loose brick and mortar) etc. at the exterior and interior, the core of the masonry walls (i.e., the portion of the walls between the outermost and innermost wythes) appear to be relatively intact and sound. Thus, repair or localized rebuilding of masonry will likely only be required in areas that are obviously deteriorated at the inner or outer wythe. We identified no conditions at exploratory openings or masonry cores that suggested underlying (concealed) deterioration is present, where damage is not readily apparent at the exterior or interior surface.

Masonry deterioration at the outer wythe is generally consistent with the age of the building, except at the south elevation where the masonry wall is close to the water, and the slope of the roof above is pitched to drain water out and over the south elevation. Additionally, on all four elevations, the brick and mortar at the exterior wythe are heavily eroded within the bottom 4 ft of grade, which is consistent with damage caused by snow accumulation against the side of the building, and the use of deicing salts near grade. If not addressed, areas of missing or deteriorated masonry constitute localized weaknesses in the building enclosure, which provide avenues for water infiltration and increased rate of future deterioration. Although the brick masonry walls are unreinforced, much of the masonry deterioration at the inner wythe is associated with localized embedded metal (e.g., steel hardware, hinges, lintels, etc.), and thus, the underlying mechanism for masonry deterioration in these locations is likely corrosion-related expansion of the embedded metal.

Note that step cracks in the masonry can be caused by irreversible long-term thermal and moisture expansion of the long masonry spandrel and pier panels, which expand past the corners of window openings causing cracking; such cracking is symptomatic of typical mass masonry wall behavior.

Of the brick we tested, the average brick compressive strength is 4,645 psi and the minimum compressive strength from our representative sampling is 2,640 psi, both of which are more than three times that of the lower bound compressive strength for masonry rated as “good” in ASCE 41-06 (i.e., 900 psi). Because the average and minimum compressive strengths are substantially greater than the values listed in ASCE 41 for “good” masonry, and because the wall is intact (i.e., the mortar is non-friable at all cores and exploratory opening locations), it is reasonably conservative to use 900 psi as a lower-bound compressive strength value for the exterior masonry wall systems, multiplied by a 1.3 factor, for an expected compressive strength of about 1,200 psi. This is higher than the lower bound compressive values from ASCE 41-13 (i.e., 1,000 x 0.6 x 1.3 = 780 psi) but appropriate given the brick and mortar testing results and our observations. If, for some reason, deteriorated areas of wall are not repaired in this project, we suggest making the analysis with lower values consistent with the conditions in the field.

For flexural strength, based on the mortar Type O classification, we recommend using the more conservative lower bound 20 psi value of ASCE 41-06 for masonry in good condition rather than the 45 psi value (75 x 0.6) from ASCE 41-13.

The recommended compressive strength is appropriate as the basis for calculating the shear strength and elastic modulus per ASCE 41-13 which references the provisions TMS 402-13.

Mortar testing results indicate the constituent proportions of the existing mortar most closely match contemporary mortar Type O; however, the higher 1:2 binder to aggregate ratio would tend to result in a stronger mortar than if the more traditional 1:3 binder to aggregate ratio were used. Thus, Type N mortar, which is stronger than Type O and is most appropriate for use in exterior/severe weather conditions according to the NPS Brief 2 – Repointing Mortar Joints in Historic Masonry Buildings and other industry standards, is a defensible alternative to using Type O mortar.

5.2 Timber Framing

Our timber species identification and in-situ visual timber grading activities on site were limited and do not represent a full existing conditions survey of all the timber components comprising the structural system of the building. The test results we provide (Appendix C) are intended to provide the SER, when used in conjunction with the National Design Specification for Wood Construction (NDS), with general wood material properties for the existing timbers for their feasibility study.

We made gross and microscopic visual examinations of the five wood samples collected on site to identify the species of wood. We concluded that the heavy timber beam and column samples are most likely southern pine or southern yellow pine *(Pinus spp.)*. Given the age of the building (circa 1870s), site location (Boston, Massachusetts), and the likelihood that all current existing timbers date back to the original building's construction, it is reasonable to assume that all timber structural beams and columns (excluding the roof level) are southern pine (*Pinus spp.*).

The structural grade of individual timber framing members can be assessed visually by trained professionals, and is based on among others, wood species, member dimensions, slope of grain, and the size and locations of knots. As such, the timber grade is specific to each individual member graded, and therefore, grades vary across the population of timbers considered. Timber grading does not incorporate existing deterioration or damage but rather the inherent quality of the individual timber member (as originally fabricated).

We observed a wide range of beam and column timber grades at the above-noted building (refer to Appendix C). While some structural elements observed were of higher quality (Select Structural or No. 1 Grade), we also observed timber elements with natural growth characteristics consistent with the lowest grade (No. 3 Grade) recognized by the SPIB grading rules.

5.3 Cast Iron Columns

The referenced BOCA Code equation for allowable compressive stress is a recognized industry standard that we recommend for calculating the allowable loads for cast iron columns.

Because of the variability in material quality and the possibility of casting imperfections, it is prudent to avoid subjecting the cast iron columns to tension stresses or eccentric loading. Additionally, cast iron's lack of ductility and quality control suggests that the live load imposed on a cast iron column should not exceed that experienced in its previous or current use. Note also that cast iron has a reputation within the firefighting field as being prone to sudden failure when heated in a fire and subsequently cooled by water.

5.4 Steel Girders

We use "The Building Law of the City of Boston" as a reference that reflects practice in Boston at the turn of the century as one way of benchmarking the design of the building and providing context for the tensile test results. While the "The Building Law of the City of Boston" provides allowable loads for steel, it also notes that the values are for steel with an ultimate tensile strength (F_u) of 60,000 psi to 68,000 psi, and a yield strength (F_y) of no less than 35,000 psi. Based on the tensile strength measured from the two existing coupons (Table 1), it is reasonable to use the yield and ultimate tensile strengths provided in the "The Building Law of the City of Boston" of F_y equal to 35,000 psi and F_u equal to 60,000 psi. However, this is slightly less conservative than the lowest yield and ultimate tensile strengths provided in the Pencoyd Iron Works' 1898 publication "Steel in Construction" of F_y equal to 32,500 psi and F_u equal to 54,000 psi. Thus, it is more conservative and arguably more appropriate to use the Pencoyd technical property values for modeling and evaluating the steel girders at the Hoosac Building.

We suggest using LRFD (Load and Resistance Factor Design) under the 2010 AISC Specification for Steel for Structural Steel Buildings, referenced by the 2015 IBC, as the design basis using the values above. The testing exhibited excellent ductility that is consistent with the materials covered under the AISC specification. Because we focused our observations of girders on the extraction of samples for each application, we suggest verifying the actual girder dimensions in the field to determine section properties and using the historic Pencoyd Beam dimensions and geometric properties that most closely match the existing steel girders.

6. RECOMMENDATIONS

6.1 Load-Bearing Masonry Walls

Based on our review of ASCE 41-06, laboratory compressive strength testing, mortar analysis, and condition assessment observations, we recommend using the following reasonably conservative material properties for preliminary modeling, understanding that localized repairs need to be completed to restore the integrity of the load-bearing masonry walls:

- Assume the load-bearing masonry walls are in "good" condition with respect to ASCE 41-06 definitions and use the lower bound material properties associated with brick in "good" condition as a basis for preliminary analysis (i.e., 1,200 psi). In our judgement, this value could reasonably and defensibly be increased above the values for "good" masonry in ASCE 41, based on the mortar being sound and intact, and the lowest value from brick compressive testing being approximately three times larger than that of the compressive strength allowed for "good" masonry in ASCE 41. The use of this value is also consistent with the provisions of ASCE 41-13 taking into account the material testing.
- For flexural strength, we recommend using 20 psi with the 1.3 factor in Fig. 2 rather than the 45 psi value (75 x 0.6) from ASCE 41-13.
- For shear strength and elastic modulus, the recommended compressive strength is appropriate as the basis for calculating the respective values per ASCE 41-13 and TMS 402-13.
- Repair or replace localized areas of deteriorated masonry as follows:
    - Repoint all eroded, deteriorated, or missing mortar joints.
    - Provide Type N mortar at all brick masonry repairs and repointing areas to most closely align with the existing mortar.
    - Remove and replace deeply eroded, spalled, or missing brick.
    - Rebuild bulged and/or displaced brick.
    - Remove and replace all existing exterior windows and doors with weathertight assemblies.
    - Remove masonry adjacent to embedded metal, and either remove or clean and coat corroded metal prior to rebuilding masonry surrounds.
    - If desired aesthetically, remove and replace existing previously rebuilt brick to provide a closer aesthetic brick and mortar match to the existing brick masonry.

Additionally, we recommend reconfiguring the roof slope and drainage system to eliminate roof runoff water that runs over the exterior masonry at the south elevation. This could involve either adequately designed and sized gutters and exterior down leaders, or an entirely different drainage system, such as internal drainage. We also recommend strategizing snow removal procedures that do not pile snow against the base of the exterior walls, and do not utilize de-icing salts in direct contact with the masonry.

6.2 Timber Framing

Based on our limited site observations and wood sampling of existing timber elements, we recommend the following to the Structural Engineer-of-Record (SER):

- Consider the heavy timber beams and columns to be southern pine.
- Assume spruce-pine-fir species group properties for the existing timber decking.
- Given the varied timber grades we observed on site (Appendix C), conservatively select one of the following three approaches for structurally modeling the material properties of the timber framing:
  - Option 1 – Assume No. 3 Grade for all Timber: Consider globally a lower grade of southern pine timber (e.g., No. 3 Grade) as appropriate for their structural analyses of beams and columns.
  - Option 2 – Assume No. 2 Grade or Better for all Timber: If the SER chooses to consider a higher grade of timber (e.g., No. 2 Grade or better) for their preliminary structural analyses of timber beams and columns, the project team will need to conduct a subsequent comprehensive visual grading survey to identify timbers with a lower stress grade than that considered by the SER. After the subsequent comprehensive grading, the SER will either need to refine the timber properties, or the project team will need to account for strengthening/replacement of lower grade timbers.
  - Option 3 – Model Existing Conditions: Rather than use the conservative or iterative modeling approaches described above, consider a comprehensive grading survey initially to determine the exact grade of timbers to include in preliminary modeling to identify whether any will require strengthening/replacement to accommodate the loading demands of the proposed renovations.

We also recommend the SER evaluate (i.e., probe) wood elements that is anticipated to remain, particularly where water-stained and/or potentially soft (e.g., at the top floor and at beam ends, where wood is in direct contact with masonry) to determine whether localized wood repairs or replacement are required to address deterioration.

6.3 Cast Iron and Steel Framing

Steel Beam and Girder Recommendations

We recommend using LRFD methodology with the 2010 AISC provisions and IBC load factors. For material properties, we recommend using the yield and ultimate tensile strengths provided in the Pencoyd Iron Works' 1898 publication "Steel in Construction" of F_y equal to 32,500 psi and F_u equal to 54,000 psi.

For any modification to beams or girders, we recommend testing the material for weldability by means of a chemical analysis, or by a bend test consisting of a trial installation of a rod or bar welded to the existing element that requires welding.

Cast Iron Column Recommendations

We recommend using an allowable compressive load determined by the 9,000 psi less 40 psi multiplied by the ratio of effective column length to radius of gyration, but do not exceed the load calculated using the existing structure and posted live loads in the building. If a column has inadequate strength to accommodate the new programming and/or anticipated architectural interventions using the method above, we recommend installing a new column or columns arranged to bypass the existing column (perhaps using the existing column to shore the load until completion) and jacking the new columns to fully transfer loads to them. Such a scheme will likely require modifying the existing steel girders. Do not alter or install any attachments, which impose moments or eccentricities into the existing columns. Concealing a new steel column designed to take the full load alone inside of the existing historic cast iron columns is an alternative approach that will preserve the historic appearance of the columns. However, this approach poses significant challenges in terms of temporary shoring, and removing, altering, splice detailing, and reinstalling the existing columns with the structural steel inserts.

Additionally, cast iron columns have fire ratings on the order of minutes. Any reuse scenario should identify the best approach to achieve a desired rating. Given that firefighters can have a preferred approach on how to fight fires on historic buildings, we recommend discussing the fire protection scheme for the columns with local fire officials and perhaps with the state fire marshal.

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ILLUSTRATIONS

Photo 1

Hoosac building – south elevation.

Photo 2

Hoosac building – west elevation.

Photo 3

Hoosac building – north elevation.

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Photo 4

Hoosac building – east elevation.

Photo 5

Example of an exploratory opening in the exterior masonry wall and full-thickness core, each of which was conducted by the assisting contractor from the interior. Opening N2.1 shown, others similar.

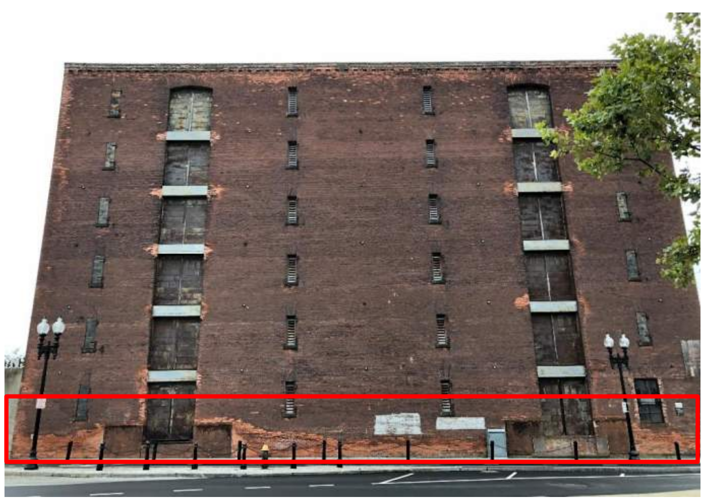

Photo 6

Eroded brick and mortar joints near grade (red) at the west elevation.

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Photo 7

Eroded brick and mortar (orange) at the east south elevation.

Photo 8

Example of eroded brick (orange) and mortar well above grade at the south elevation.

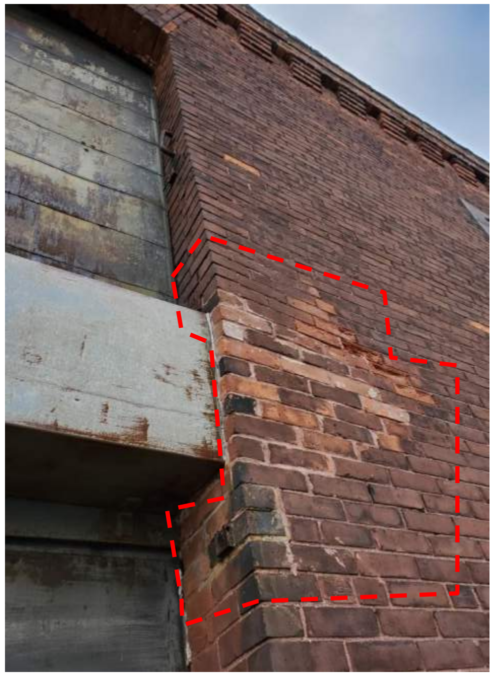

Photo 9

Example of bulged brick masonry at door jamb (indicated in red). North elevation shown.

Photo 10

Example of bulged brick masonry at previously rebuilt areas (indicated in red). South elevation shown.

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Photo 11

Example of eroded and bulged brick (indicated in red) below gutter at south elevation.

Photo 12

Cracked brick (red arrows) and mortar is present within the field of the wall at the east elevation.

Photo 13

Cracked brick (red arrows) and mortar is present between windows at the south elevation.

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Photo 14

Cracked brick (red arrows) at door return (north elevation). Embedded steel (yellow arrows).

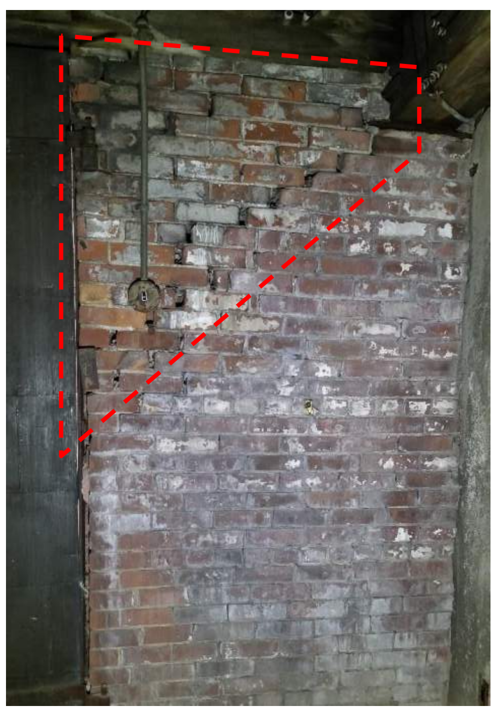

Photo 15

Cracked and bulged brick at interior (red) adjacent to door.

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Photo 16

Example of cracked mortar joints (red arrows) at head of doorway.

Photo 17

Example of cracked brick and mortar joints (red arrows) below window sills.

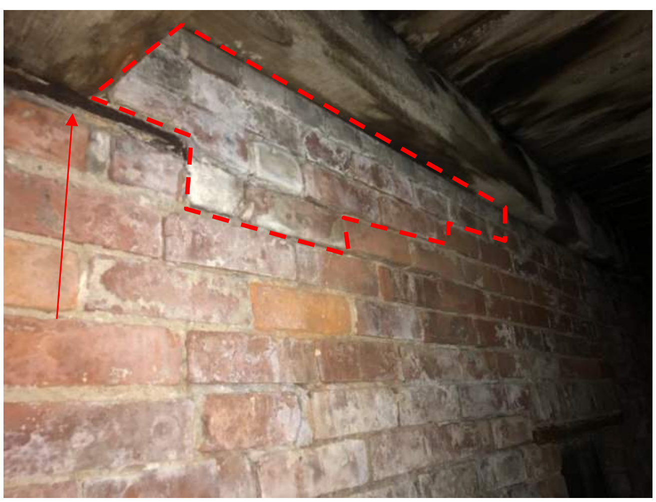

Photo 18

Brick is bugled and mortar joints are cracked (area indicated in red) adjacent to corroded metal bearing plates (red arrow), where timber beams extend into the exterior masonry wall.

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Photo 19

Corroded metal plate at window heads typically corresponds with mortar joint cracking.

Photo 20

Underside of roof deck is stained and rotted.

Photo 21

Bottom flange of steel girder stamped “PENCOYD” (indicated in red).

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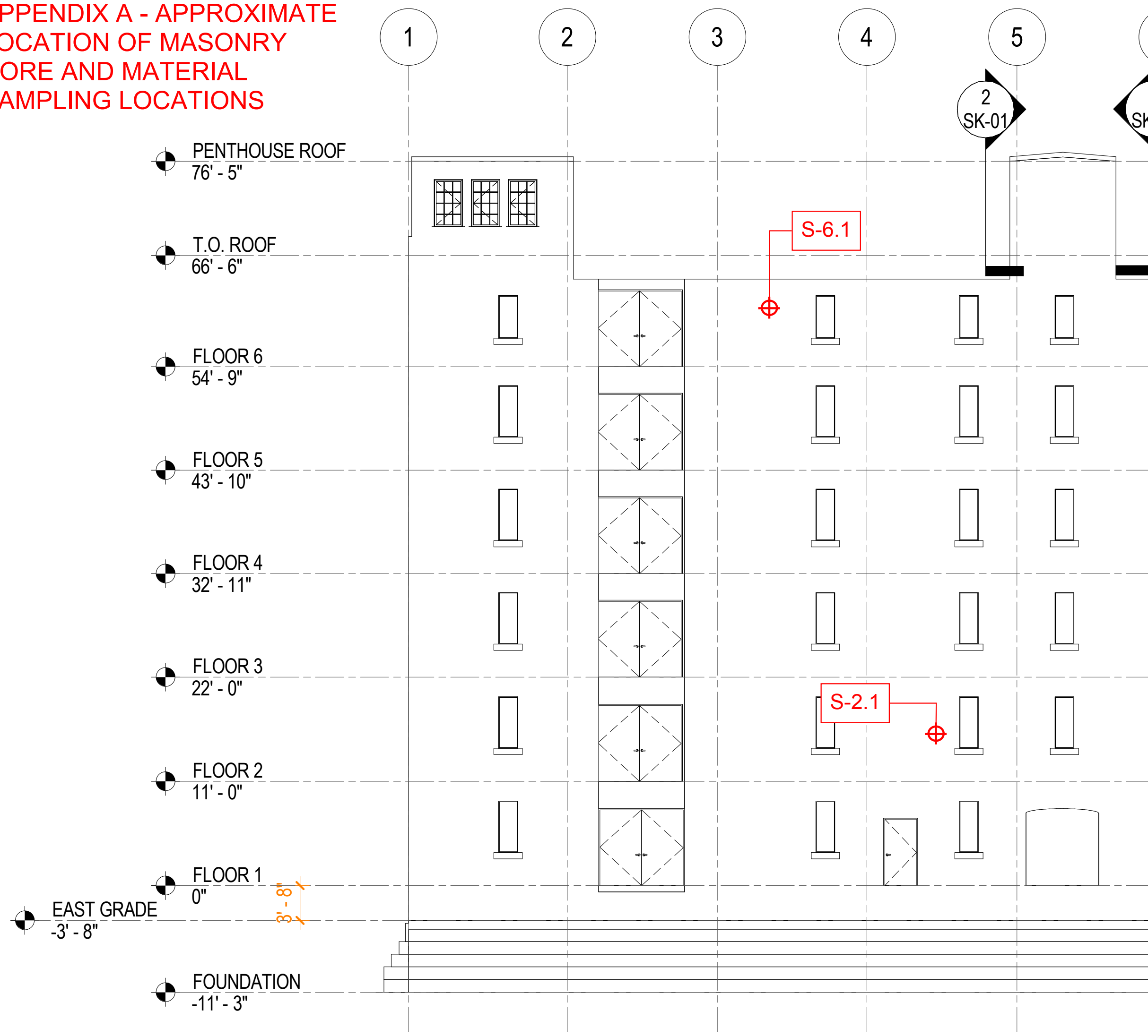
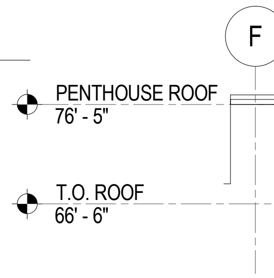
APPENDIX A

Summary of Approximate Location of Masonry Cores and Material Sampling

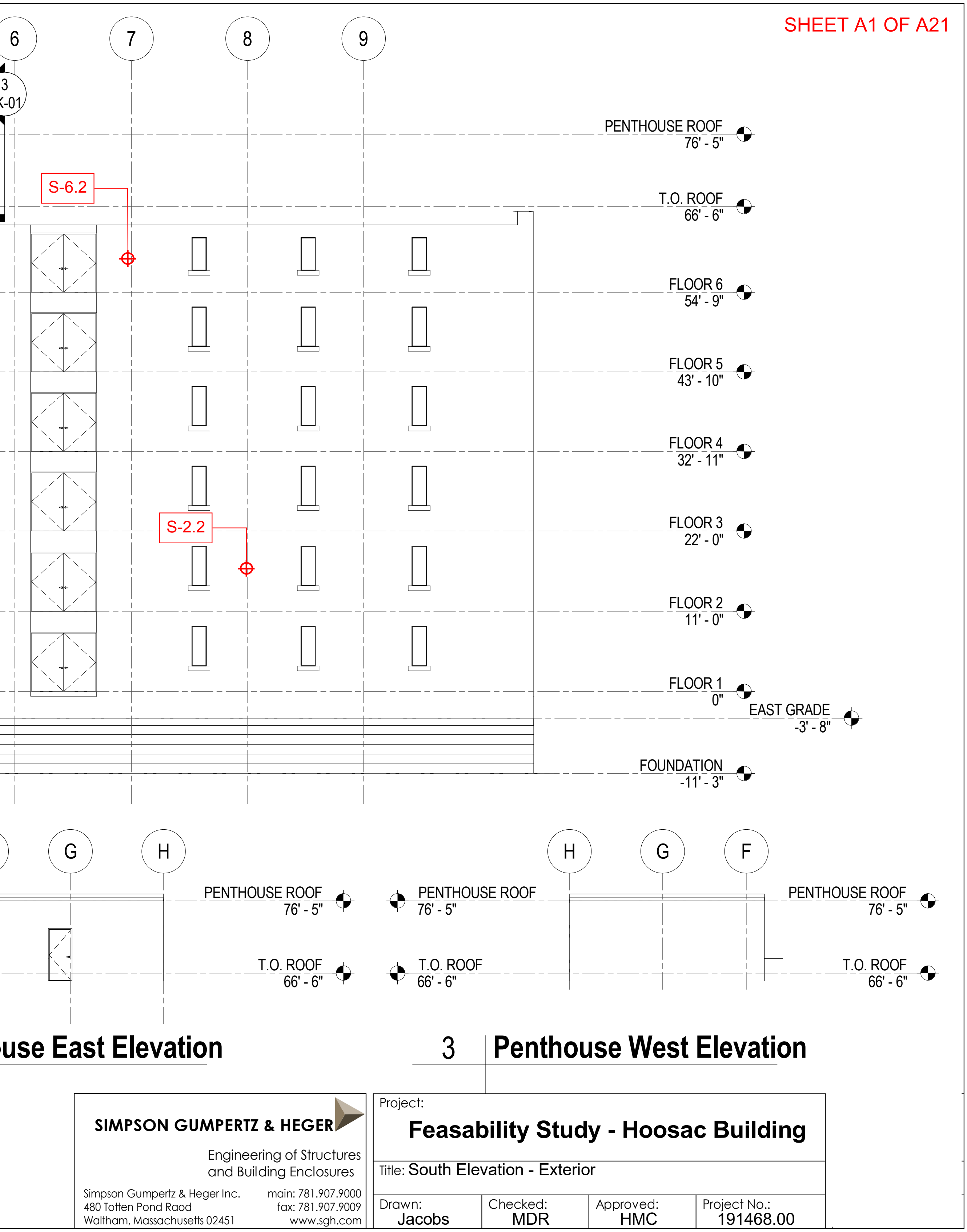
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



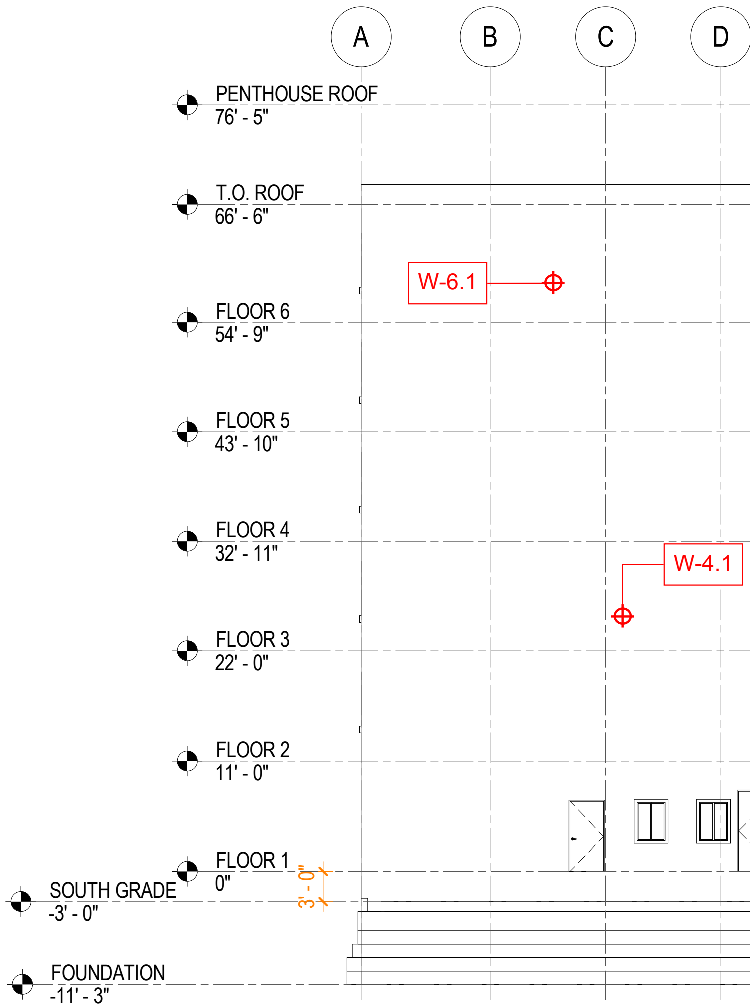
1 **South Elevation - Exterior**



2 **Pentho**

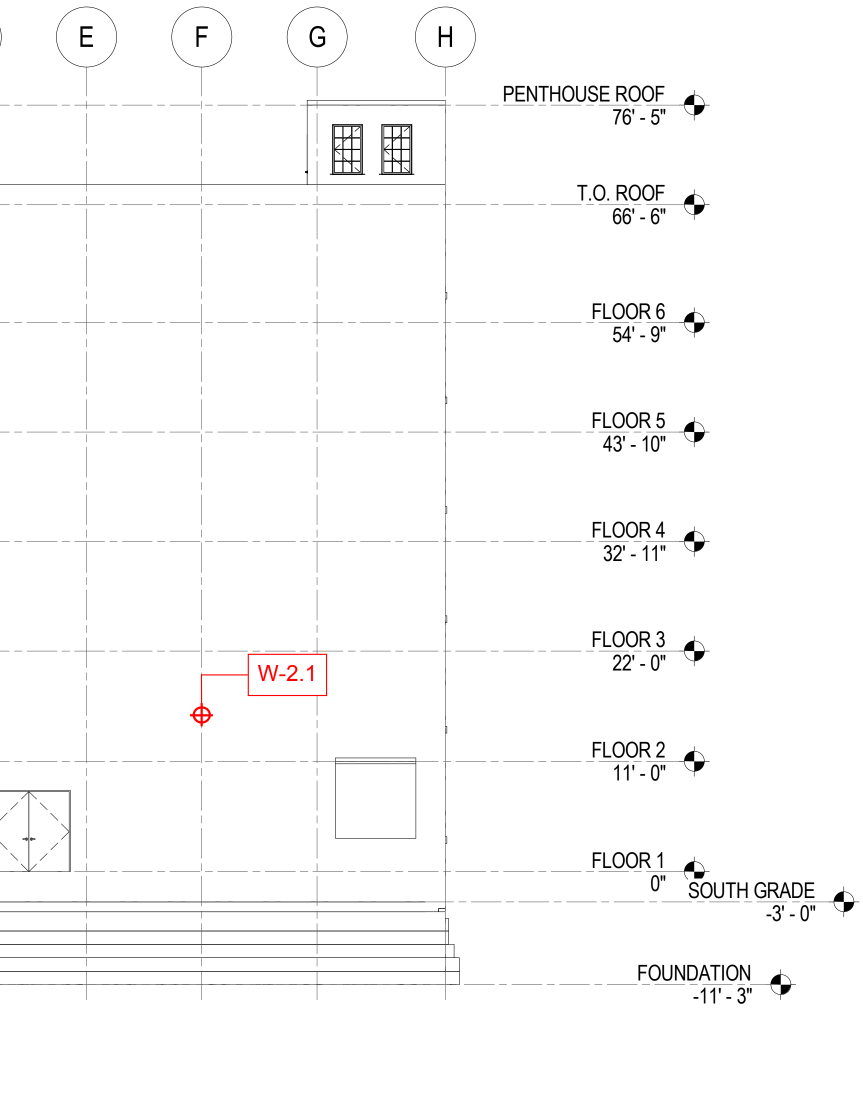

SHEET A1 OF A21
6
7
8
9
PENTHOUSE ROOF 76' - 5"
T.O. ROOF 66' - 6"
FLOOR 6 54' - 9"
FLOOR 5 43' - 10"
FLOOR 4 32' - 11"
FLOOR 3 22' - 0"
FLOOR 2 11' - 0"
FLOOR 1 0"
EAST GRADE -3' - 8"
FOUNDATION -11' - 3"
S-6.2
S-2.2
G
H
PENTHOUSE ROOF 76' - 5"
T.O. ROOF 66' - 6"
use East Elevation
H
G
F
PENTHOUSE ROOF 76' - 5"
T.O. ROOF 66' - 6"
PENTHOUSE ROOF 76' - 5"
T.O. ROOF 66' - 6"
3
Penthouse West Elevation
SIMPSON GUMPERTZ & HEGER
Engineering of Structures
and Building Enclosures
Simpson Gumpertz & Heger Inc.
480 Totten Pond Raod
Waltham, Massachusetts 02451
main: 781.907.9000
fax: 781.907.9009
www.sgh.com
Project:
Feasability Study - Hoosac Building
Title: South Elevation - Exterior
Drawn: Jacobs
Checked: MDR
Approved: HMC
Project No.: 191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 West Elevation - Exterior

SHEET A2 OF A21



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Project:			
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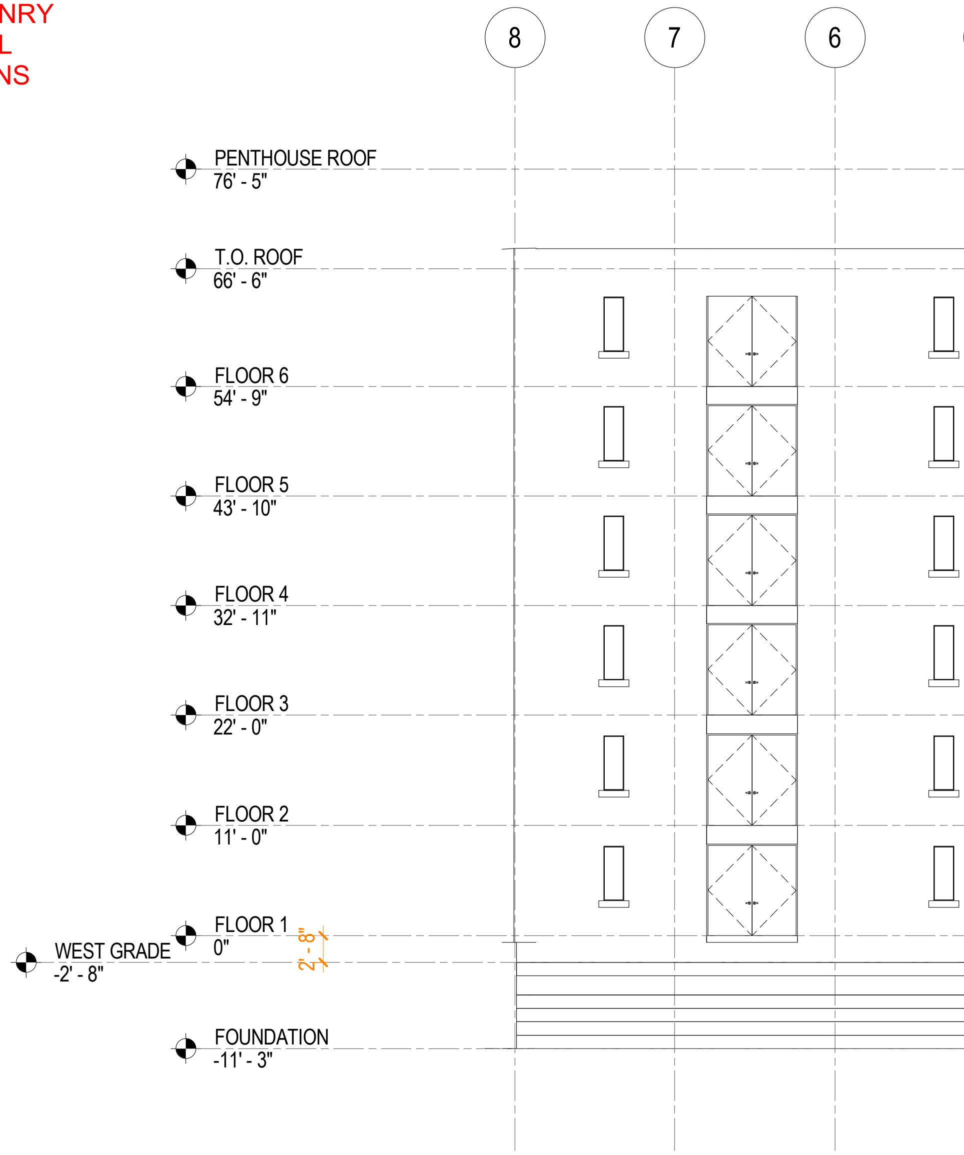
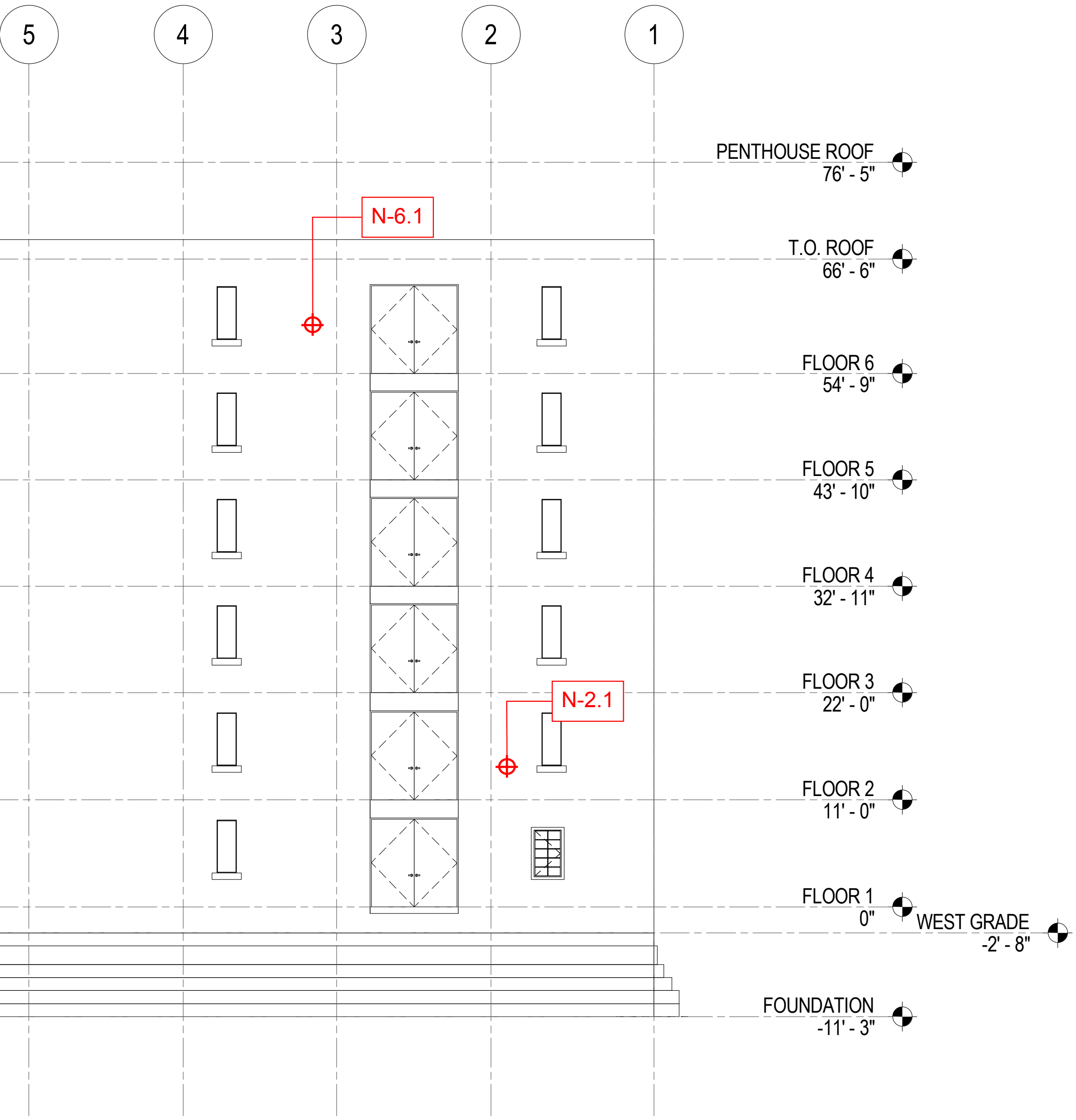
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 North Elevation - Exterior

SHEET A3 OF A21



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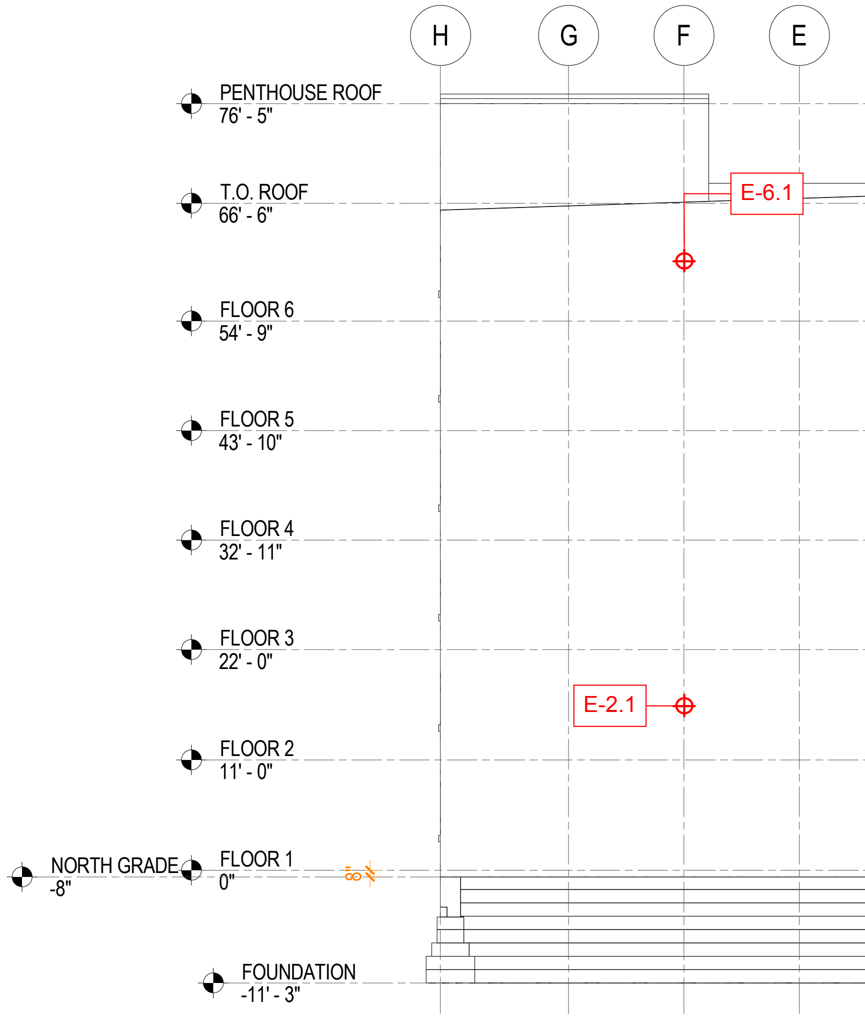
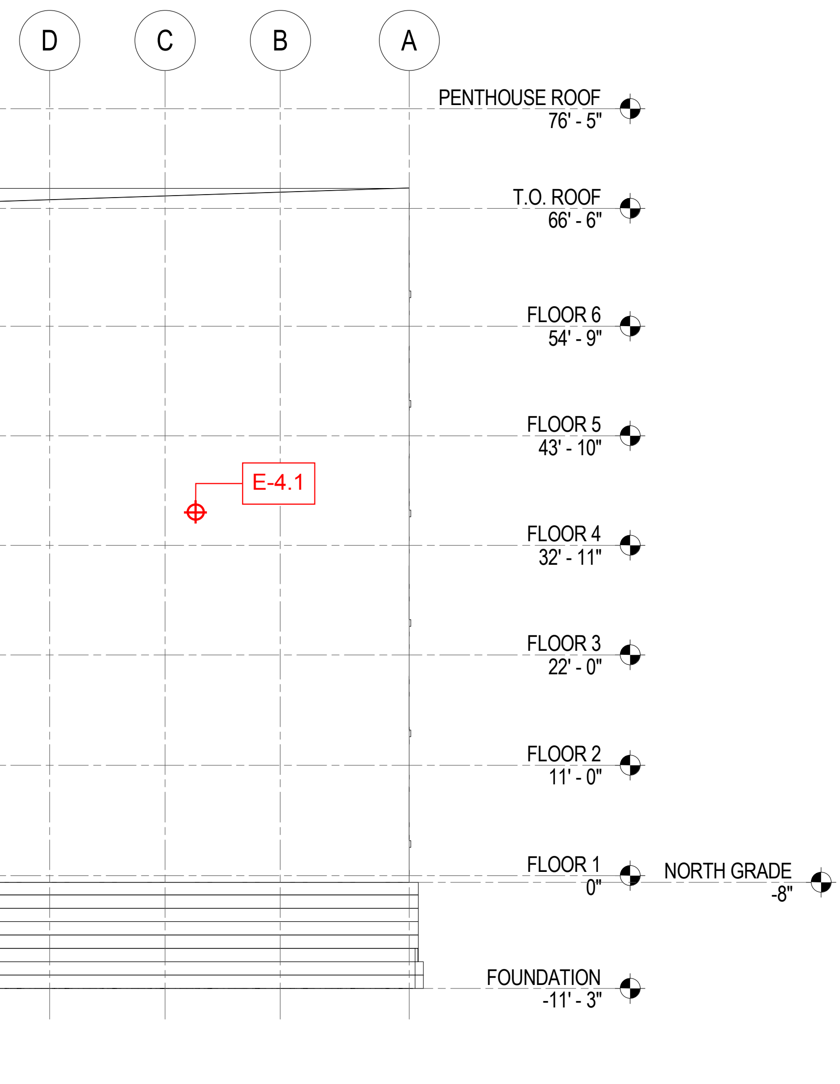
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 **East Elevation - Exterior**

SHEET A4 OF A21



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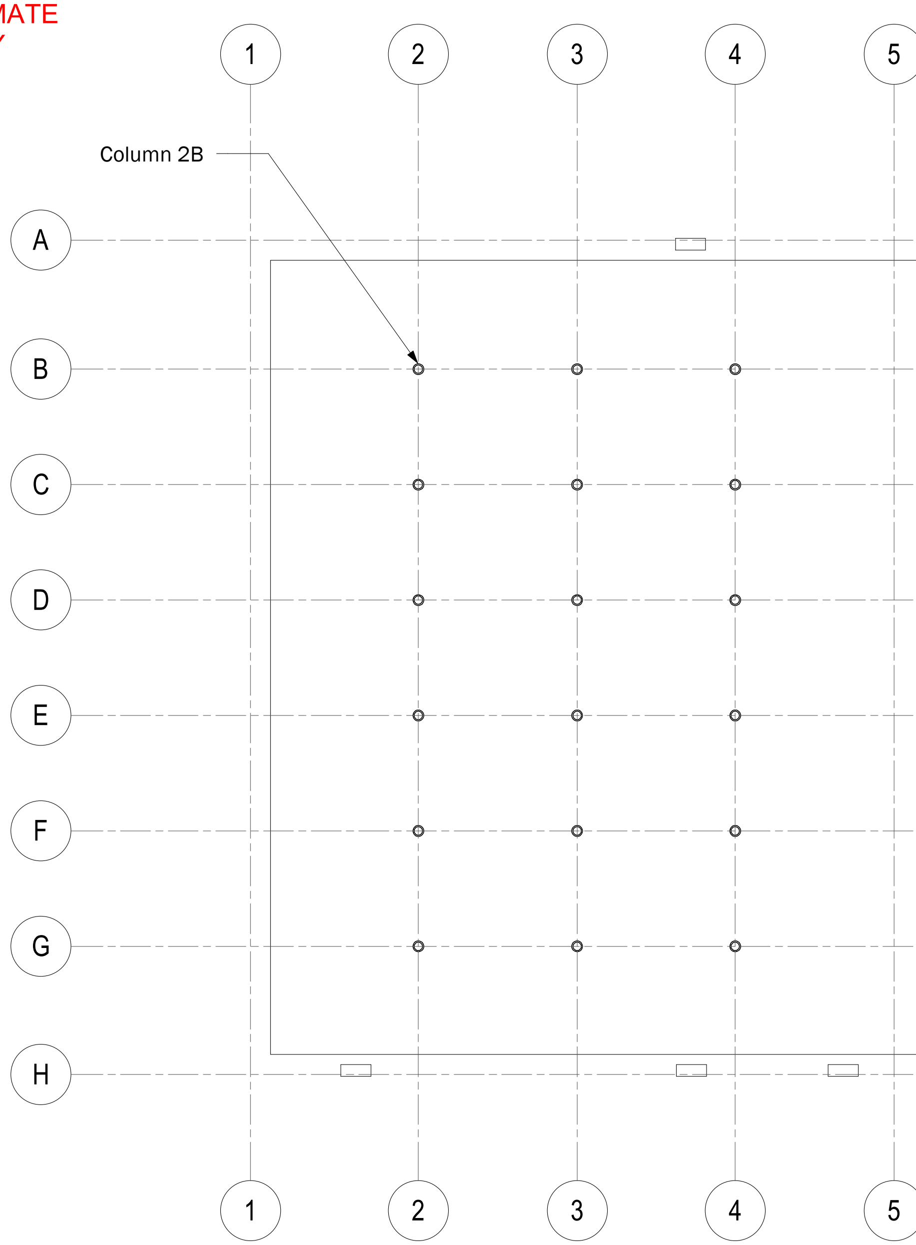
Project: **Feasability Study - Hoosac Building**

Title: East Elevation - Exterior

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

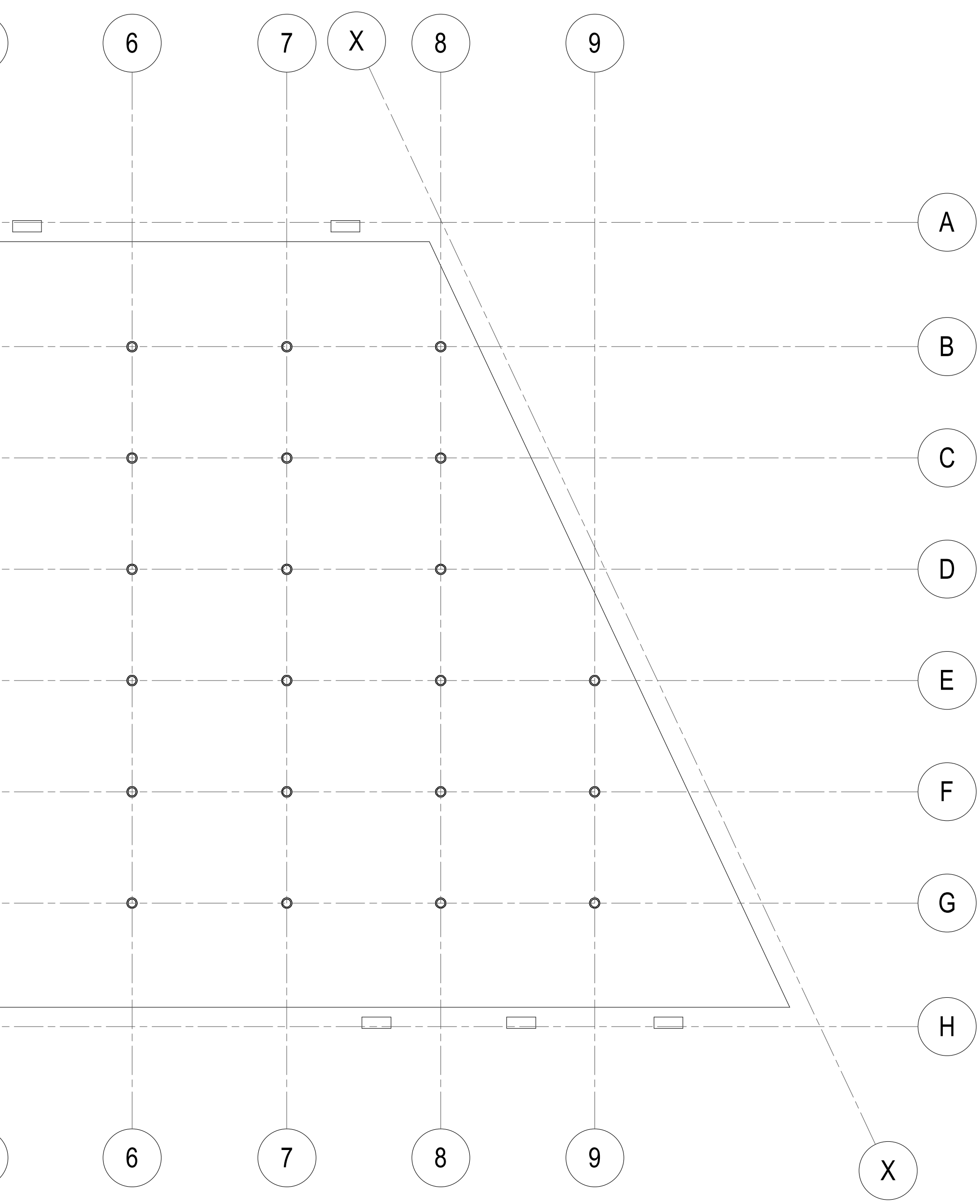
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 **FLOOR 1 Framing**

SHEET A5 OF A21



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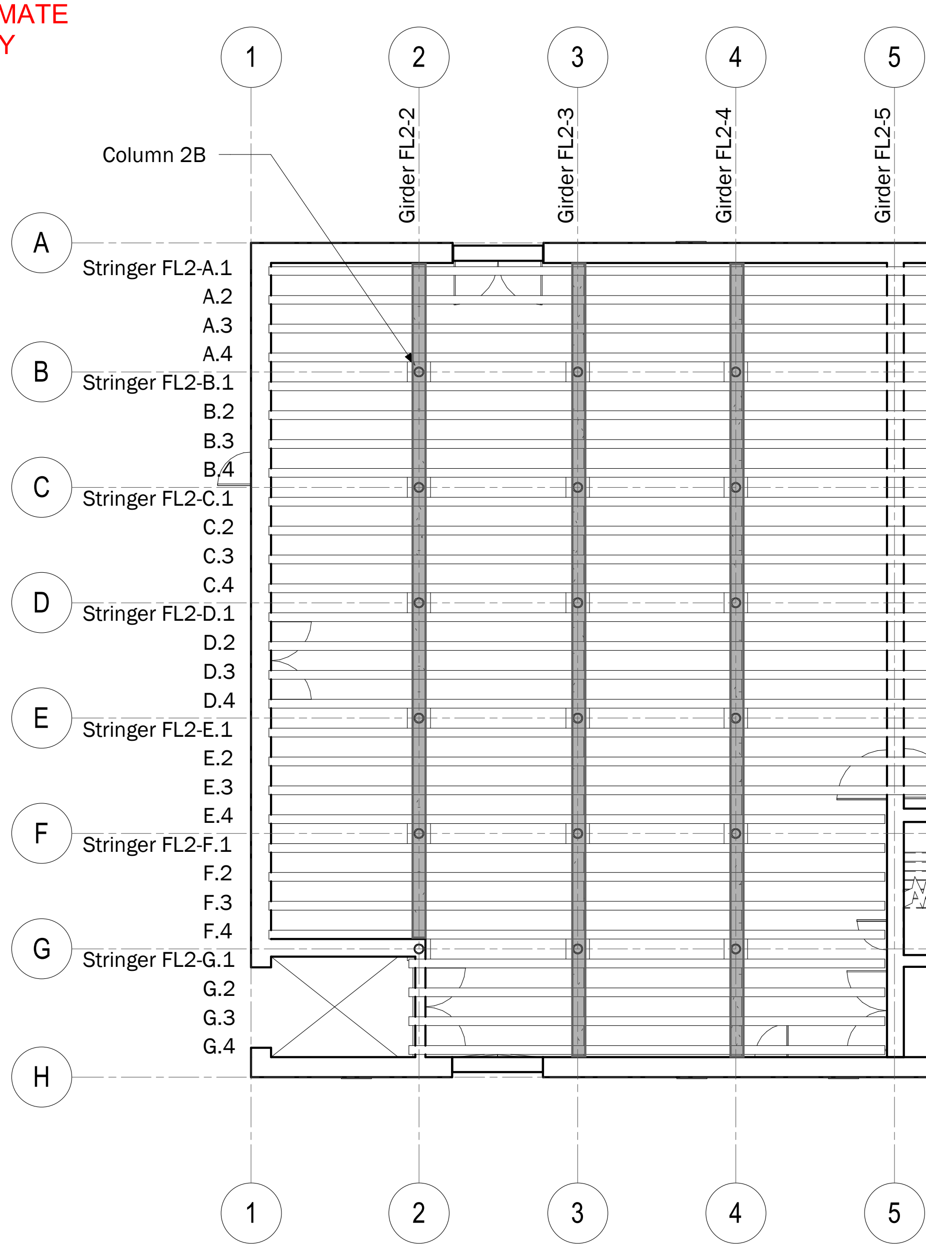
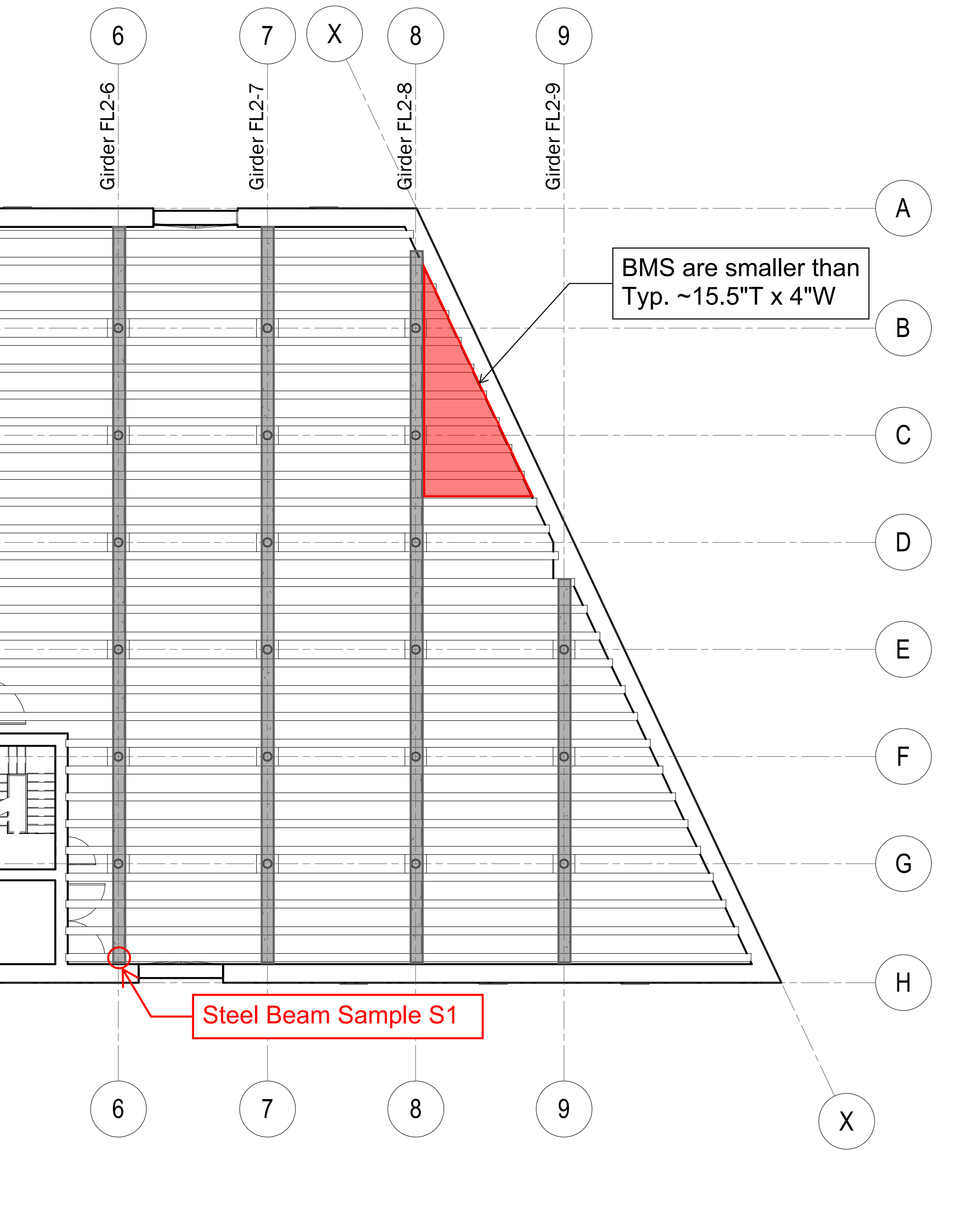
Title: Floor 1 Framing Plan			
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 **FLOOR 2 Framing**

SHEET A6 OF A21



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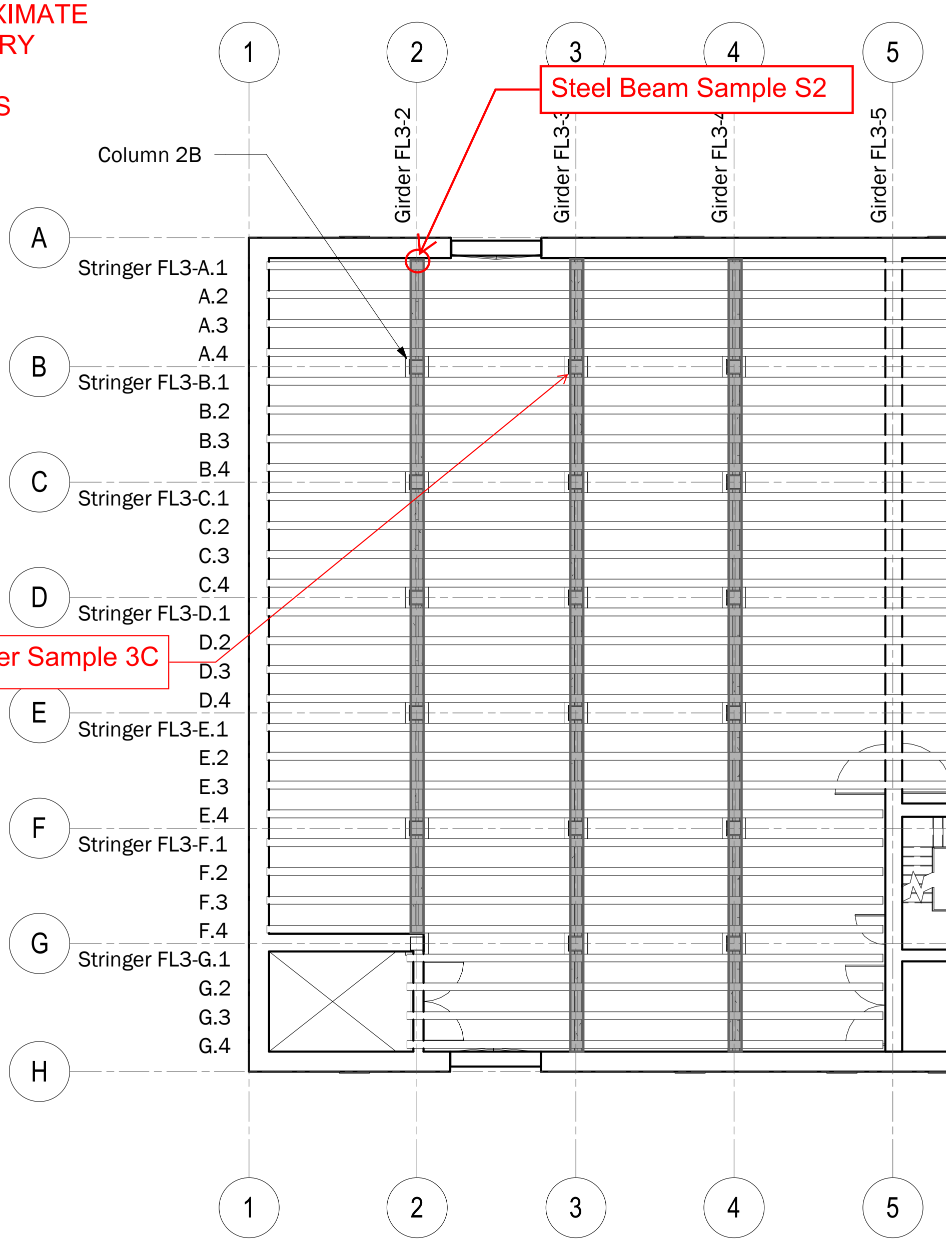
Project: **Feasability Study - Hoosac Building**

Title: Floor 2 Framing Plan

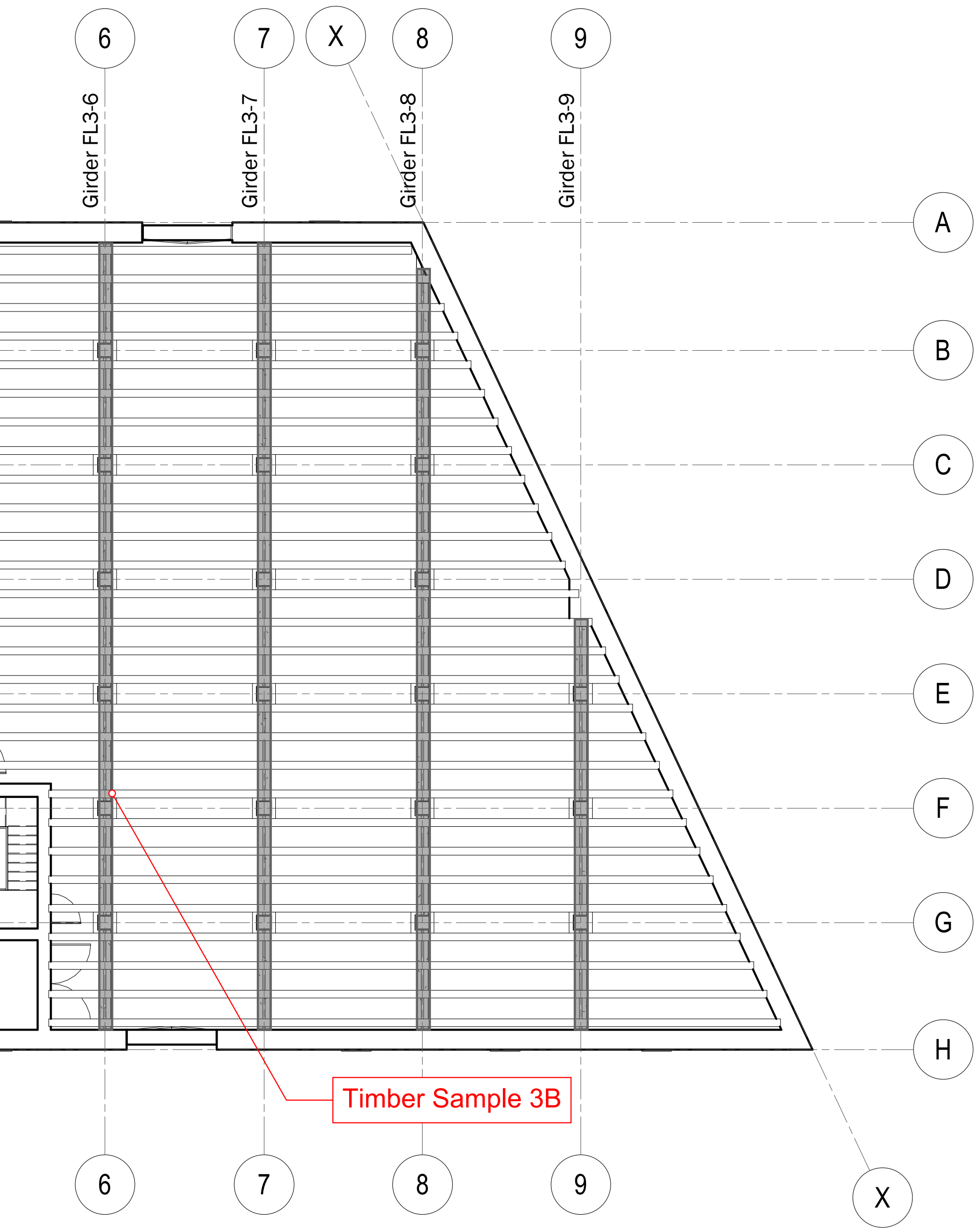
Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 **FLOOR 3 Framing**

SHEET A7 OF A21



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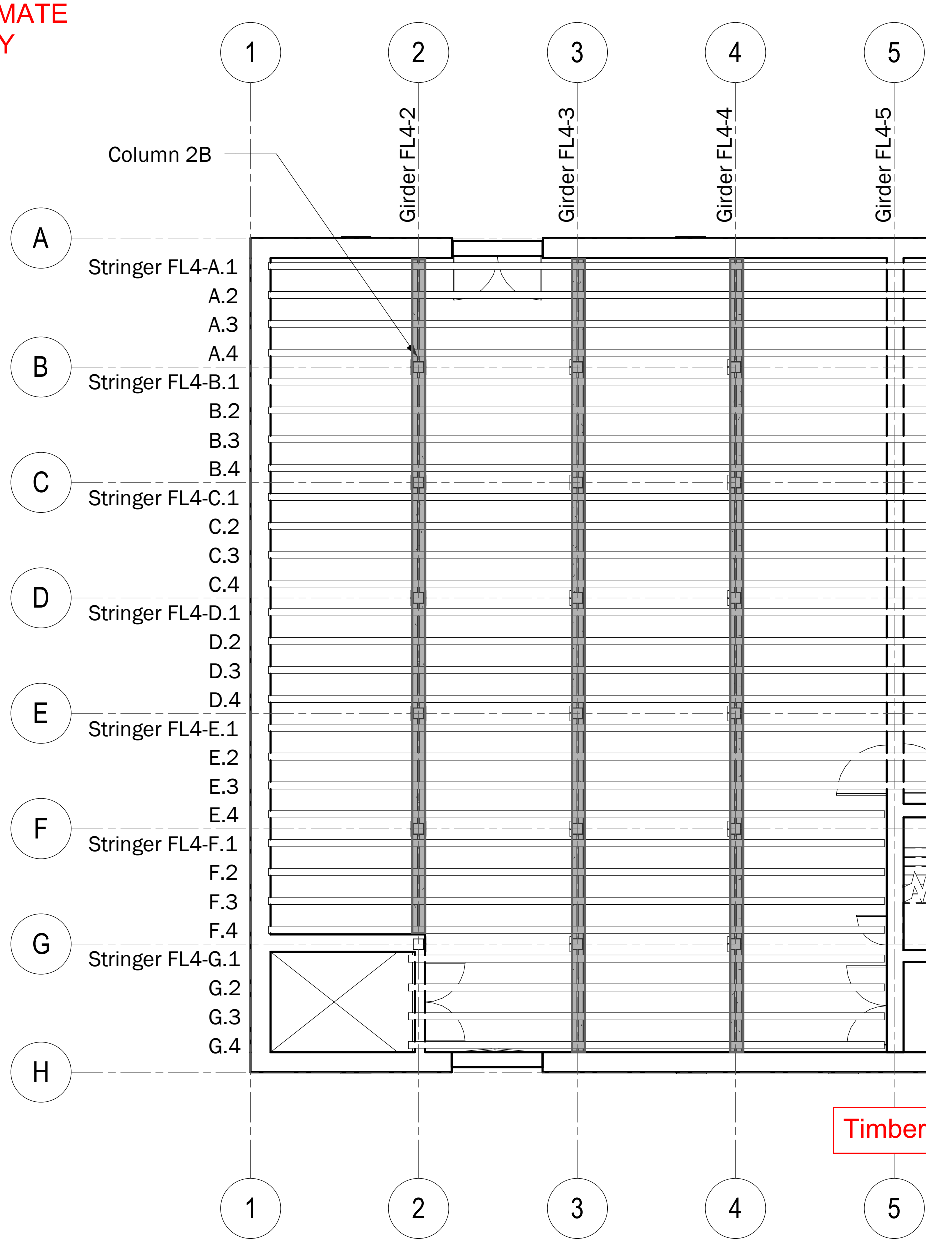
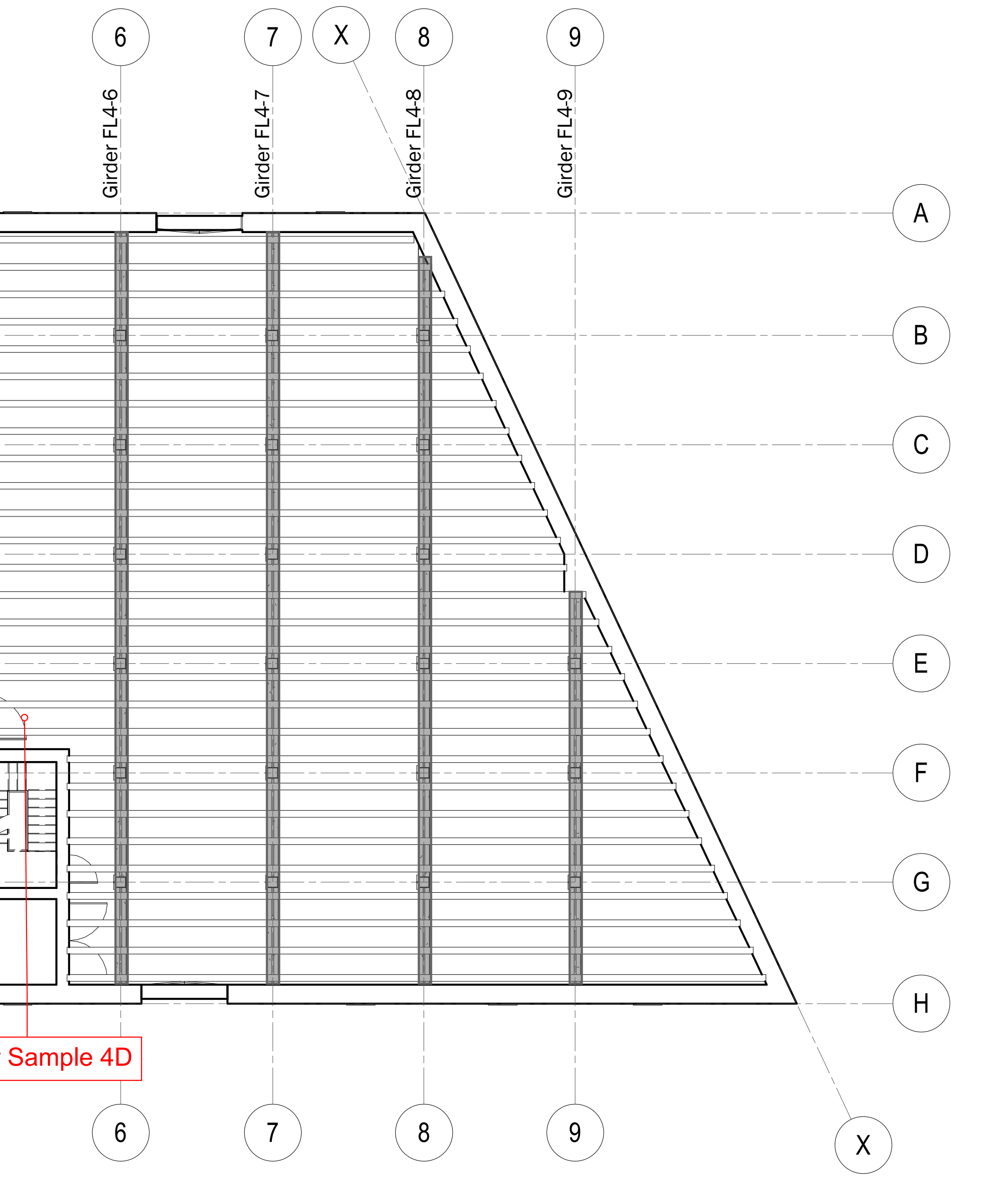
Project: **Feasability Study - Hoosac Building**			
Title: Floor 3 Framing Plan			
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 **FLOOR 4 Framing**

SHEET A8 OF A21



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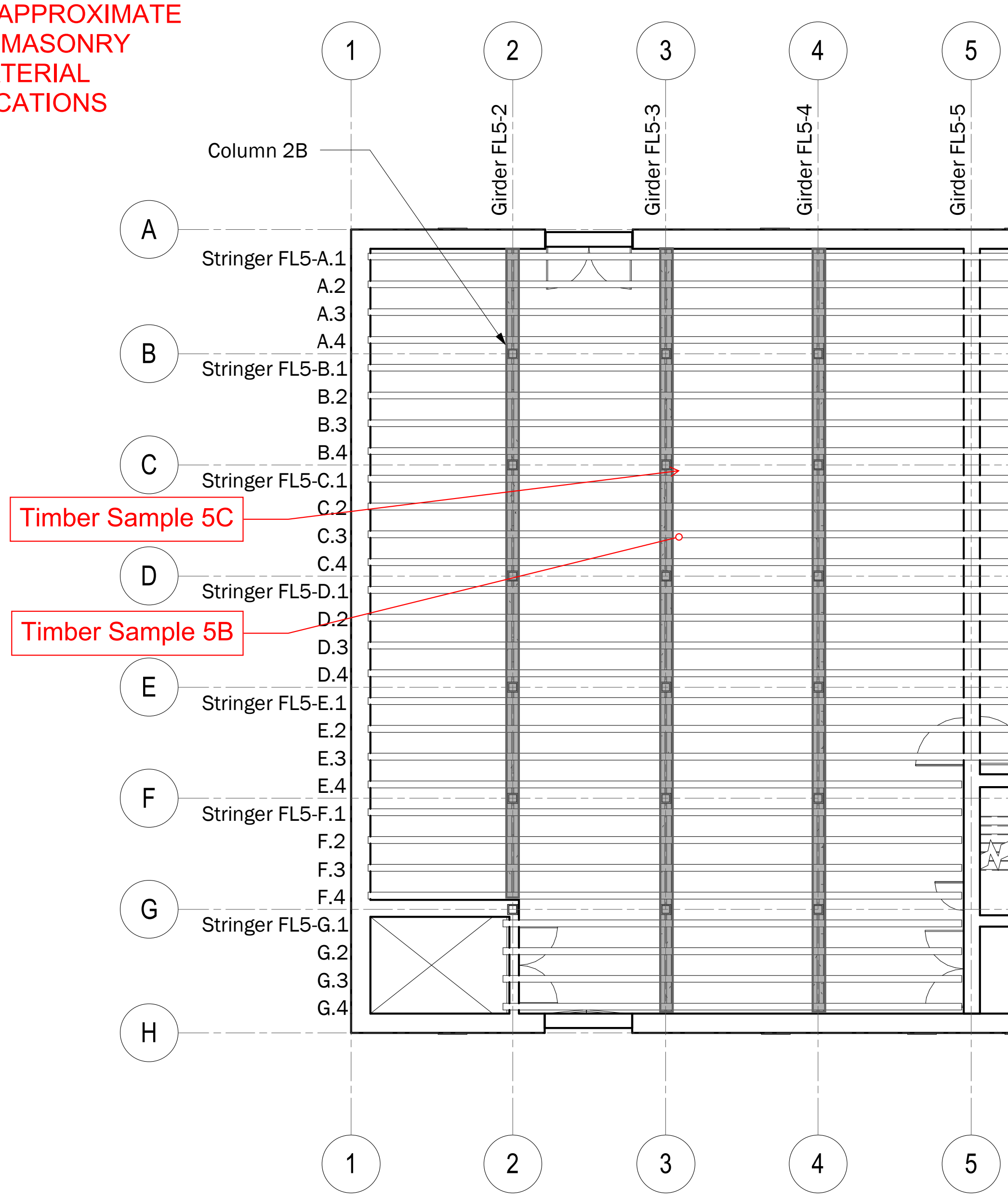
Project: **Feasability Study - Hoosac Building**

Title: Floor 4 Framing Plan

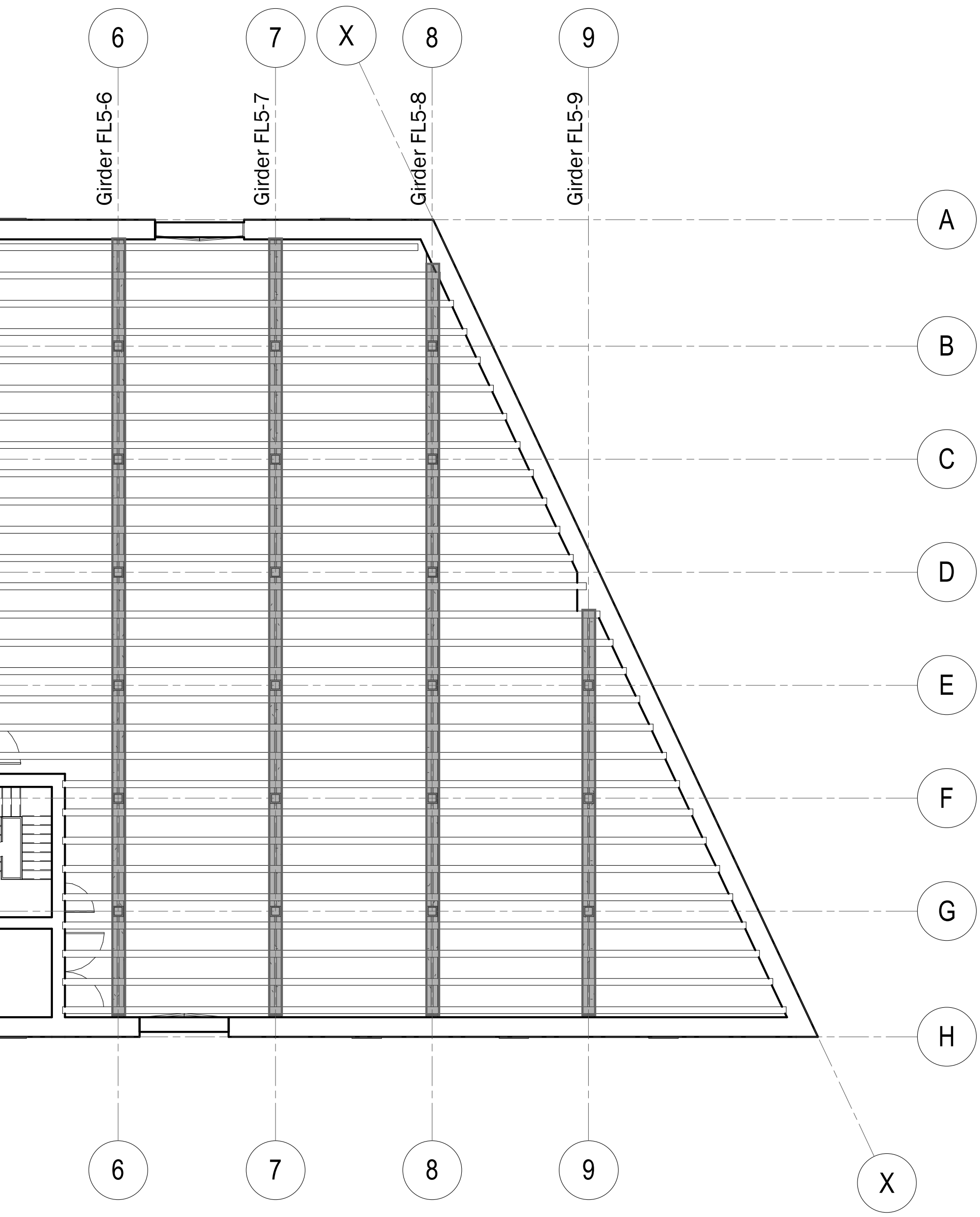
Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 **FLOOR 5 Framing**

SHEET A9 OF A21



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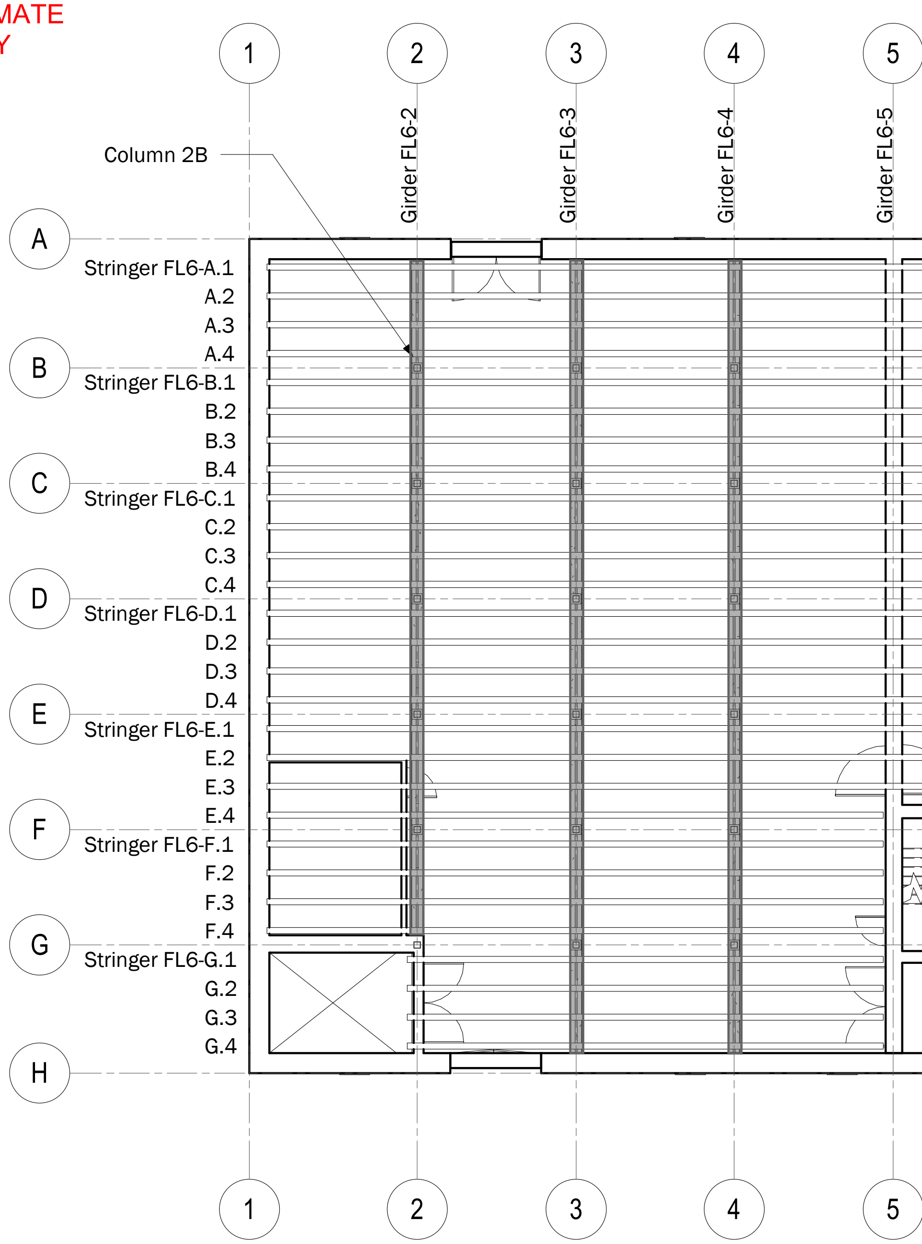
Project: **Feasability Study - Hoosac Building**			
Title: Floor 5 Framing Plan			
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

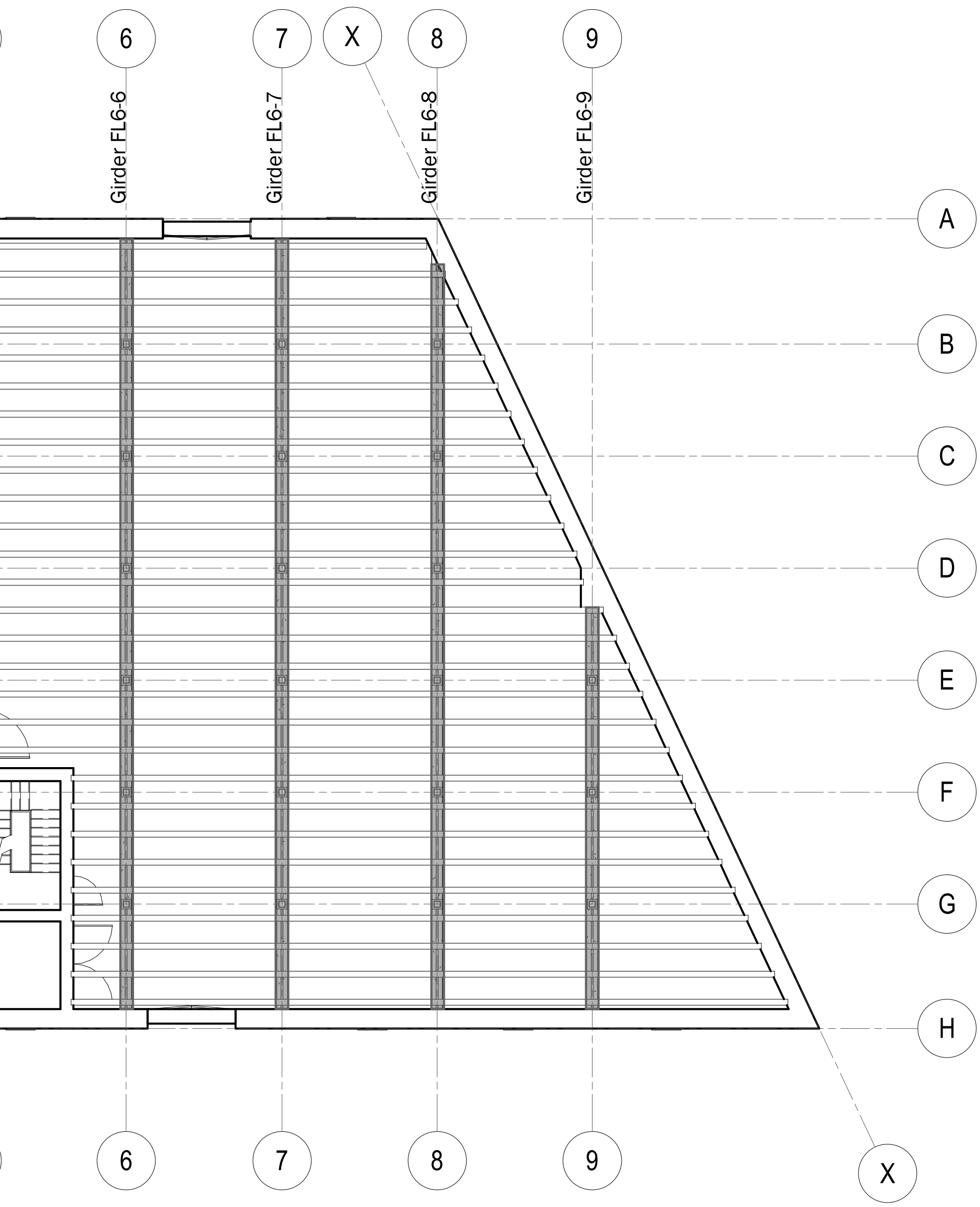
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 **FLOOR 6 Framing**

SHEET A10 OF A21



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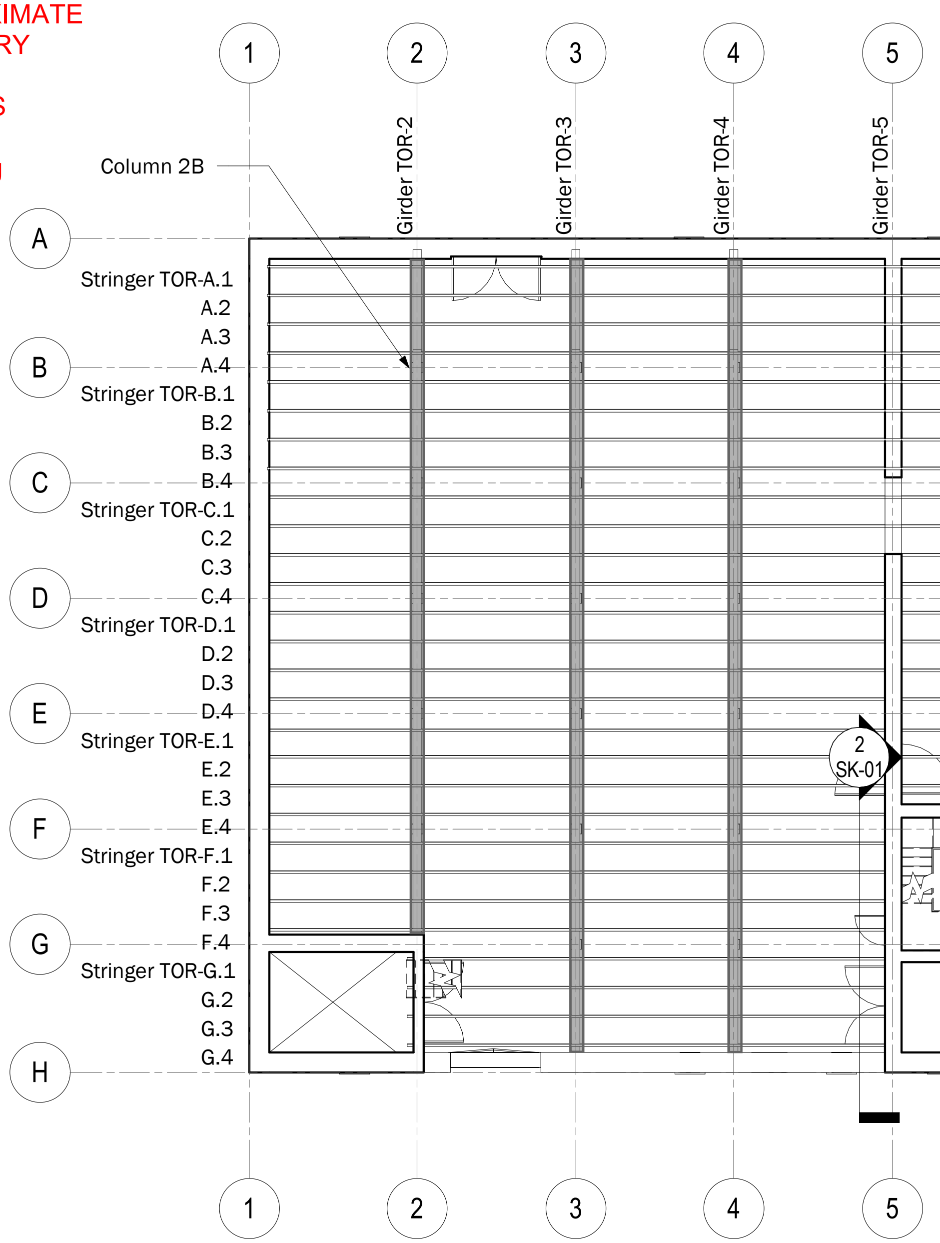
Project: **Feasability Study - Hoosac Building**

Title: Floor 6 Framing Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

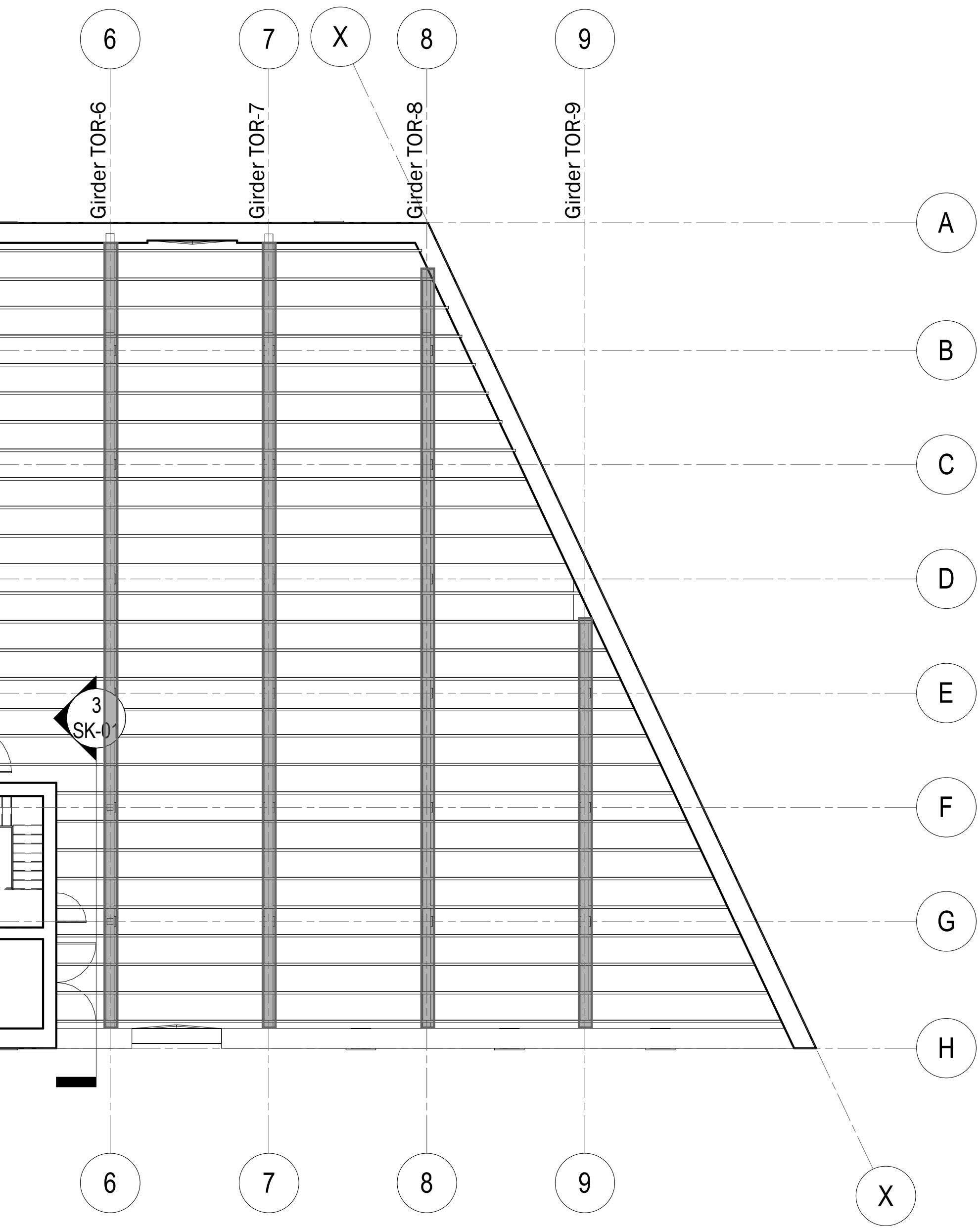
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 | T.O. ROOF Framing

SHEET A11 OF A21



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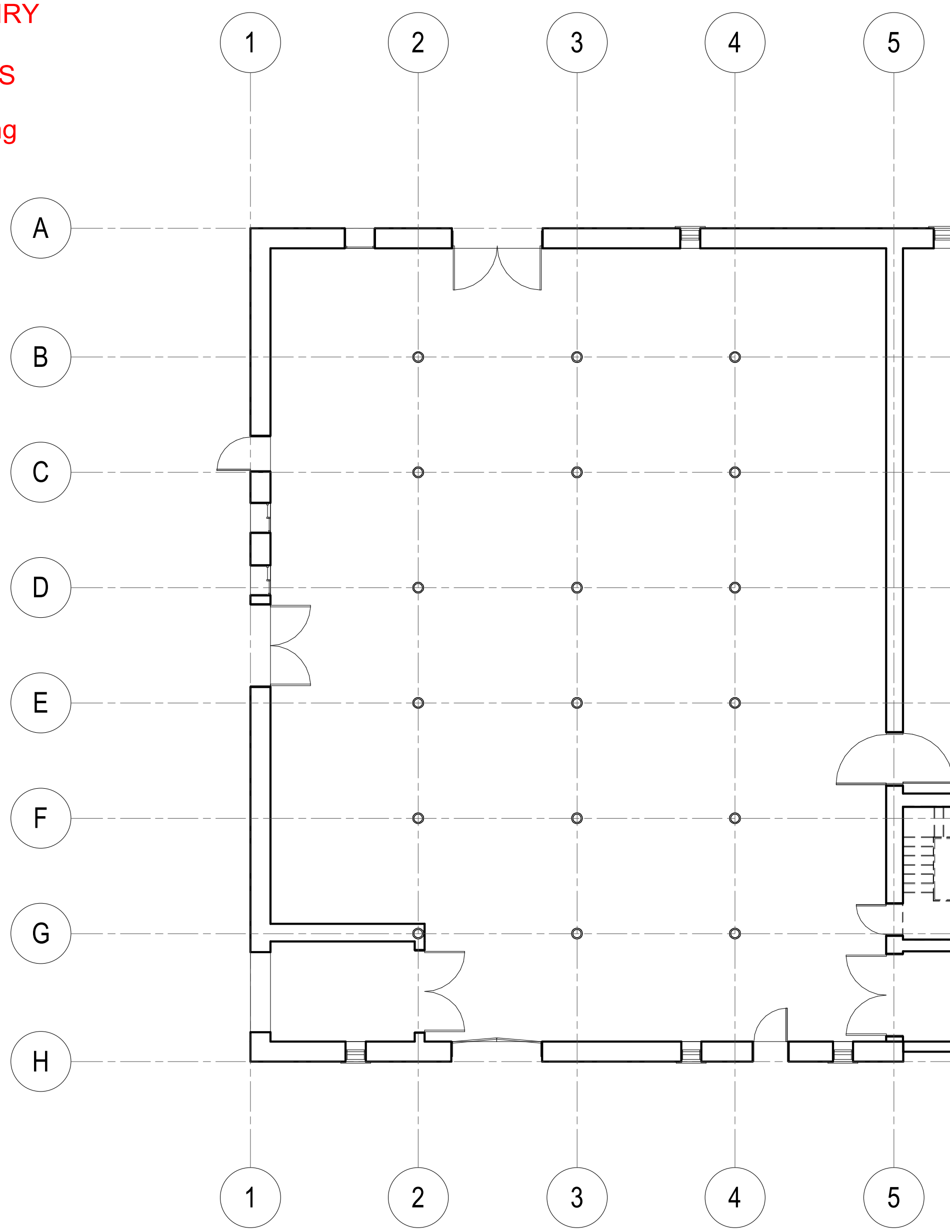
Project: **Feasability Study - Hoosac Building**			
Title: T.O. Roof Framing Plan			
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

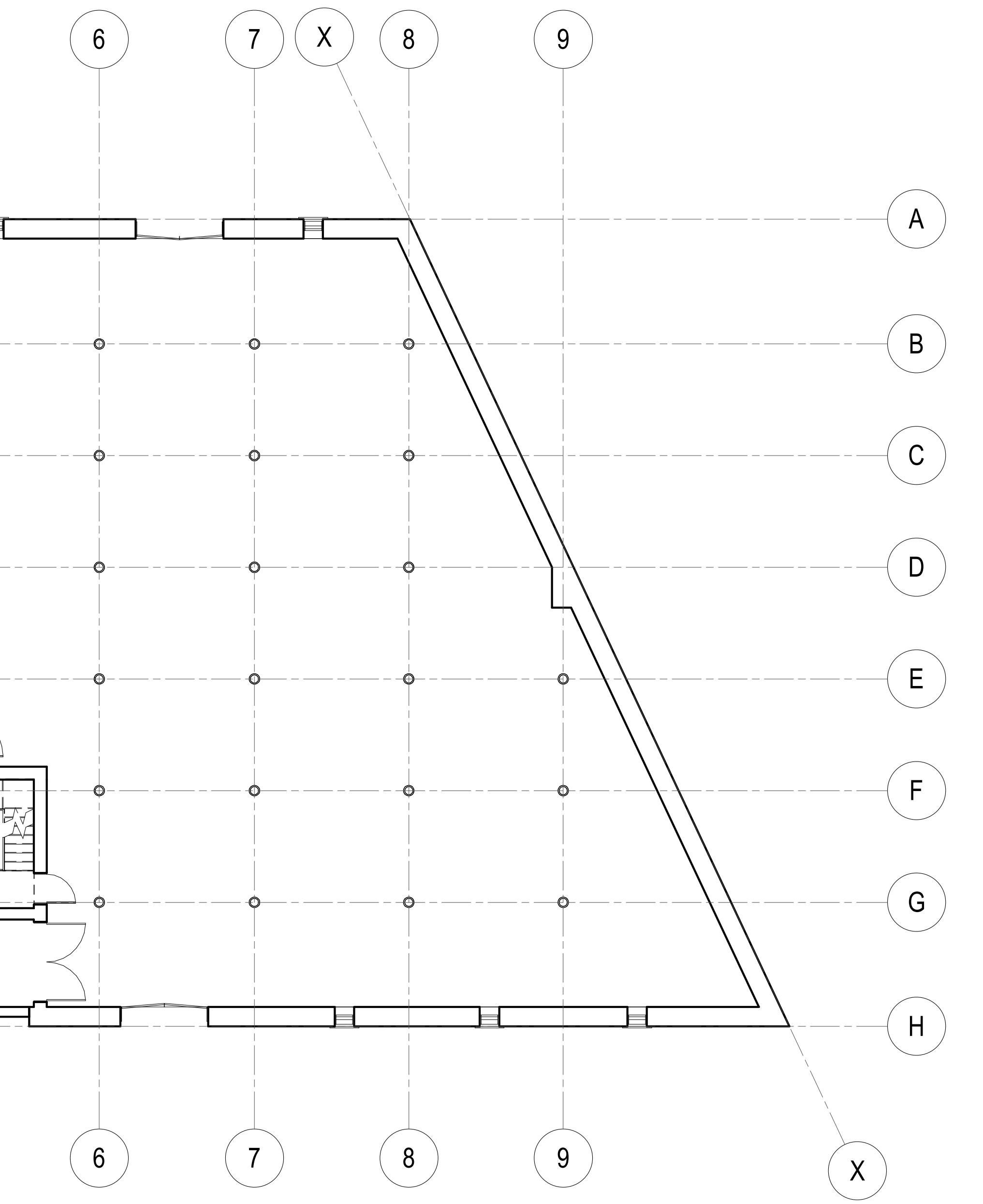
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 1 - EXISTING Floor Plan

SHEET A12 OF A21



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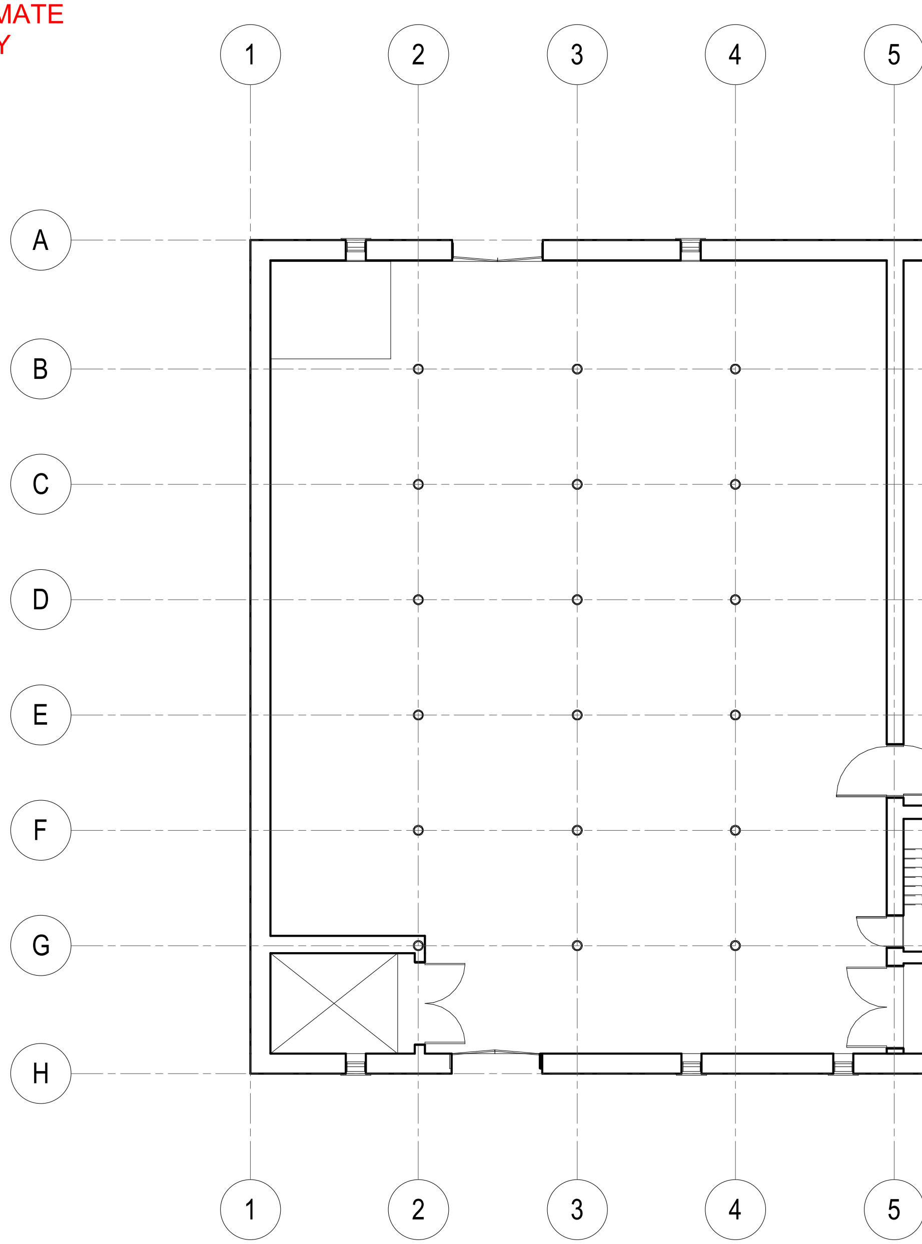
Project:
Feasability Study - Hoosac Building

Title: Floor 1 Floor Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

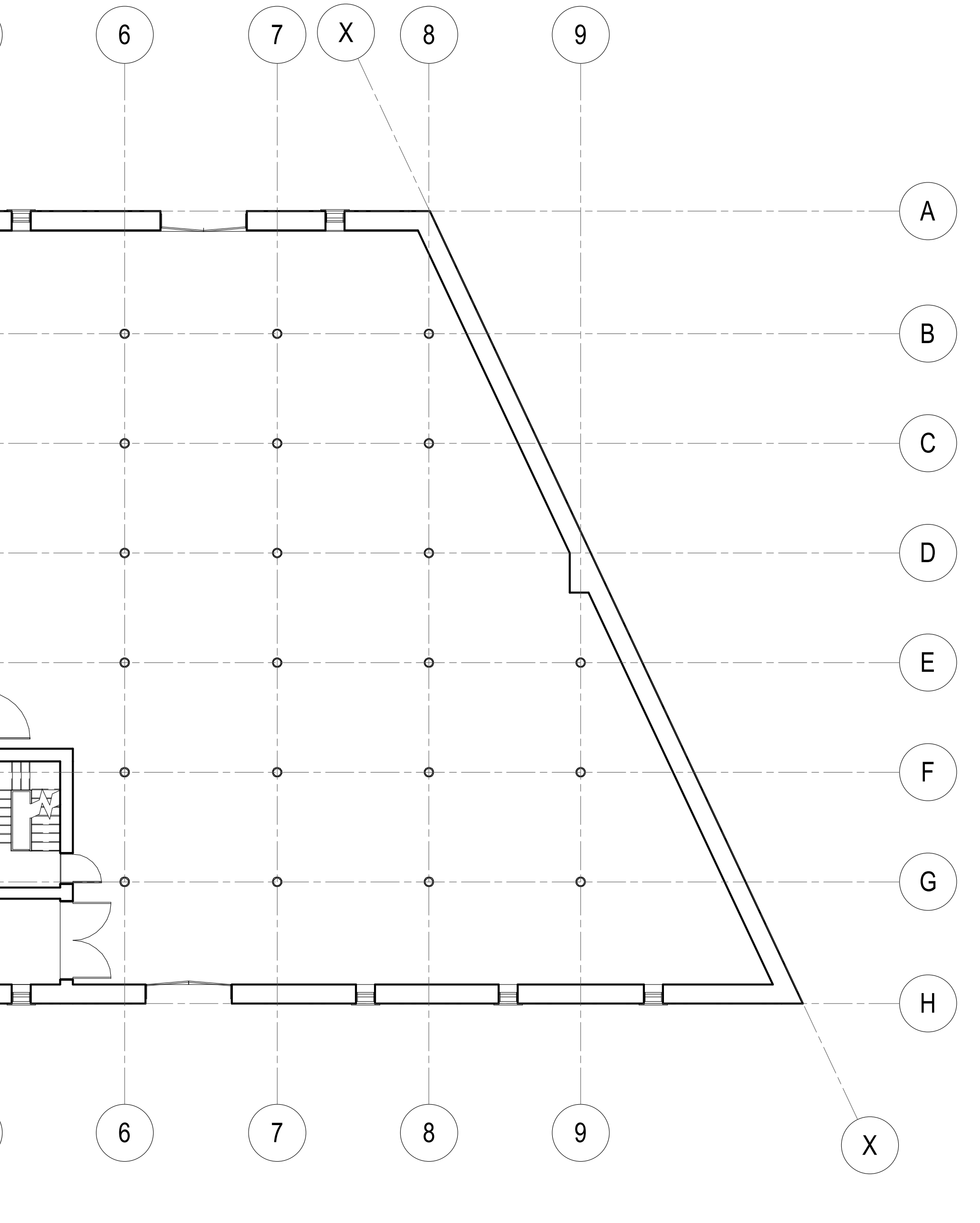
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 2 - EXISTING Floor Plan

SHEET A13 OF A21



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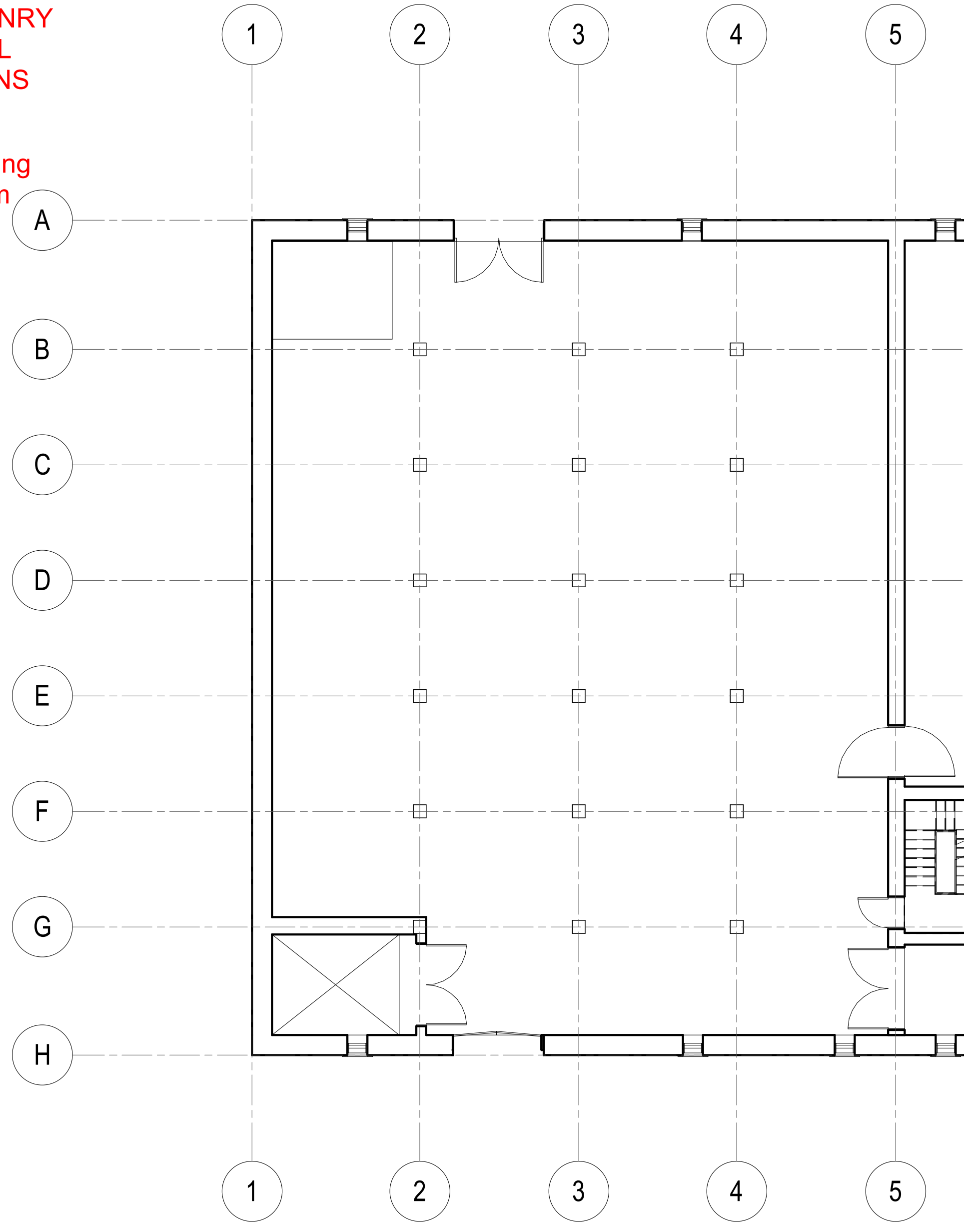
Project: **Feasability Study - Hoosac Building**

Title: Floor 2 Floor Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

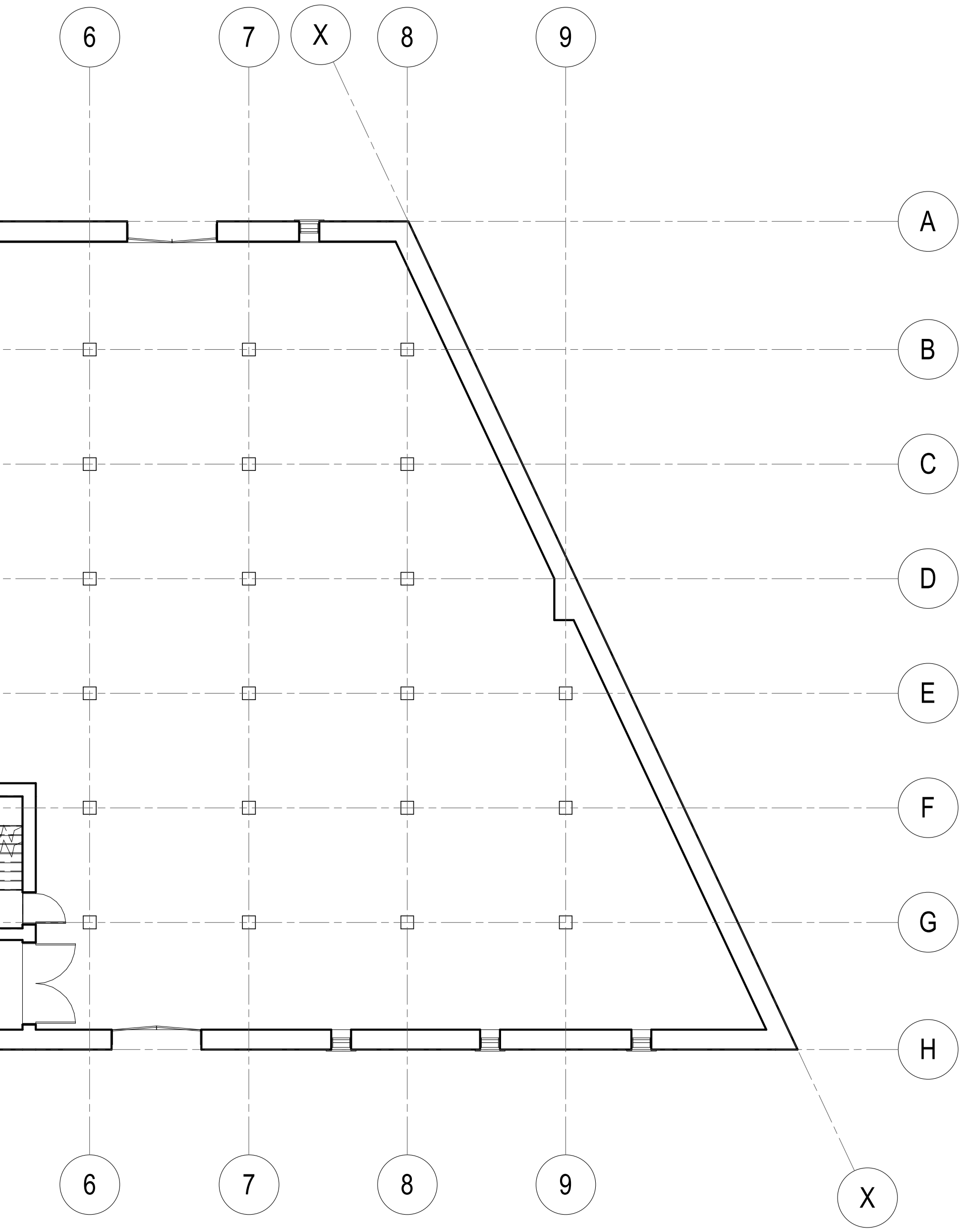
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 3 - EXISTING Floor Plan

SHEET A14 OF A21



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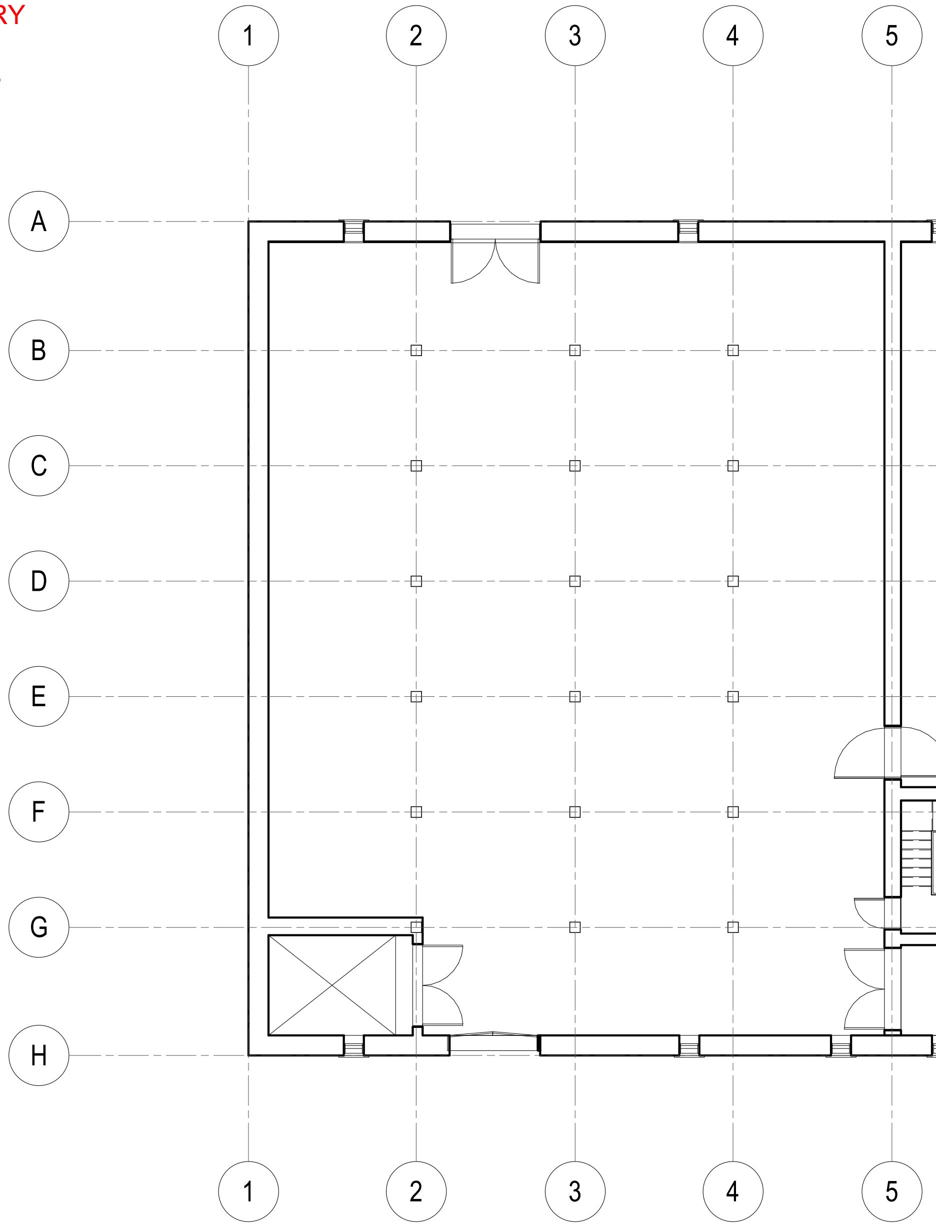
Project: **Feasability Study - Hoosac Building**

Title: Floor 3 Floor Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

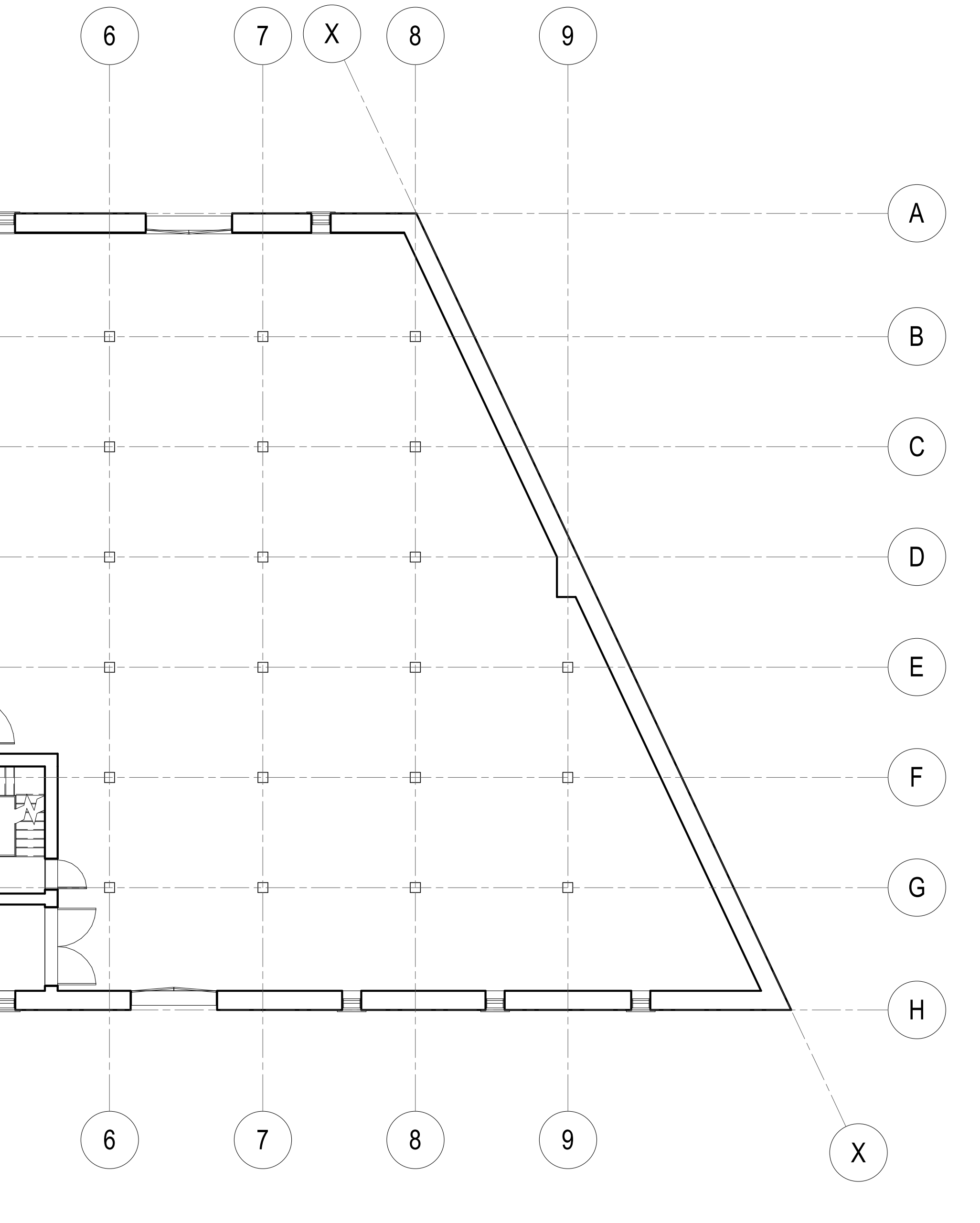
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 4 - EXISTING Floor Plan

SHEET A15 OF A21



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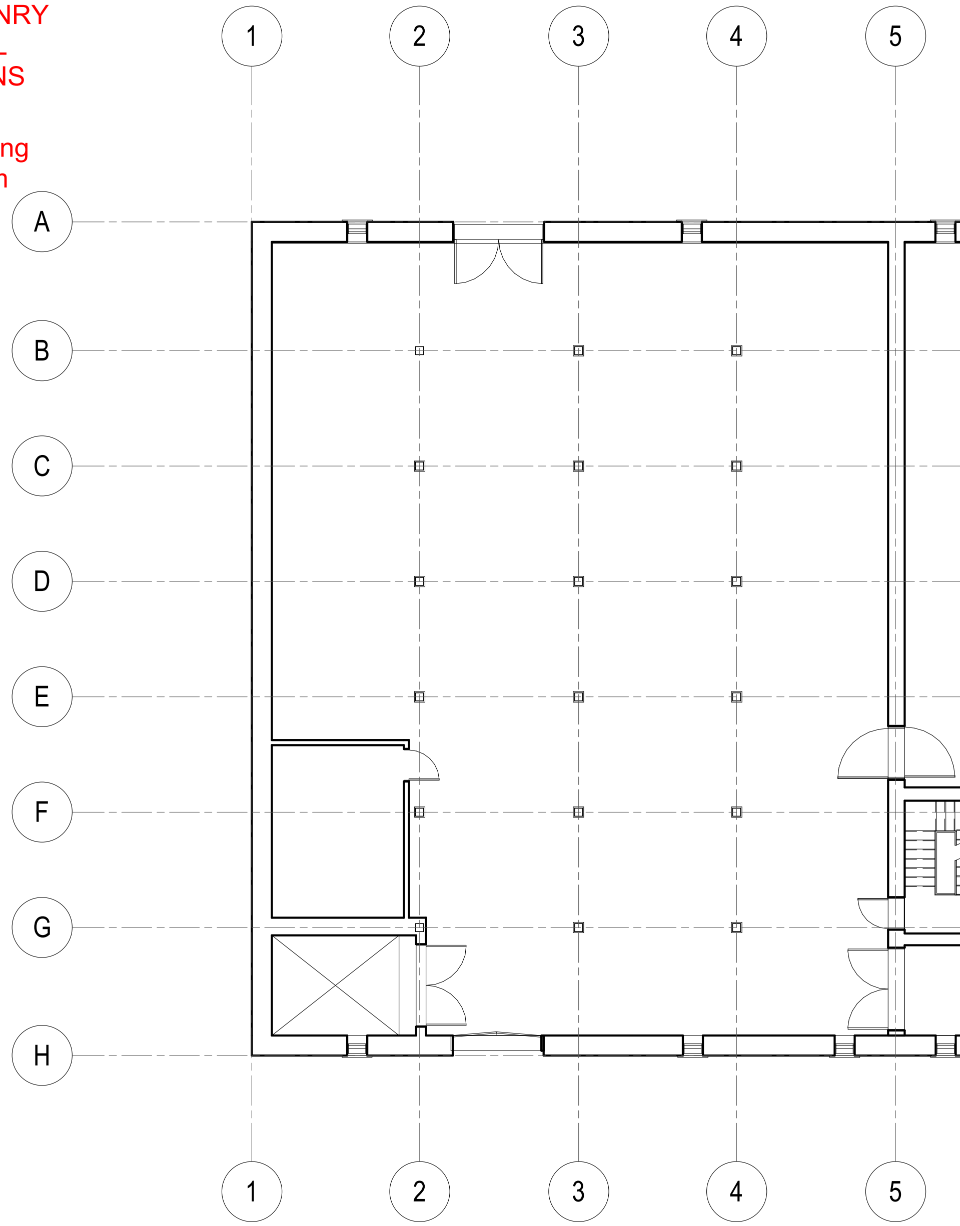
Project: **Feasability Study - Hoosac Building**

Title: Floor 4 Floor Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

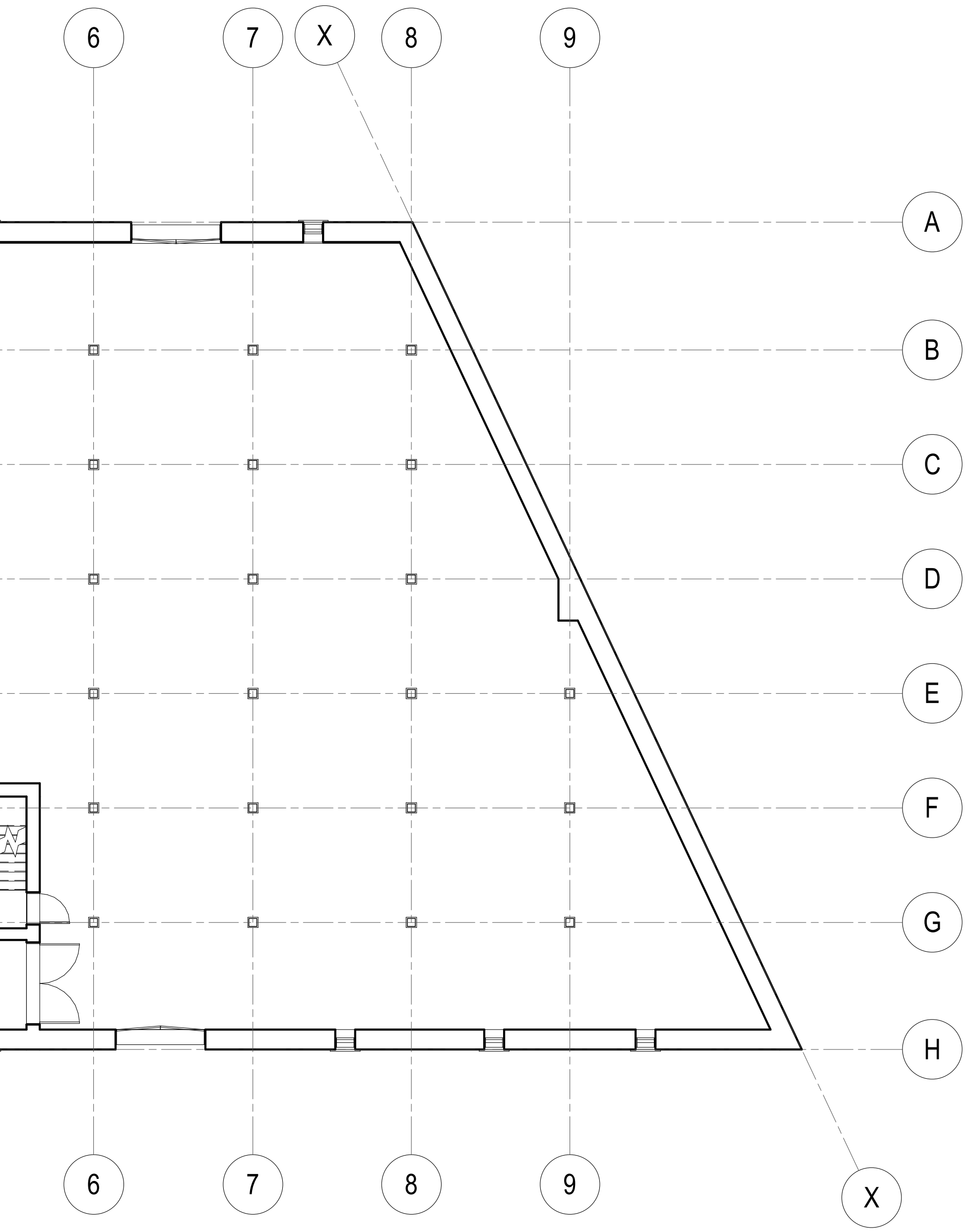
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 5 - EXISTING Floor Plan

SHEET A16 OF A21



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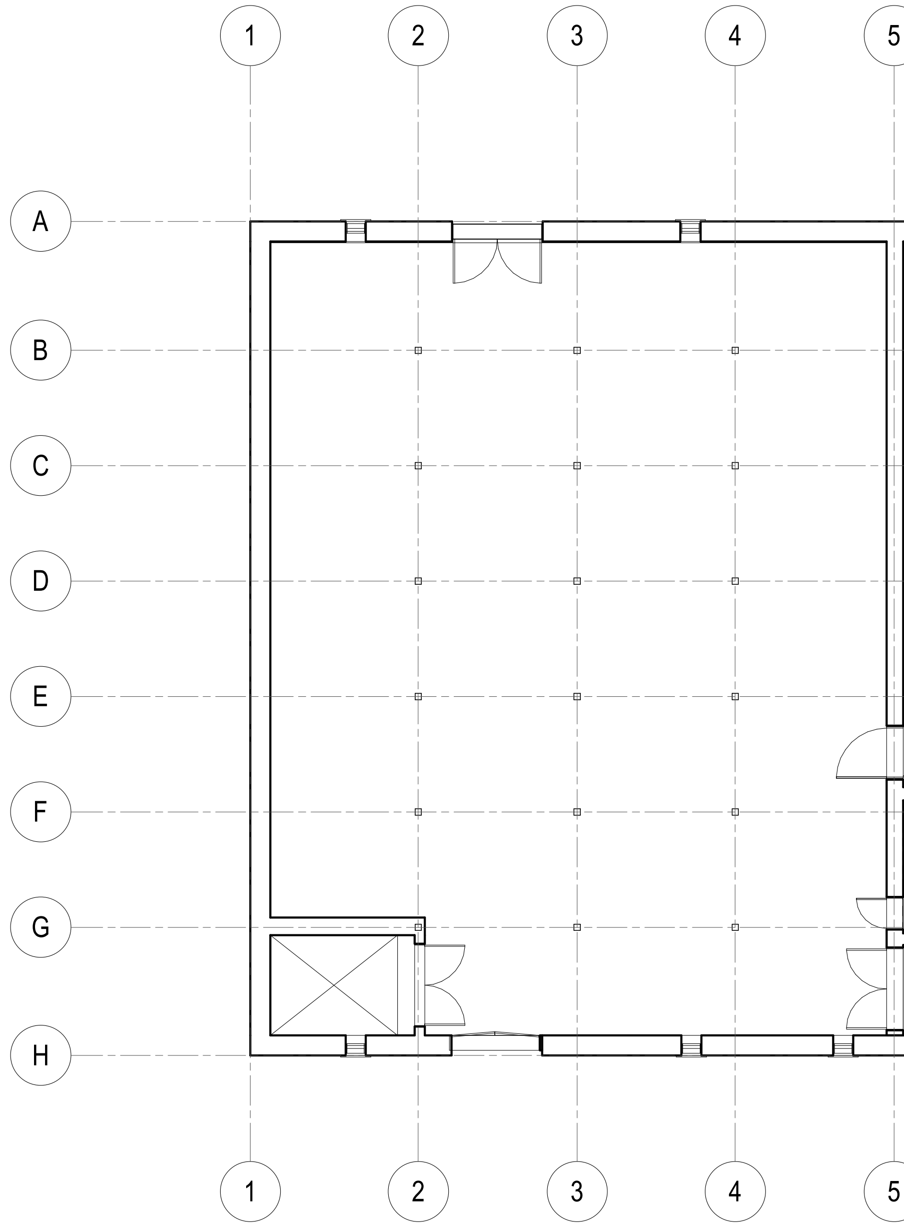
Project: **Feasability Study - Hoosac Building**

Title: Floor 5 Floor Plan

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

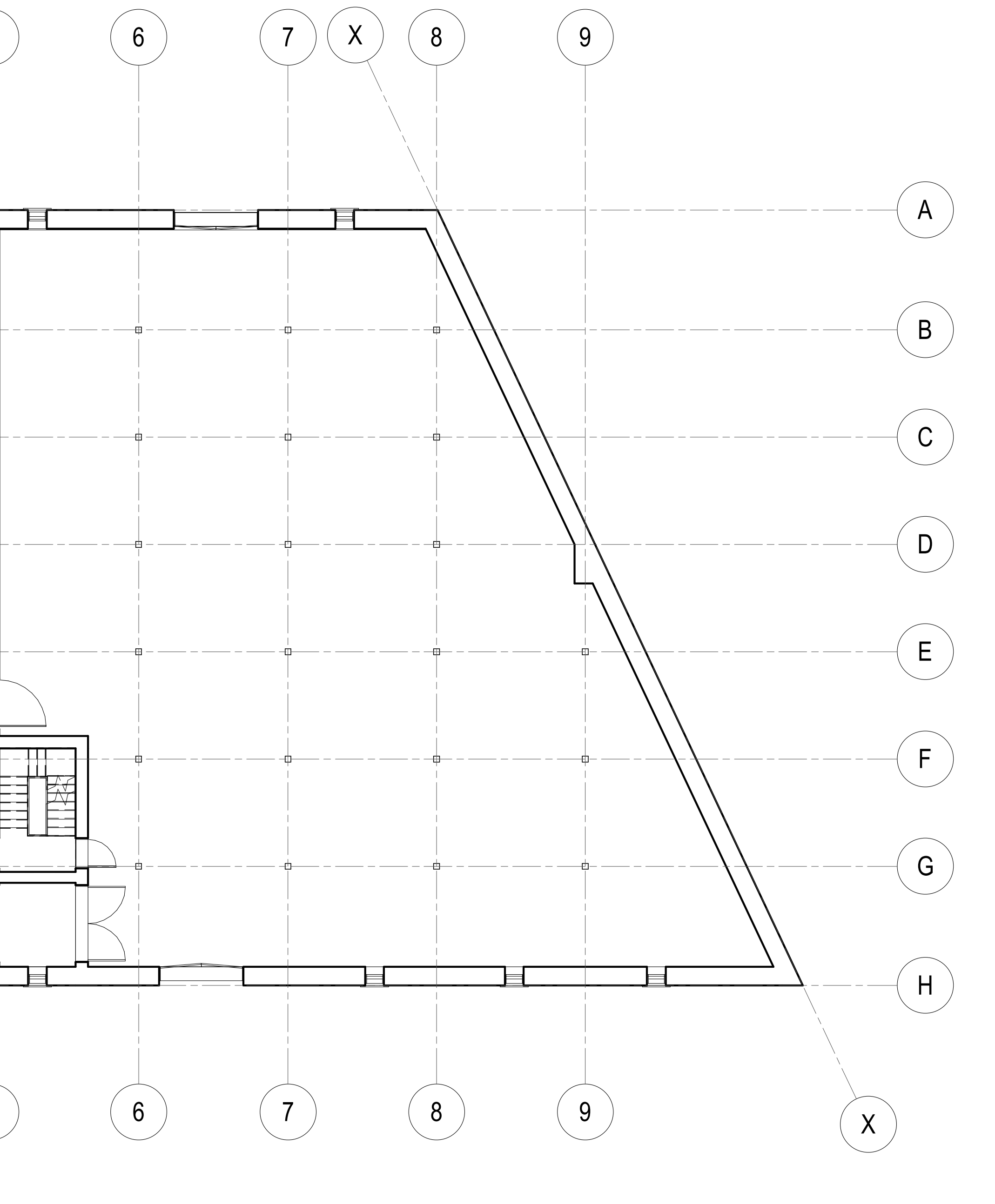
APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS

Note: No material testing samples collected from this level.



1 FLOOR 6 - EXISTING Floor Plan

SHEET A17 OF A21



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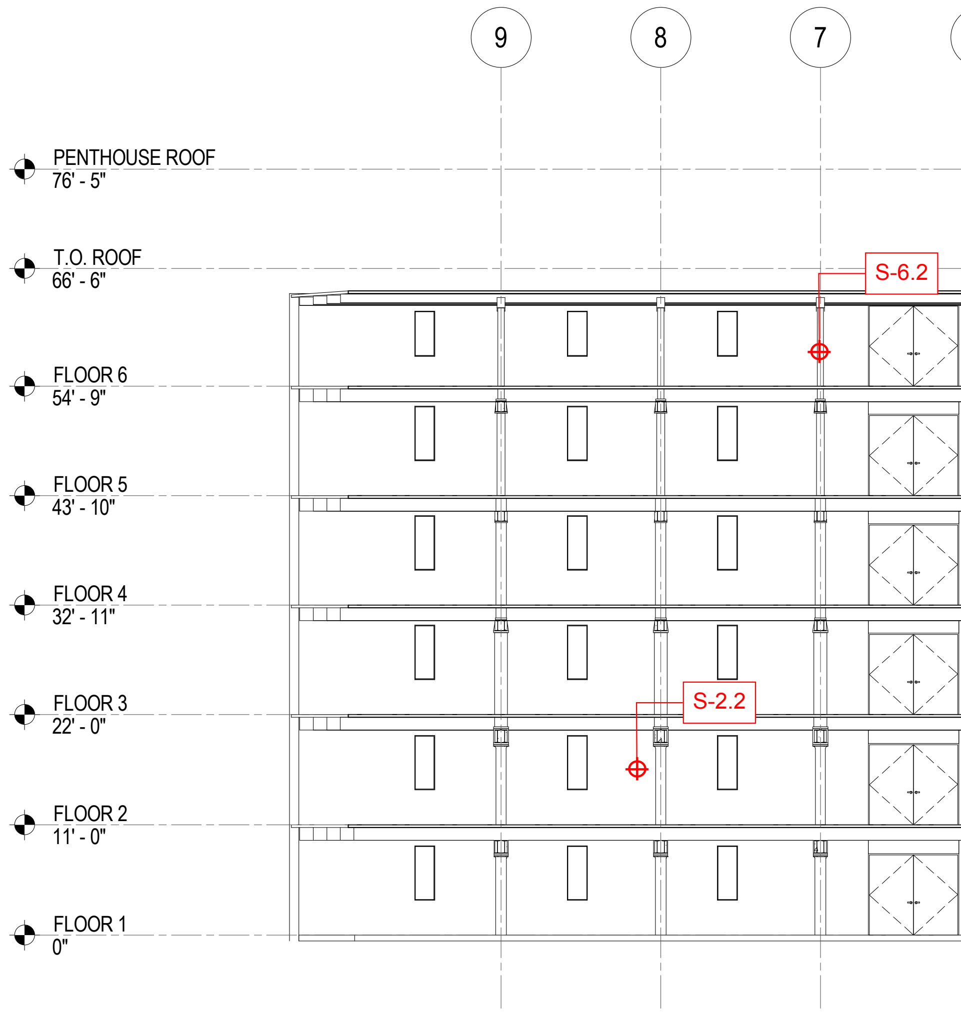
Project:
Feasability Study - Hoosac Building

Title: Floor 6 Floor Plan

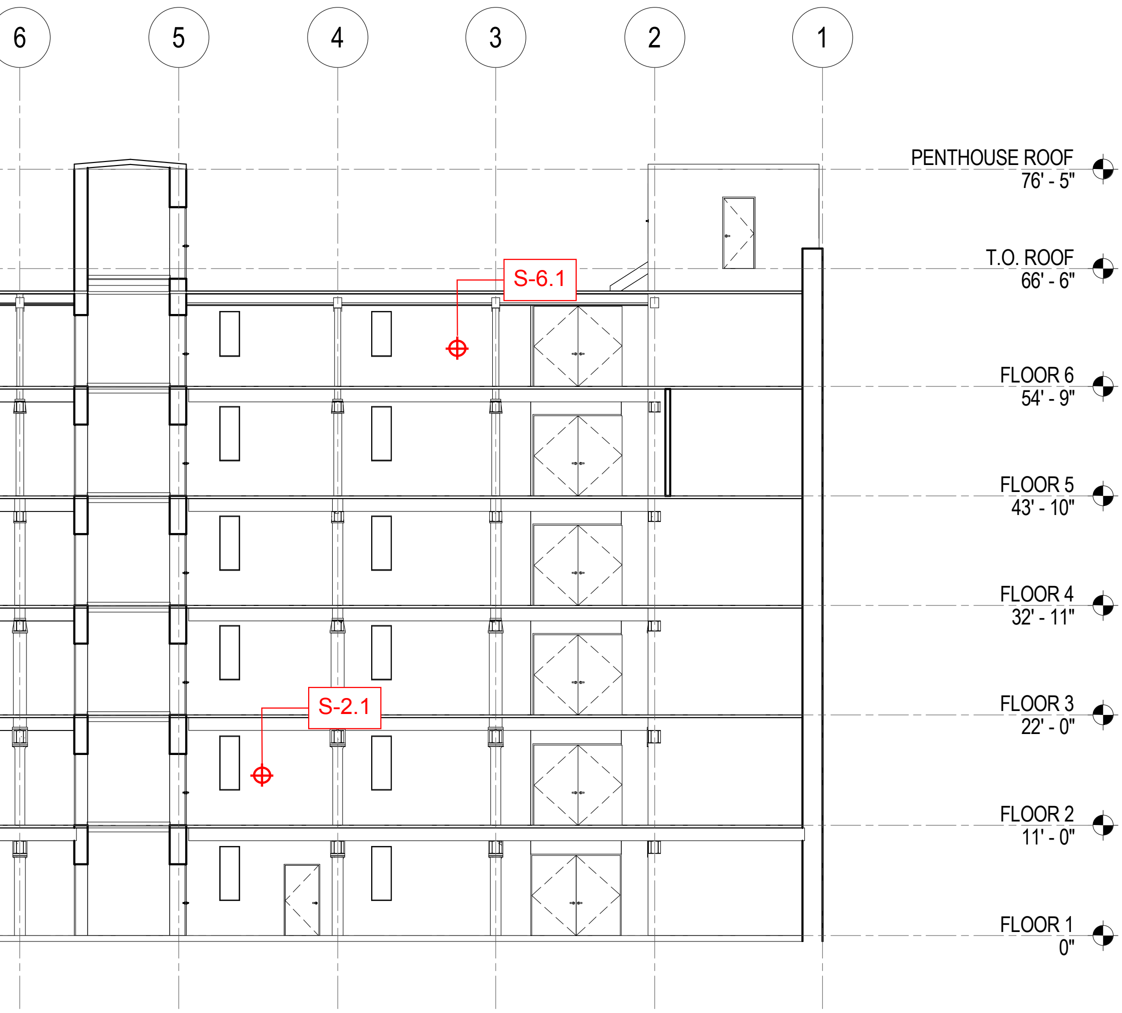
Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 South Elevation - Interior

SHEET A18 OF A21



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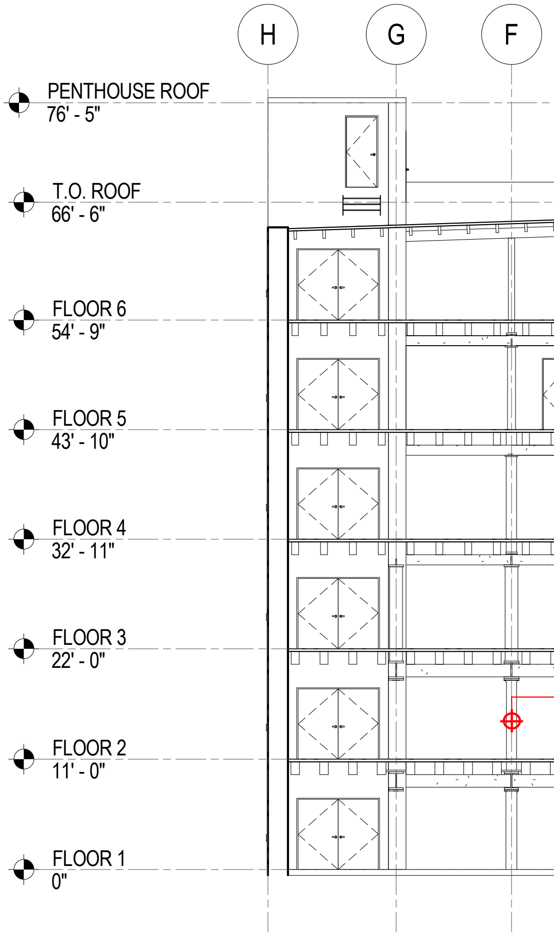
Project:
Feasability Study - Hoosac Building

Title: South Elevation - Interior

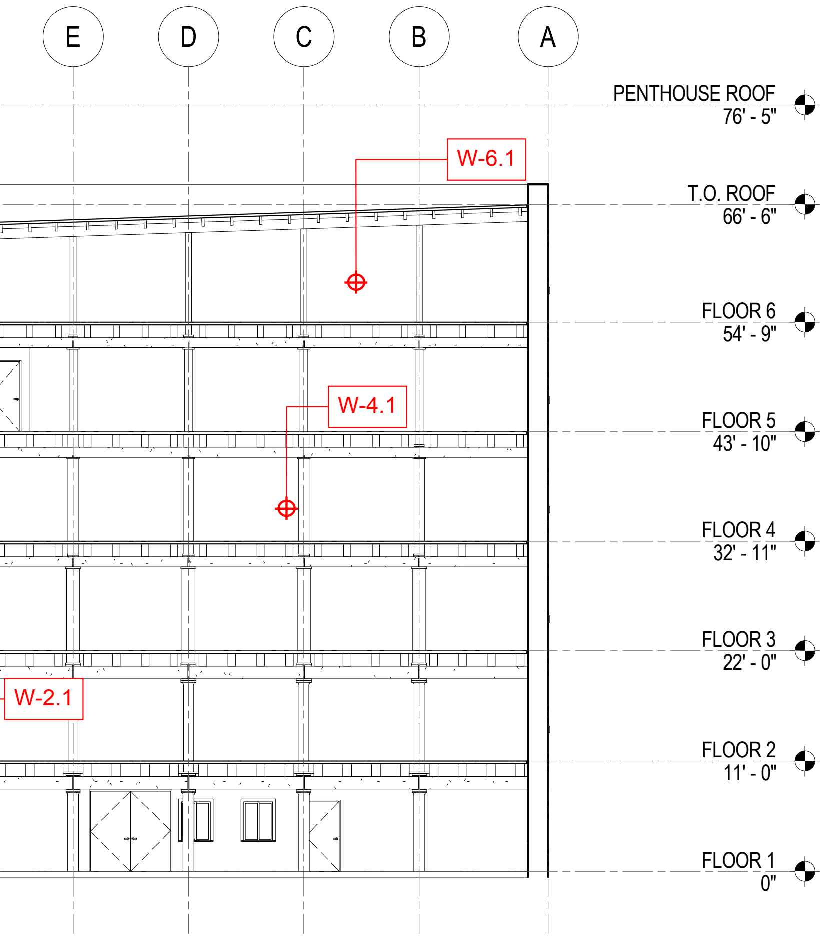
Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 West Elevation - Interior

SHEET A19 OF A21



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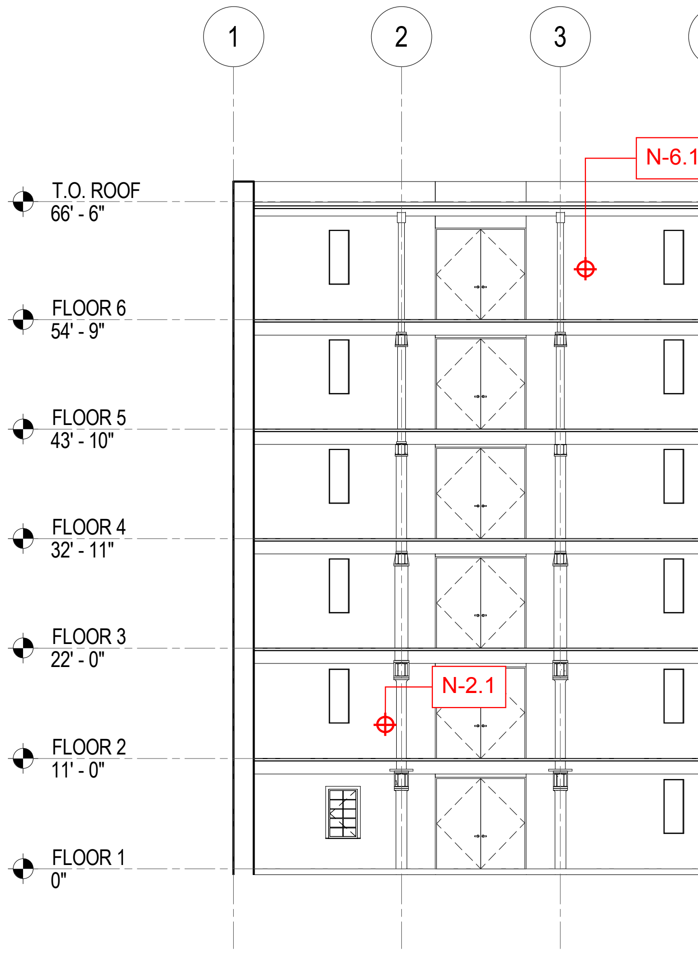
Project: **Feasability Study - Hoosac Building**

Title: West Elevation - Interior

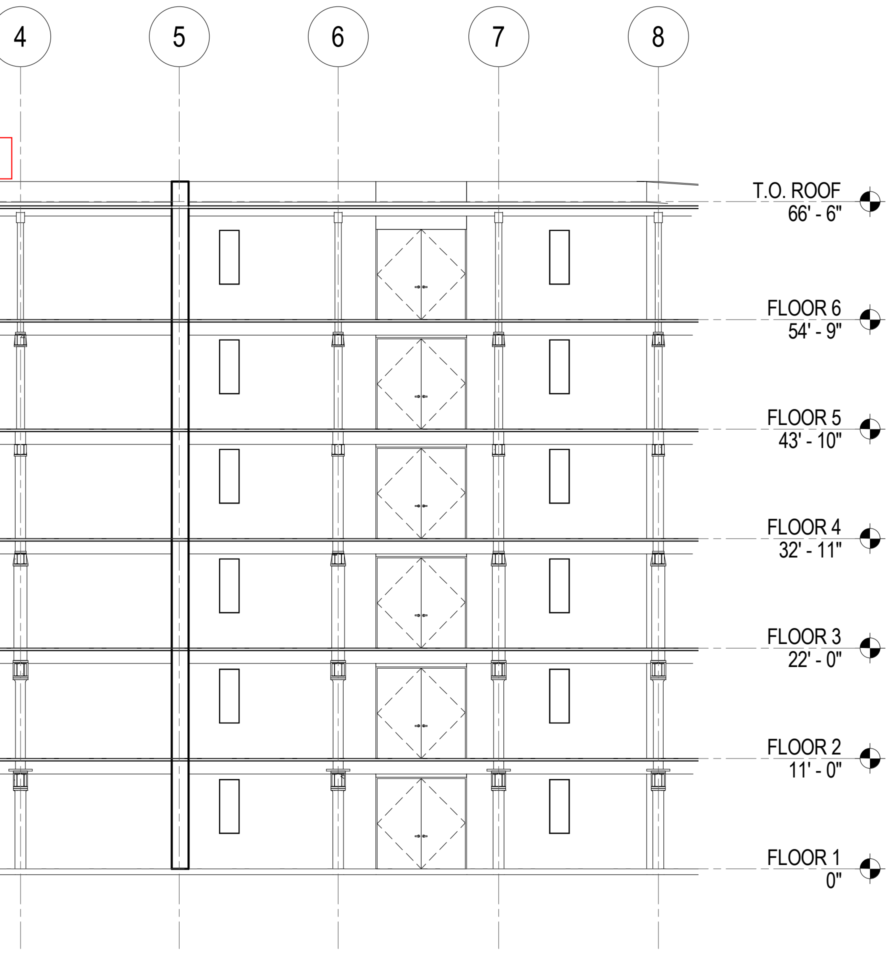
Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 North Elevation - Interior

SHEET A20 OF A21



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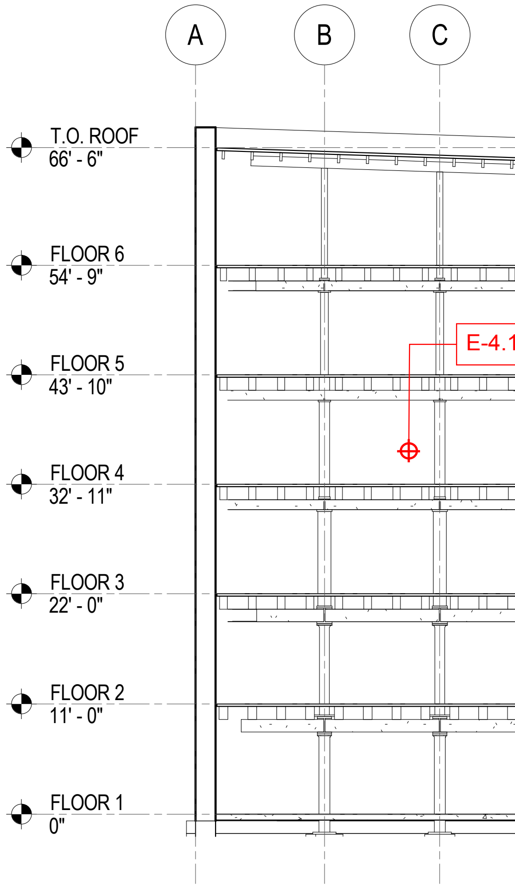
Project:

Feasability Study - Hoosac Building

Title: North Elevation - Interior

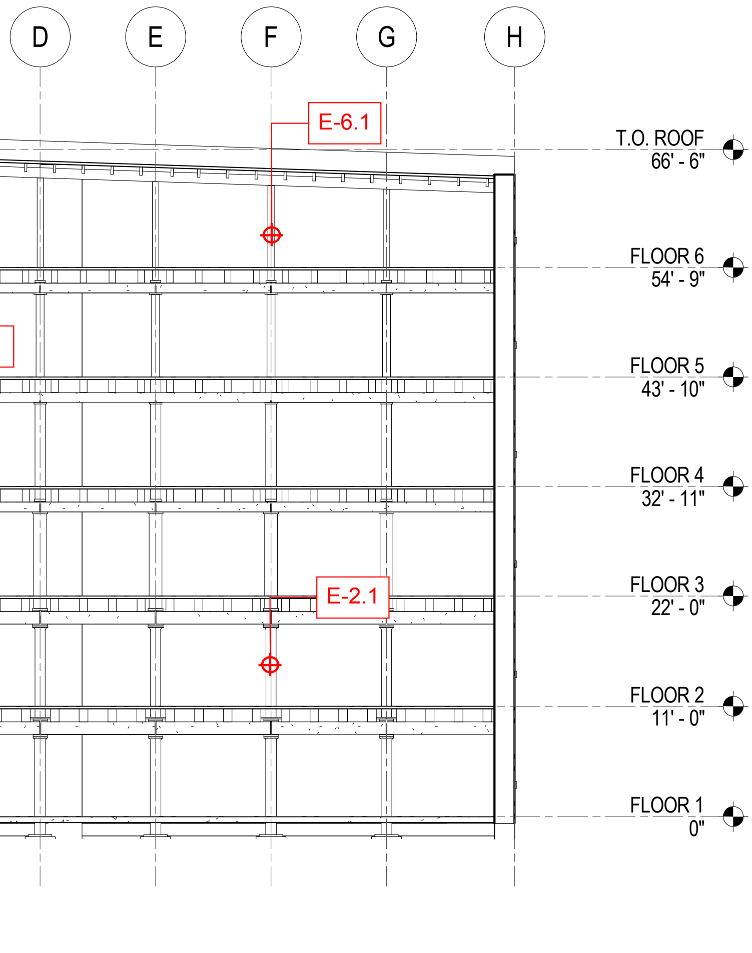
Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX A - APPROXIMATE LOCATION OF MASONRY CORE AND MATERIAL SAMPLING LOCATIONS



1 East Elevation - Interior

SHEET A21 OF A21



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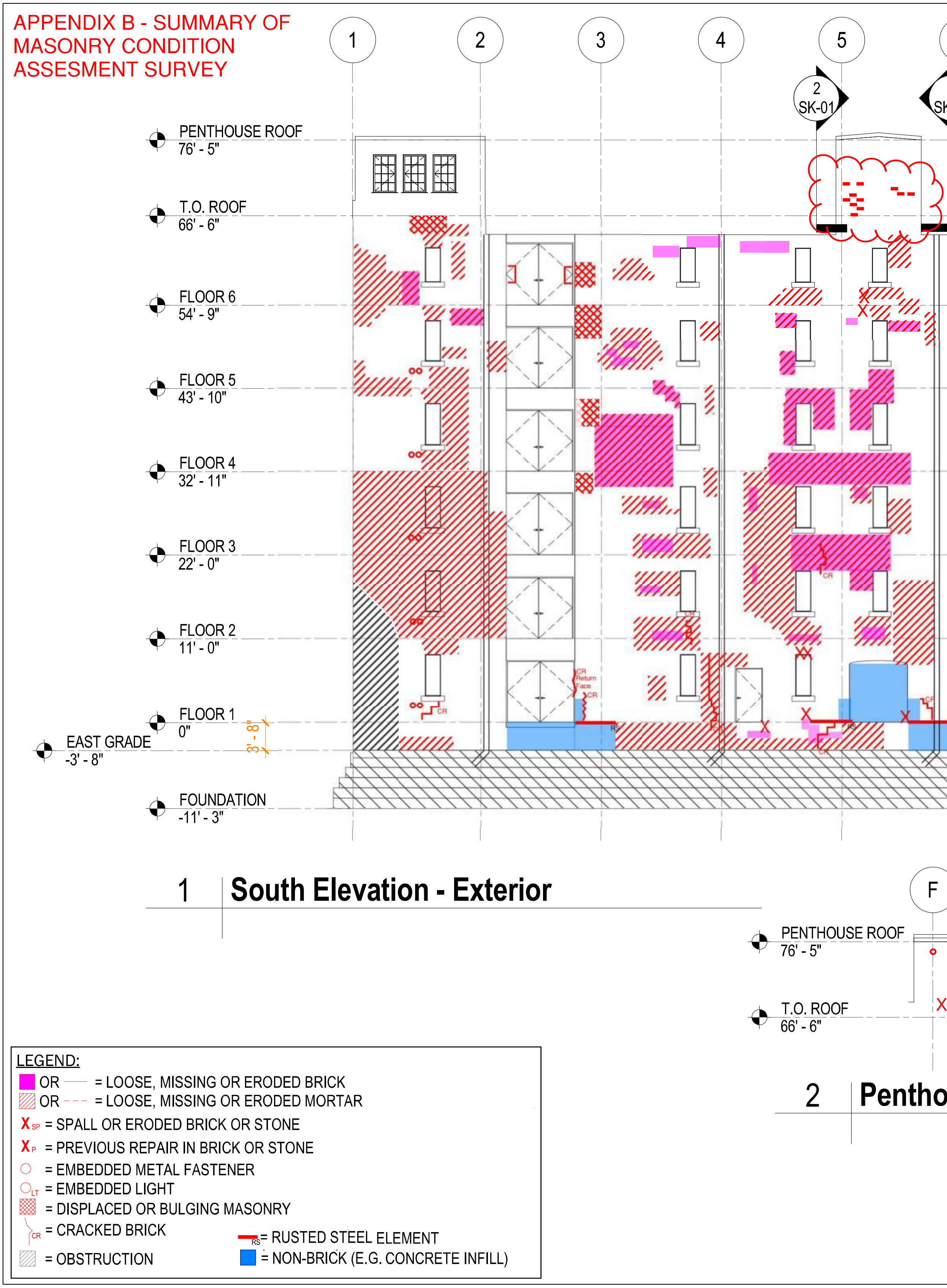
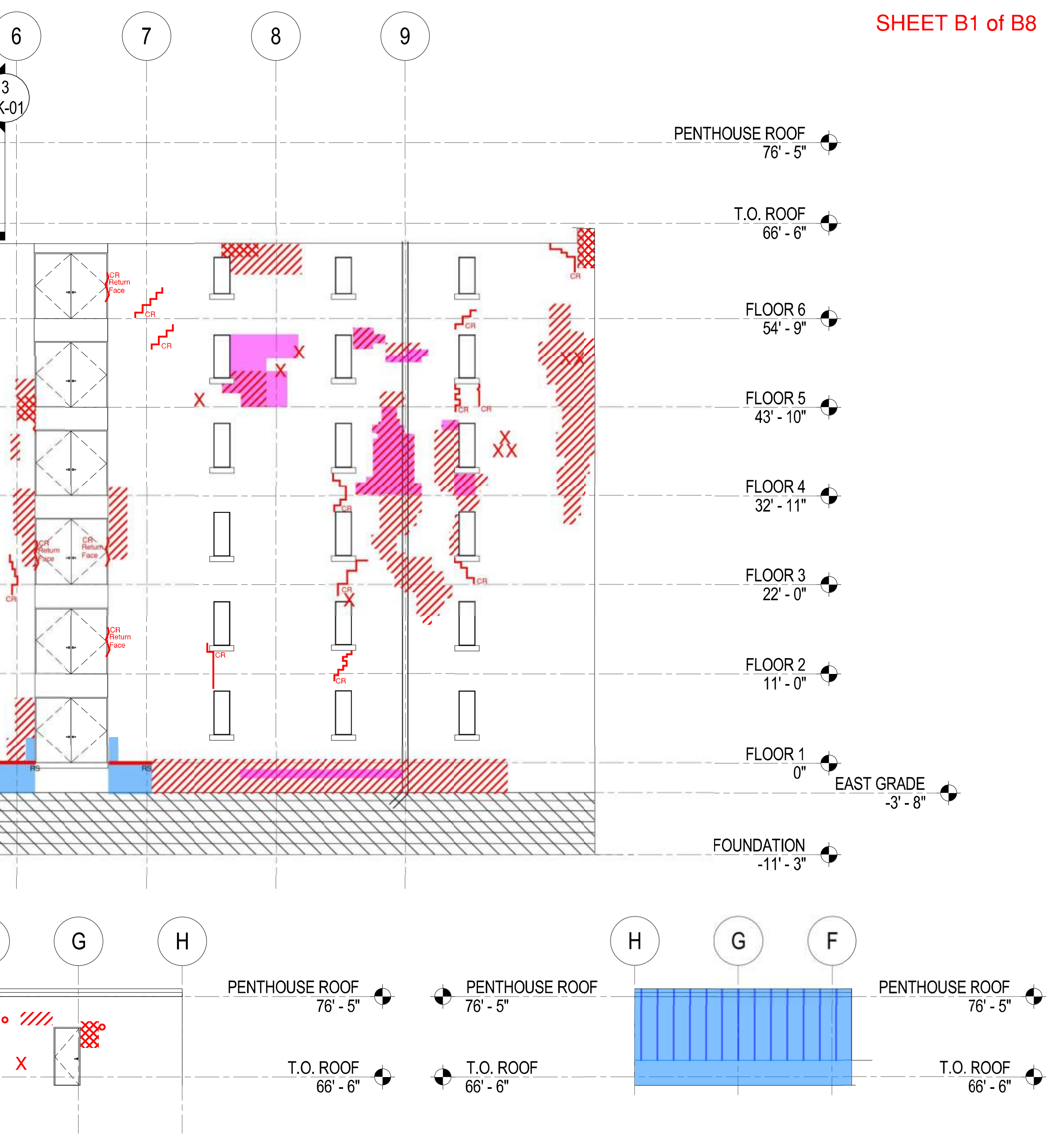
Project: Feasability Study - Hoosac Building			
Title: East Elevation - Interior			
Drawn: Author	Checked: Checker	Approved: Approver	Project No.: 191468.00

APPENDIX B

Summary of Masonry Condition Assessment Survey


APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY
1
2
3
4
5
2
SK-01
PENTHOUSE ROOF
76' - 5"
T.O. ROOF
66' - 6"
FLOOR 6
54' - 9"
FLOOR 5
43' - 10"
FLOOR 4
32' - 11"
FLOOR 3
22' - 0"
FLOOR 2
11' - 0"
FLOOR 1
0"
EAST GRADE
-3' - 8"
3' - 8"
FOUNDATION
-11' - 3"
1 South Elevation - Exterior
F
PENTHOUSE ROOF
76' - 5"
T.O. ROOF
66' - 6"
2 Pentho
LEGEND:
OR = LOOSE, MISSING OR ERODED BRICK
OR = LOOSE, MISSING OR ERODED MORTAR
X SP = SPALL OR ERODED BRICK OR STONE
X P = PREVIOUS REPAIR IN BRICK OR STONE
= EMBEDDED METAL FASTENER
LT = EMBEDDED LIGHT
= DISPLACED OR BULGING MASONRY
CR = CRACKED BRICK
RS = RUSTED STEEL ELEMENT
= OBSTRUCTION
= NON-BRICK (E.G. CONCRETE INFILL)

SHEET B1 of B8



use East Elevation

3 Penthouse West Elevation

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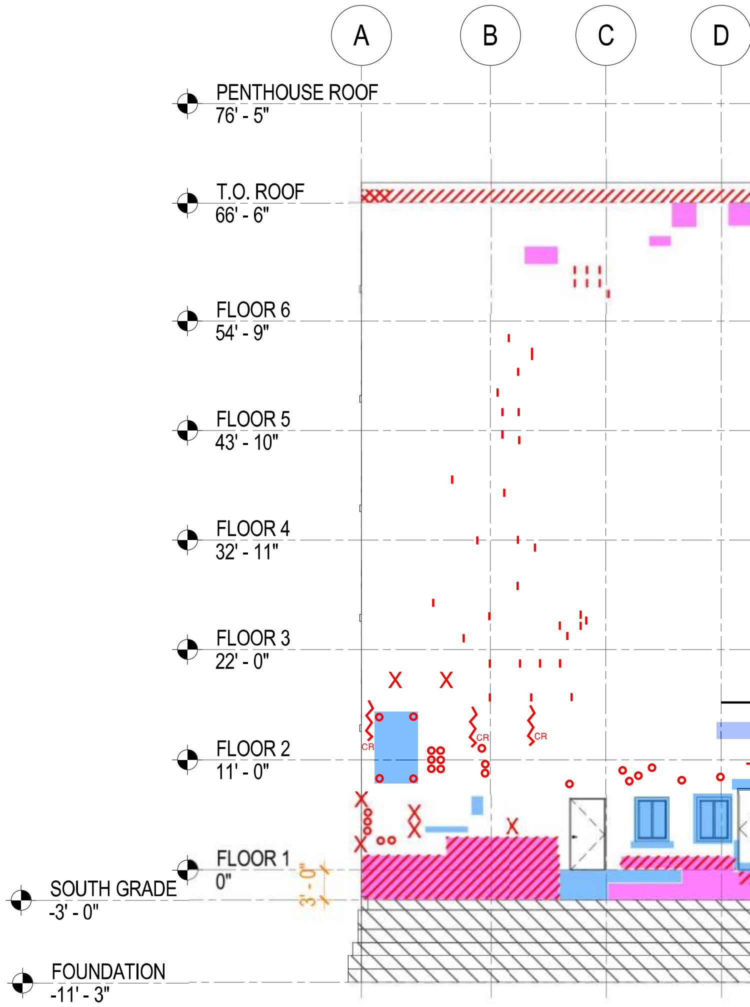
Project: **Feasability Study - Hoosac Building**

Title: South Elevation - Exterior

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY



1 West Elevation - Exterior

LEGEND:

OR = LOOSE, MISSING OR ERODED BRICK

OR = LOOSE, MISSING OR ERODED MORTAR

X SP = SPALL OR ERODED BRICK OR STONE

X P = PREVIOUS REPAIR IN BRICK OR STONE

= EMBEDDED METAL FASTENER

LT = EMBEDDED LIGHT

= DISPLACED OR BULGING MASONRY

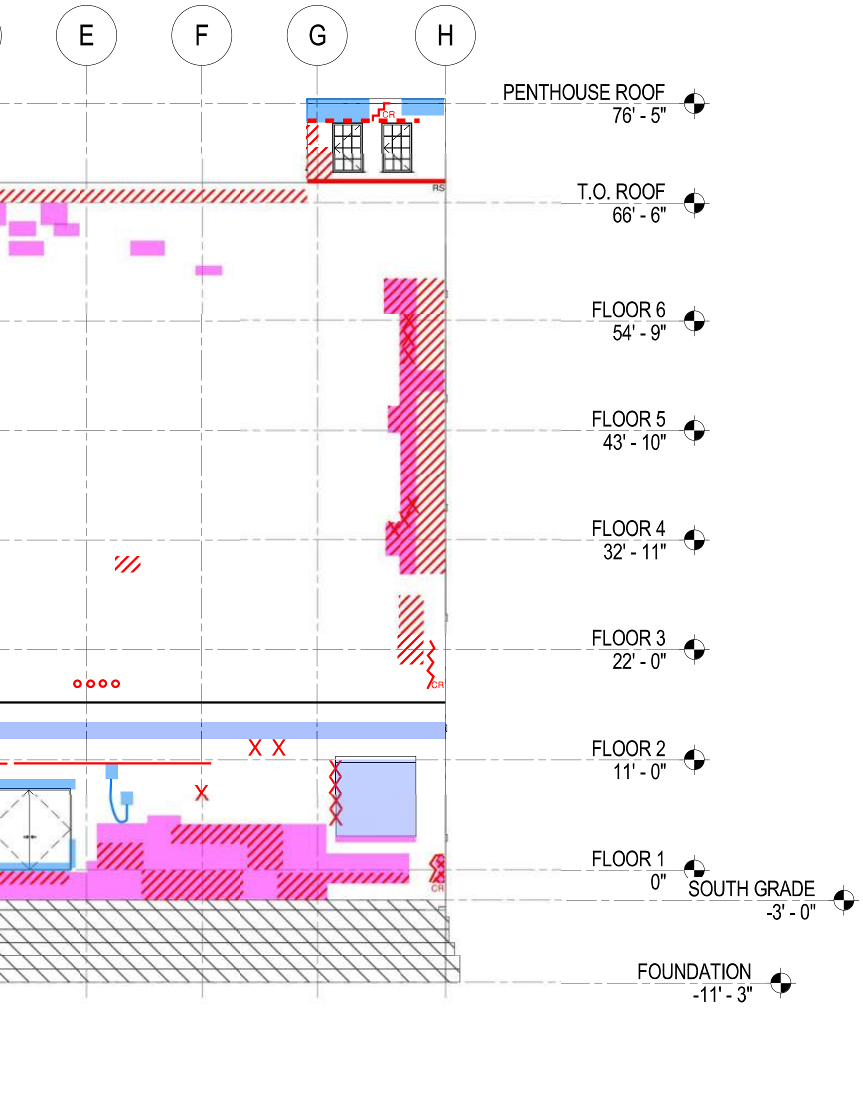
CR = CRACKED BRICK

RS = RUSTED STEEL ELEMENT

= OBSTRUCTION

= NON-BRICK (E.G. CONCRETE INFILL)

SHEET B2 of B8



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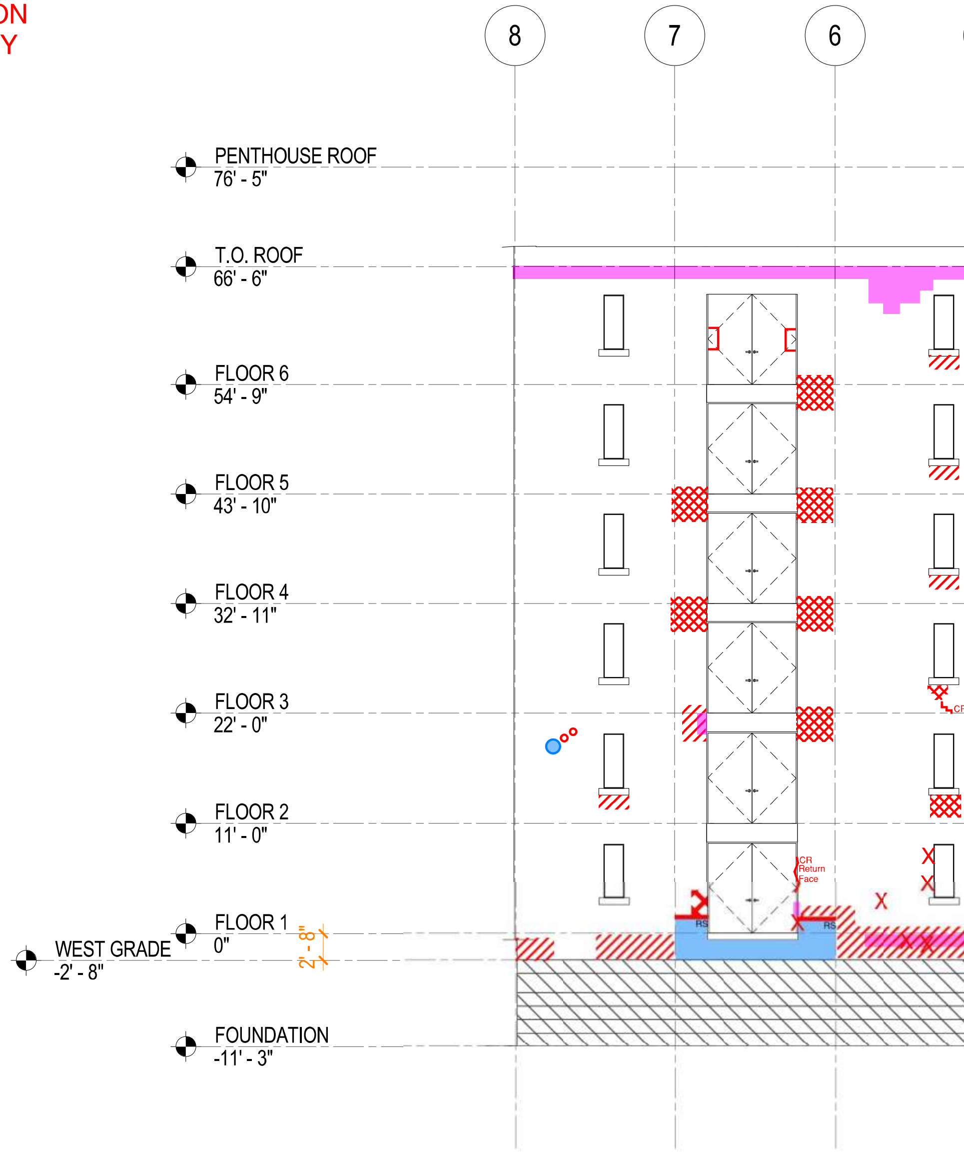
	Title: West Elevation - Exterior		
Drawn: Jacobs	Checked: MDR	Approved: HMC	Project No.: 191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY

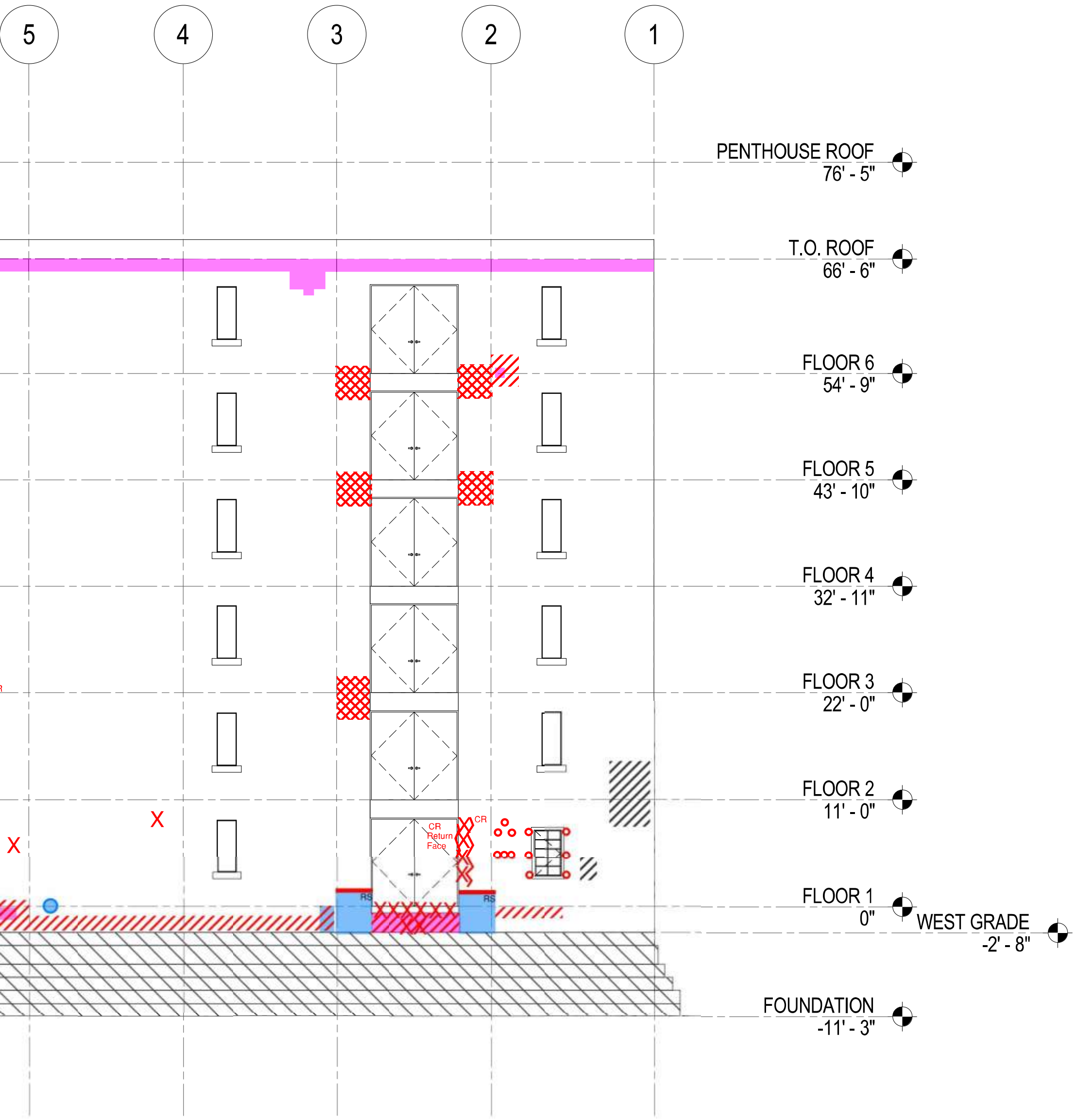


1 **North Elevation - Exterior**

LEGEND:

- OR —— = LOOSE, MISSING OR ERODED BRICK
- OR - - - = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
- X P = PREVIOUS REPAIR IN BRICK OR STONE
- ○ = EMBEDDED METAL FASTENER
- ○ LT = EMBEDDED LIGHT
- = DISPLACED OR BULGING MASONRY
- CR = CRACKED BRICK
- = OBSTRUCTION
- RS = RUSTED STEEL ELEMENT
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B3 of B8



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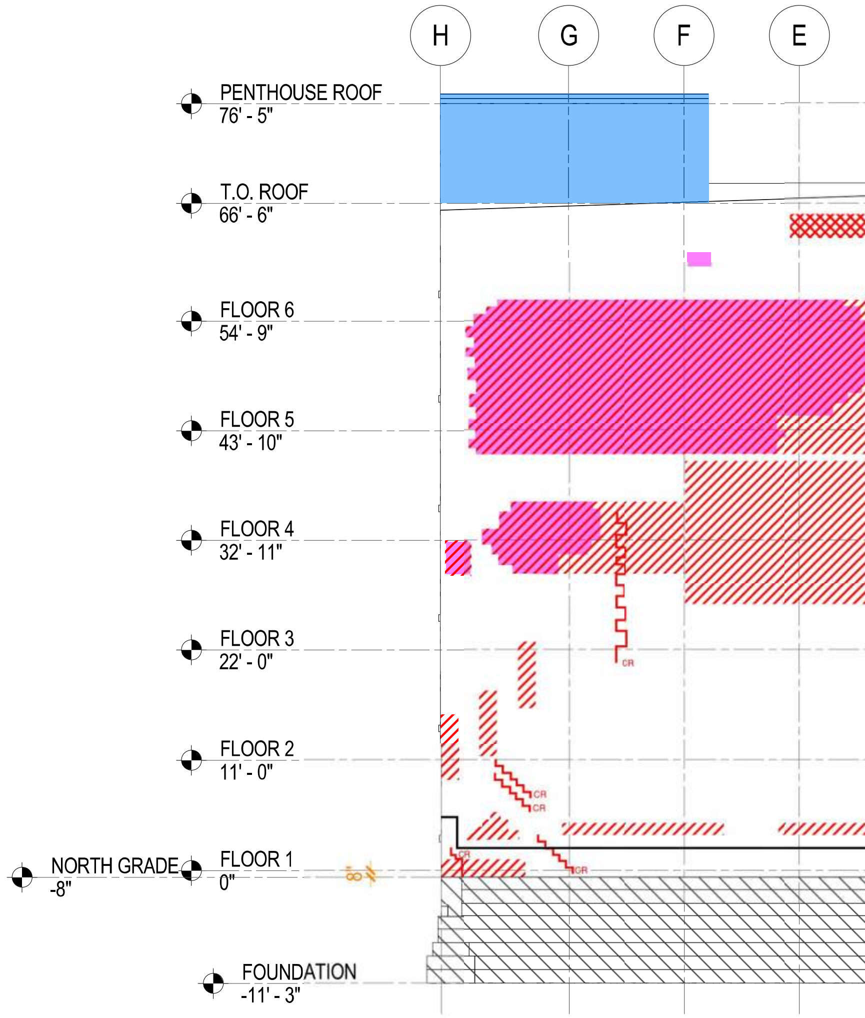
Project:
Feasability Study - Hoosac Building

Title: North Elevation - Exterior

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY

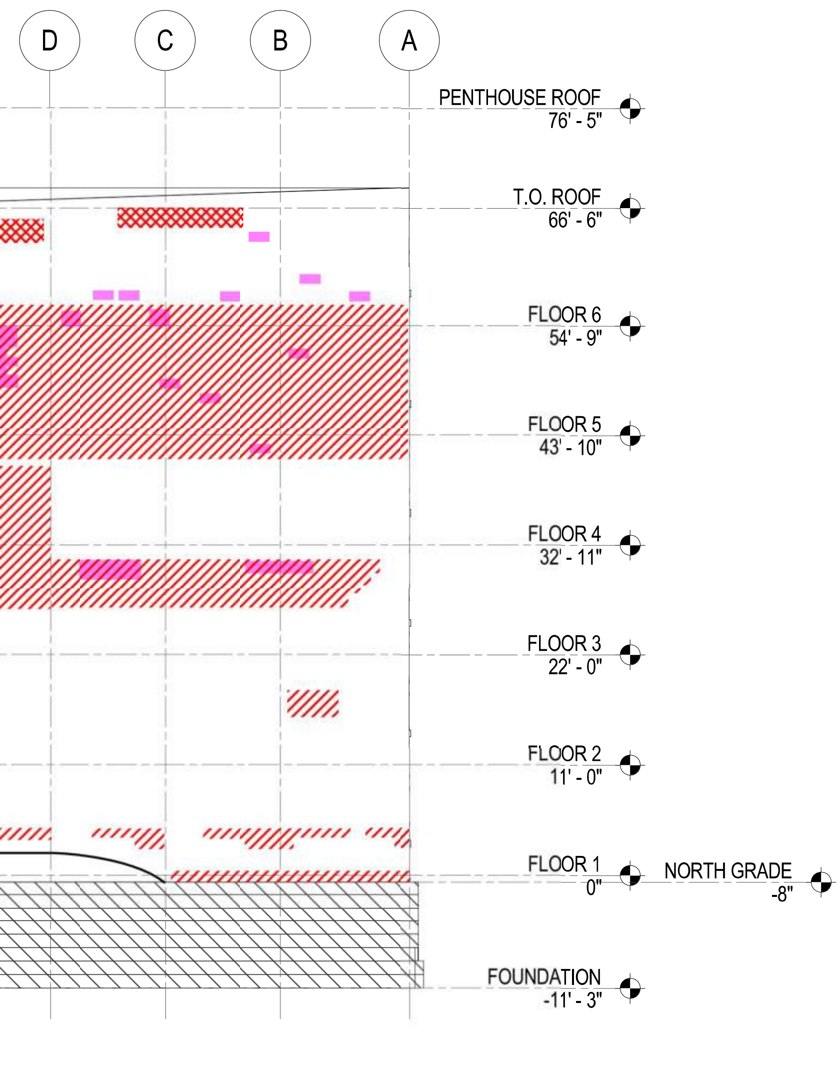


1 **East Elevation - Exterior**

LEGEND:

- OR = LOOSE, MISSING OR ERODED BRICK
- OR = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
- X P = PREVIOUS REPAIR IN BRICK OR STONE
- = EMBEDDED METAL FASTENER
- LT = EMBEDDED LIGHT
- = DISPLACED OR BULGING MASONRY
- CR = CRACKED BRICK
- = OBSTRUCTION
- RS = RUSTED STEEL ELEMENT
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B4 of B8



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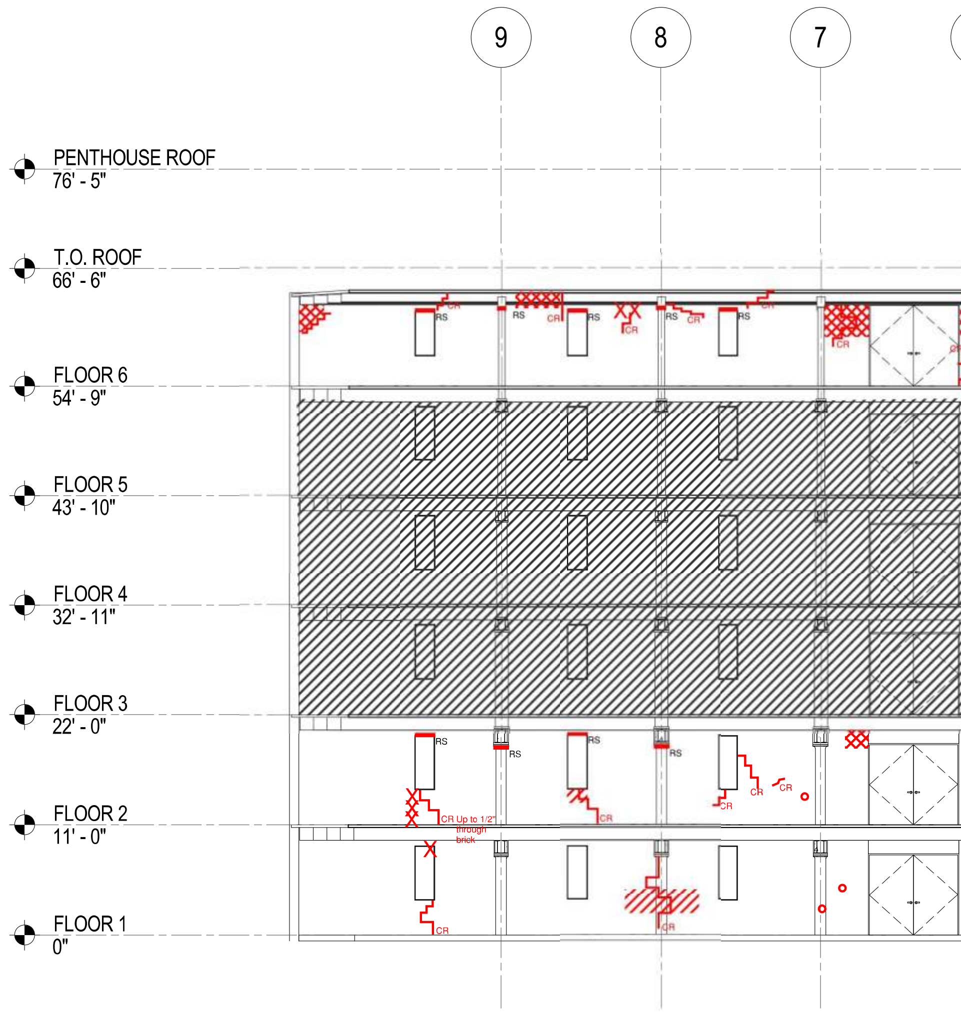
Project:
Feasability Study - Hoosac Building

Title: East Elevation - Exterior

Drawn:	Checked:	Approved:	Project No.:
Jacobs	MDR	HMC	191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY

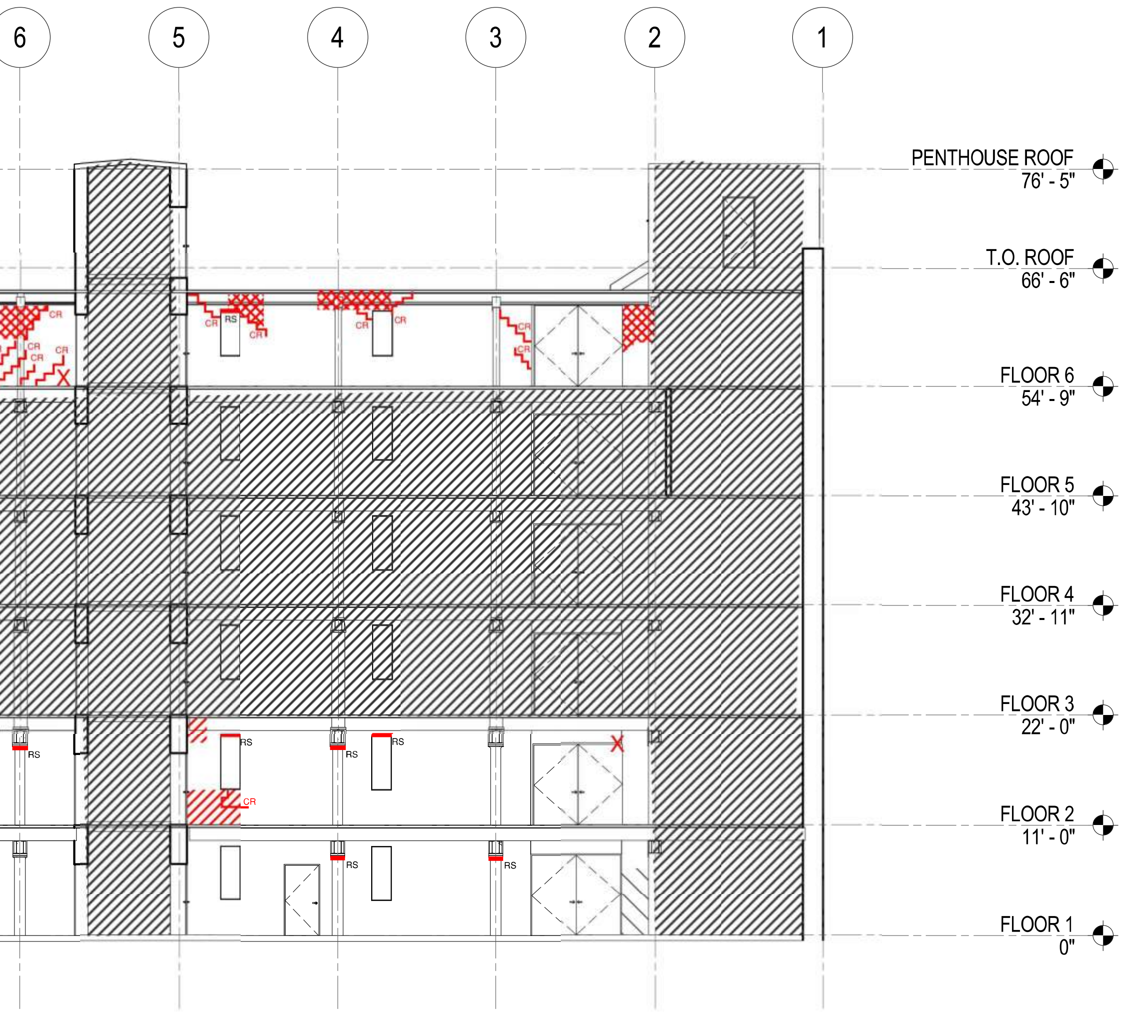


1 South Elevation - Interior

LEGEND:

- OR —— = LOOSE, MISSING OR ERODED BRICK
- OR - - - = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
- X P = PREVIOUS REPAIR IN BRICK OR STONE
- ○ = EMBEDDED METAL FASTENER
- ○ LT = EMBEDDED LIGHT
- = DISPLACED OR BULGING MASONRY
- CR = CRACKED BRICK
- = OBSTRUCTION
- RS = RUSTED STEEL ELEMENT
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B5 of B8



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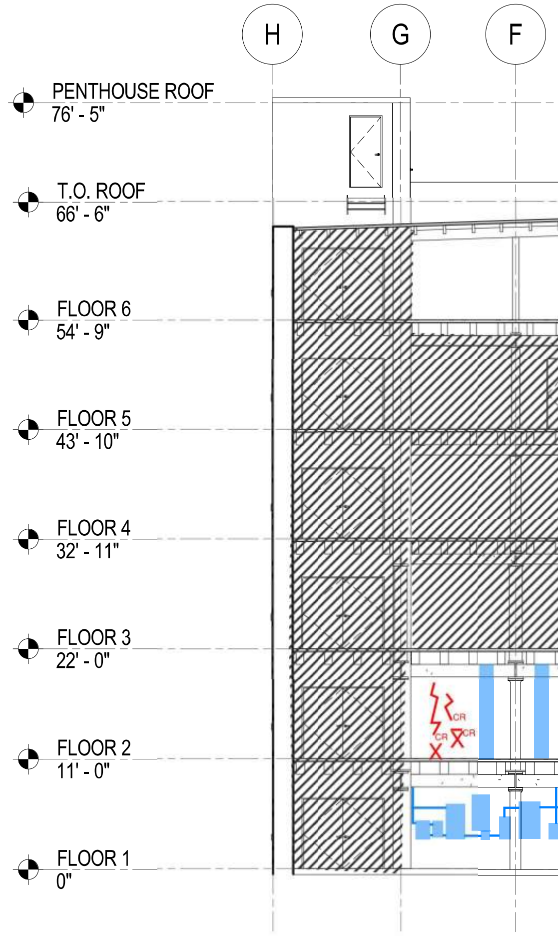
Project: **Feasability Study - Hoosac Building**			
Title: South Elevation - Interior			
Drawn: Author	Checked: Checker	Approved: Approver	Project No.: 191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY

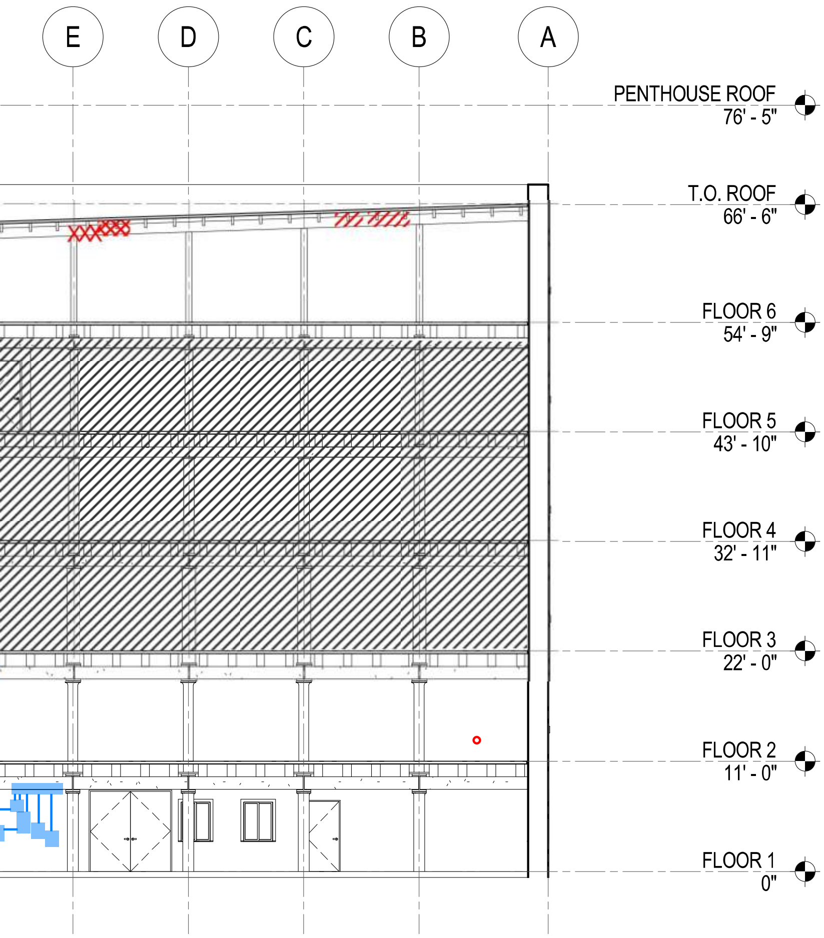


1 **West Elevation - Interior**

LEGEND:

- OR = LOOSE, MISSING OR ERODED BRICK
- OR = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
- X P = PREVIOUS REPAIR IN BRICK OR STONE
- = EMBEDDED METAL FASTENER
- LT = EMBEDDED LIGHT
- = DISPLACED OR BULGING MASONRY
- CR = CRACKED BRICK
- RS = RUSTED STEEL ELEMENT
- = OBSTRUCTION
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B6 of B8



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Project:
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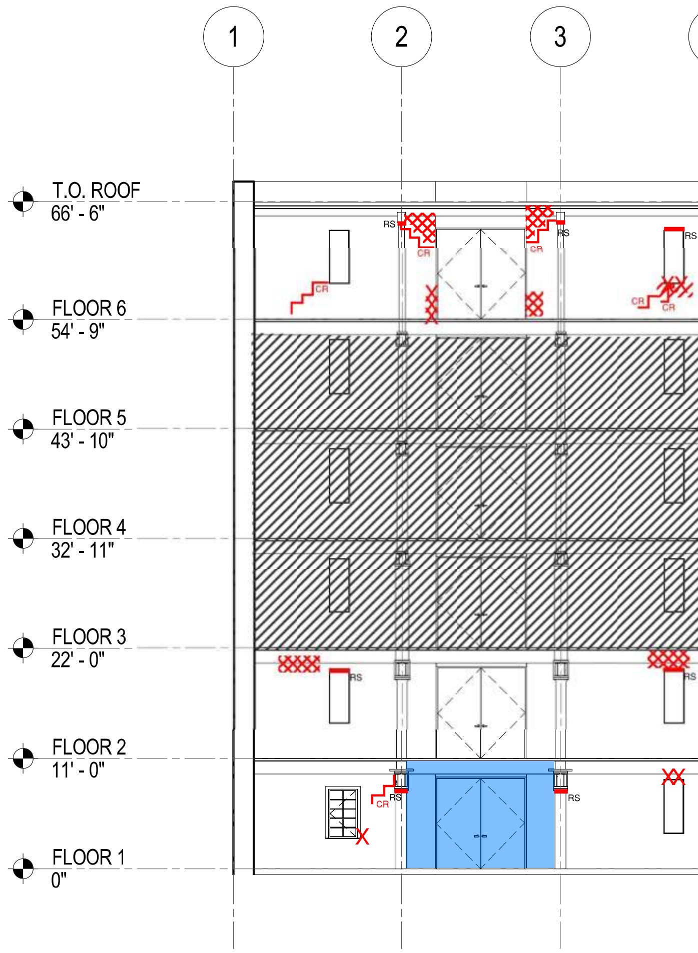
Title: West Elevation - Interior

Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY



1 **North Elevation - Interior**

LEGEND:

- OR = LOOSE, MISSING OR ERODED BRICK
- OR = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
- X P = PREVIOUS REPAIR IN BRICK OR STONE
- = EMBEDDED METAL FASTENER
- LT = EMBEDDED LIGHT
- = DISPLACED OR BULGING MASONRY
- CR = CRACKED BRICK
- = OBSTRUCTION
- RS = RUSTED STEEL ELEMENT
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B7 of B8

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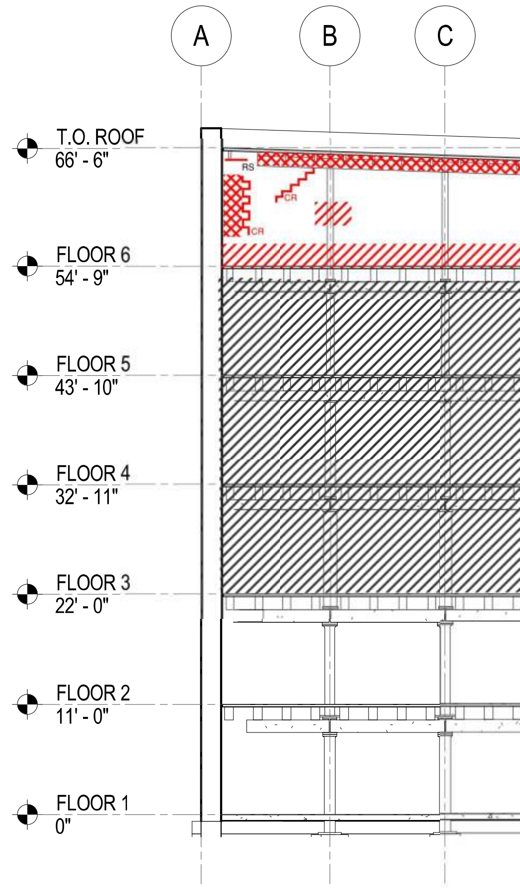
Project: **Feasability Study - Hoosac Building**

Title: North Elevation - Interior

Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX B - SUMMARY OF MASONRY CONDITION ASSESMENT SURVEY



1 East Elevation - Interior

LEGEND:

- OR —— = LOOSE, MISSING OR ERODED BRICK
- OR - - - = LOOSE, MISSING OR ERODED MORTAR
- X SP = SPALL OR ERODED BRICK OR STONE
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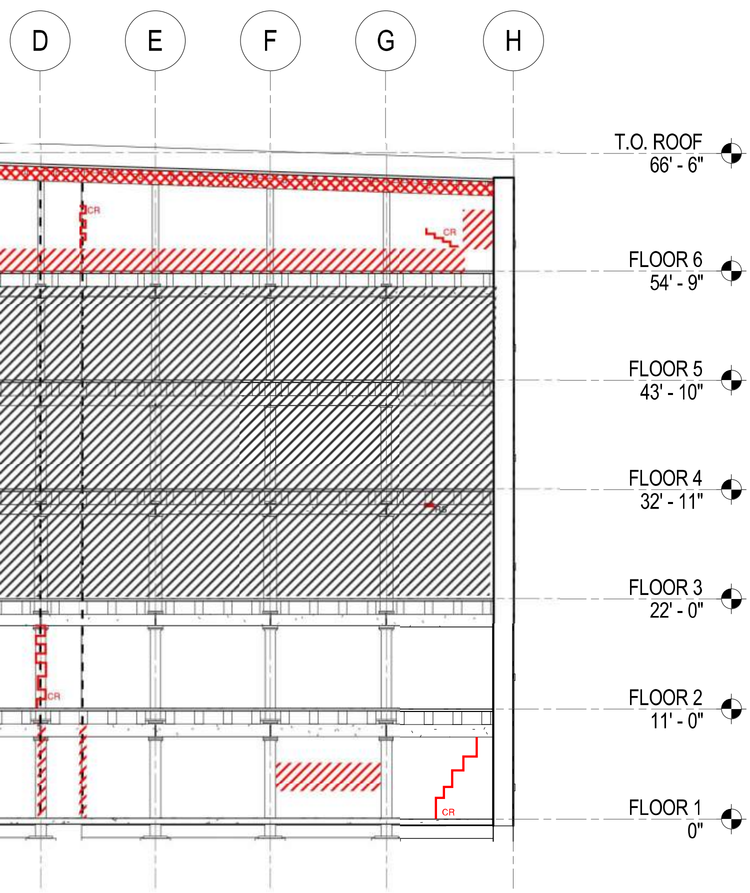
- RS = RUSTED STEEL ELEMENT
- = OBSTRUCTION
- = NON-BRICK (E.G. CONCRETE INFILL)

SHEET B8 of B8



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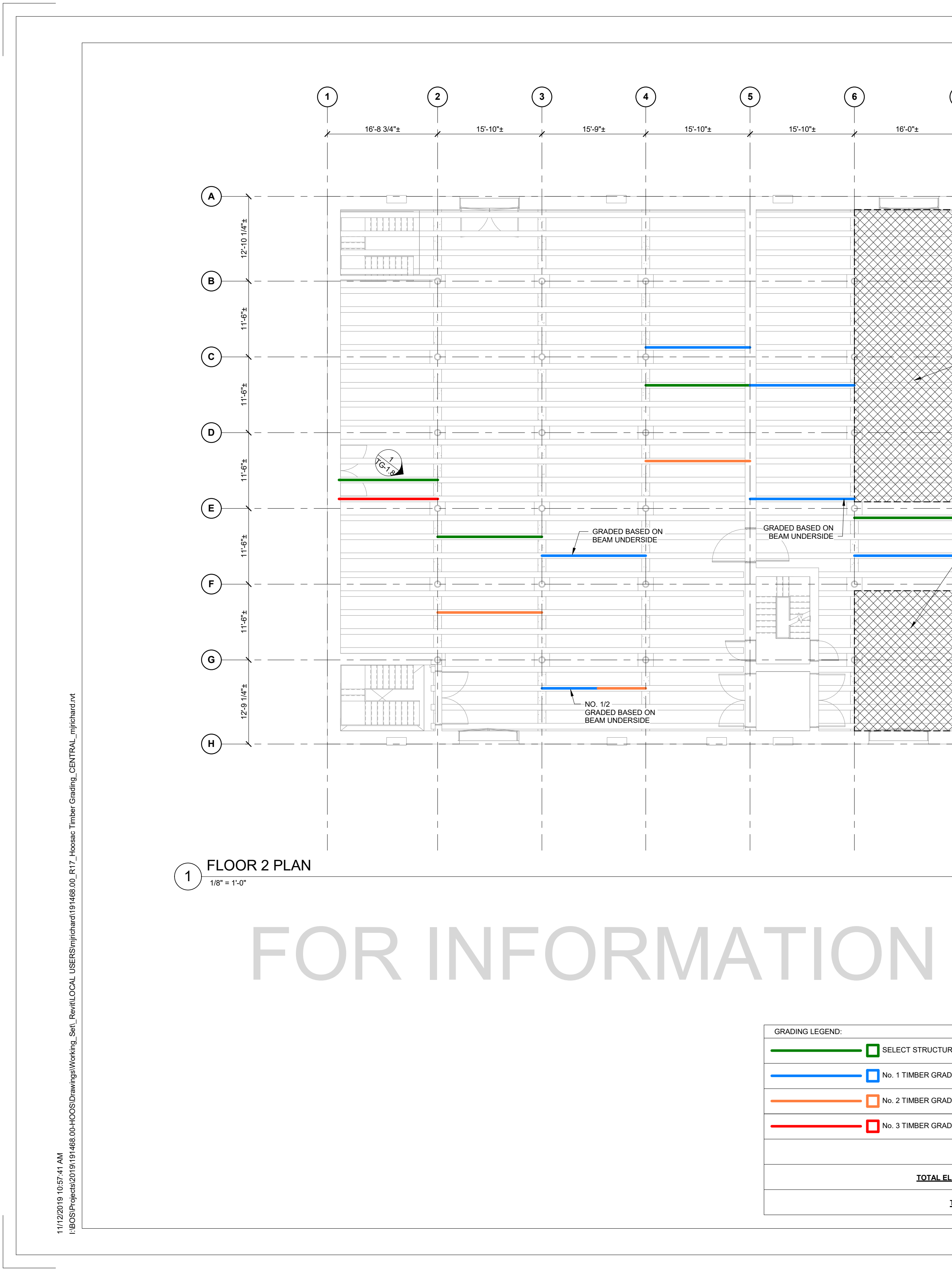
Project: **Feasability Study - Hoosac Building**

Title: East Elevation - Interior

Drawn:	Checked:	Approved:	Project No.:
Author	Checker	Approver	191468.00

APPENDIX C

Summary of Representative Timber Grading


1 2 3 4 5 6
16'-8 3/4"± 15'-10"± 15'-9"± 15'-10"± 15'-10"± 16'-0"±
A B C D E F G H
12'-10 1/4"± 11'-6"± 11'-6"± 11'-6"± 11'-6"± 11'-6"± 12'-9 1/4"±
GRADED BASED ON BEAM UNDERSIDE
GRADED BASED ON BEAM UNDERSIDE
NO. 1/2 GRADED BASED ON BEAM UNDERSIDE
1 FLOOR 2 PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTUR
No. 1 TIMBER GRAD
No. 2 TIMBER GRAD
No. 3 TIMBER GRAD
TOTAL EL
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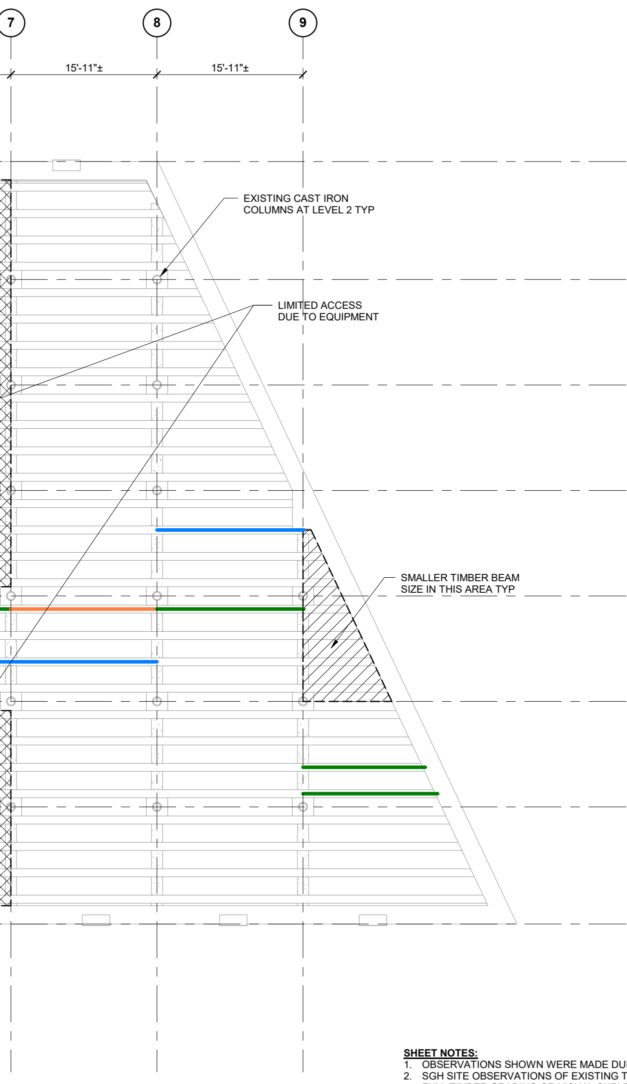

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No.	Date	Description	By

SHEET NOTES:
1. OBSERVATIONS SHOWN WERE MADE DURING SGH SITE VISITS ON 09, 15, & 18 OCTOBER 2019.
2. SGH SITE OBSERVATIONS OF EXISTING TIMBERS ARE LIMITED AND SGH DID NOT CONDUCT A FULL TIMBER GRADING OR VISUAL SURVEY OF THE ENTIRE EXISTING BUILDING.
3. THE VISUAL GRADING OF EXISTING TIMBERS WAS BASED ON LIMITED OBSERVATIONS OF ALL ACCESSIBLE TIMBER SURFACES AT THE TIME OF SGH'S SITE VISIT. PARTIALLY OBSTRUCTED TIMBERS, HEAVILY PAINTED TIMBERS, AND INACCESSIBLE SURFACES COULD NOT BE GRADED OR GRADED FULLY. EXISTING TIMBERS COULD ONLY BE REVIEWED BASED ON EXPOSED TIMBER FACES. PORTIONS OF TIMBERS ENCLOSED OR COVERED BY FINISHES OR OTHER MATERIAL ARE NOTED TO THE BEST EXTENT POSSIBLE.
4. ALL TIMBER BEAMS AND COLUMNS GRADED ARE ASSUMED TO BE SOUTHERN PINE SPECIES BASED ON A WOOD MICROSCOPY EXAMINATION OF (4) LIMITED MATERIAL SAMPLES TAKEN AT LEVELS 3, 4, 5, & 6 AS NOTED ON PLAN.
5. TIMBER VISUAL GRADING IS BASED ON THE 2014 STANDARD GRADING RULES FOR SOUTHERN PINE LUMBER BY THE SOUTHERN PINE INSPECTION BUREAU (SPIB).
6. BEAMS SHOWN ON PLAN AT A SPECIFIC FLOOR LEVEL ARE VISIBLE WHEN STANDING ON THE FLOOR LEVEL BELOW AND LOOKING UP. COLUMNS SHOWN ARE VISIBLE WHEN STANDING ON THE NOTED FLOOR LEVEL.
7. SEE ARCHITECTURAL/STRUCTURAL DRAWINGS FOR PROJECT AREAS OUTSIDE OF SGH SCOPE OF WORK.
8. THE PROJECT STRUCTURAL ENGINEER OF RECORD (SER) IS RESPONSIBLE FOR SURVEYING THE CONDITION OF EXISTING STRUCTURAL MEMBERS TO REMAIN AS PART OF THEIR FEASBILITY STUDY.

ONLY

	SUMMARY	
	BEAMS	COLUMNS
AL TIMBER GRADE	7 (3%)	0
E	7 (3%)	0
E	4 (1.7%)	0
E	1 (0.4%)	0
UNGRADED:	213 (91.8%)	39
EMENTS GRADED:	**19 (8.2%)**	**0**
TOTAL ELEMENTS:	232 (100%)	39

HOOSAC DOCKS
CHARLESTOWN, MA

Project

FLOOR 2 TIMBER GRADING

Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Drawing No.
TG-1.2

Seal

1
2
3
4
5
6
16'-8 3/4"±
15'-10"±
15'-9"±
15'-10"±
15'-10"±
16'-0"±
A
B
C
D
E
F
G
H
12'-10 1/4"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
12'-9 1/4"±
15 1/2" X 15 1/2" ± TIMBER COLUMN TYP THIS LEVEL
COLUMN PARTIALLY
NO. 2/3
4
TG-1.8
3
TG-1.8
LOCATION OF TIMBER
SAMPLE FOR TESTING
1
FLOOR 3 PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTUR
No. 1 TIMBER GRAD
No. 2 TIMBER GRAD
No. 3 TIMBER GRAD
TOTAL EL
11/12/2019 10:57:42 AM
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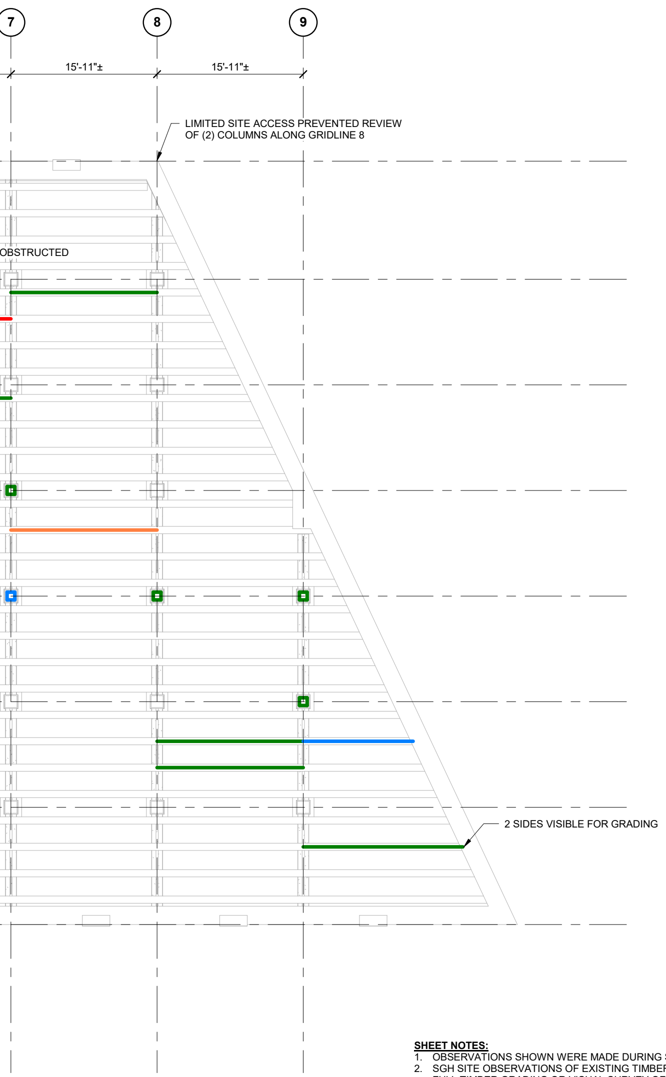

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	SUMMARY	
	BEAMS	COLUMNS
RAL TIMBER GRADE	10 (4.3%)	10 (25.6%)
DE	4 (1.7%)	3 (7.7%)
DE	5 (2.2%)	0
DE	1 (0.4%)	0
UNGRADED:	212 (91.4%)	26 (66.7%)
LEMENTS GRADED:	**20 (8.6%)**	**13 (33.3%)**
TOTAL ELEMENTS:	232 (100%)	39 (100%)

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Los Angeles
New York
San Francisco
Washington, DC

Consultant

No.	Date	Description	By

HOOSAC DOCKS

CHARLESTOWN, MA

Project

FLOOR 3 TIMBER GRADING

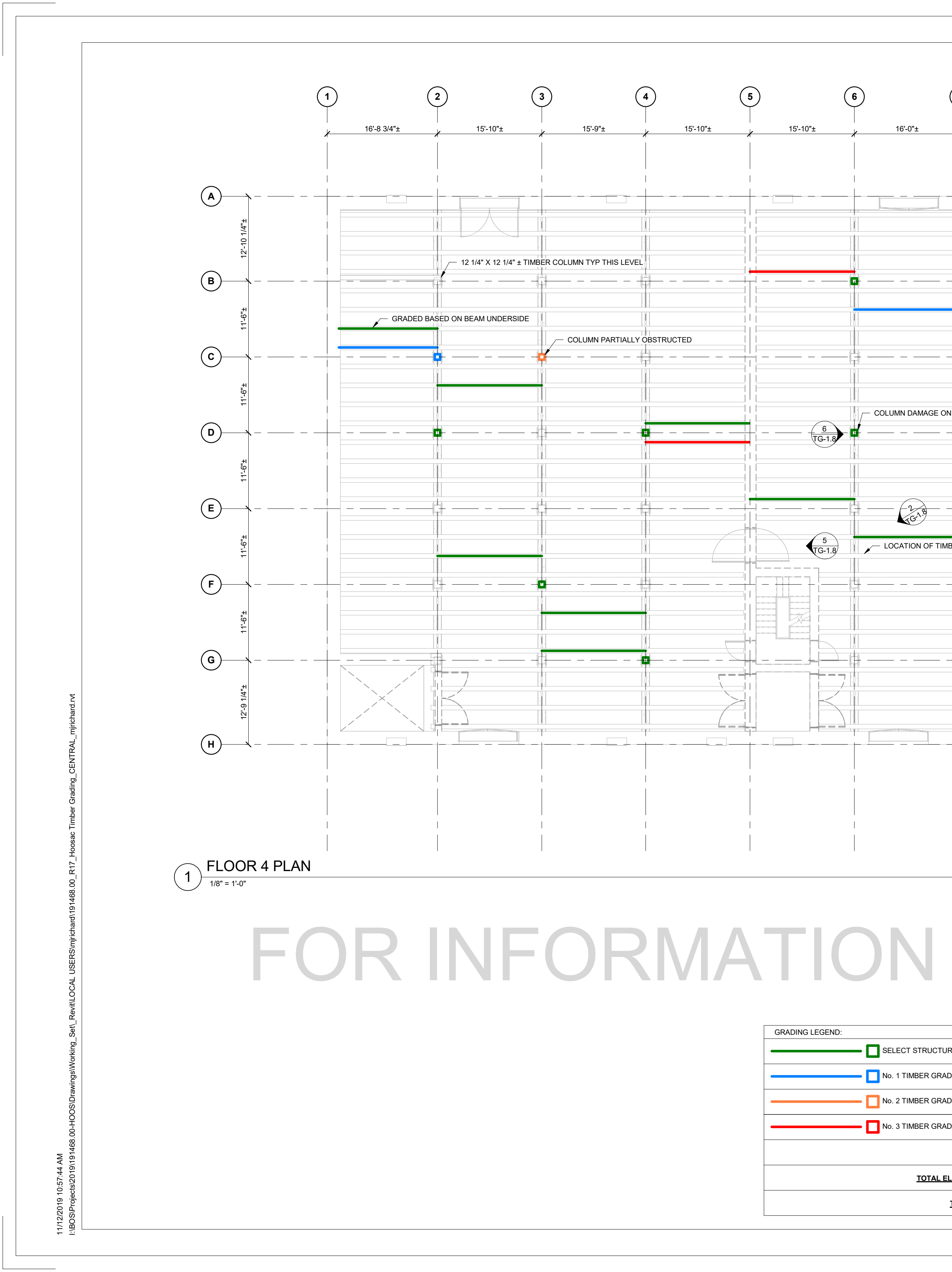
Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Drawing No.

TG-1.3

Seal



1
2
3
4
5
6
16'-8 3/4"±
15'-10"±
15'-9"±
15'-10"±
15'-10"±
16'-0"±
A
B
C
D
E
F
G
H
12'-10 1/4"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
12'-9 1/4"±
12 1/4" X 12 1/4" ± TIMBER COLUMN TYP THIS LEVEL
GRADED BASED ON BEAM UNDERSIDE
COLUMN PARTIALLY OBSTRUCTED
COLUMN DAMAGE ON
LOCATION OF TIMB
6
TG-1.8
2
TG-1.8
5
TG-1.8
1
FLOOR 4 PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTUR
No. 1 TIMBER GRAD
No. 2 TIMBER GRAD
No. 3 TIMBER GRAD
TOTAL EL
11/12/2019 10:57:44 AM
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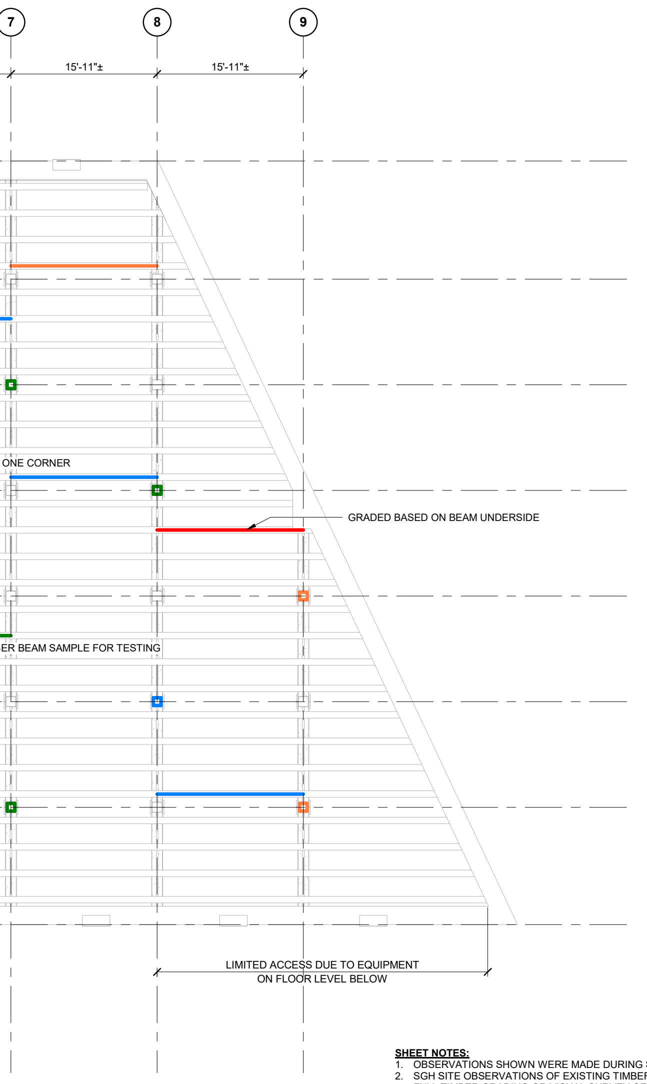

SHEET NOTES:

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8. THE PROJECT STRUCTURAL ENGINEER OF RECORD (SER) IS RESPONSIBLE FOR SURVEYING THE CONDITION OF EXISTING STRUCTURAL MEMBERS TO REMAIN AS PART OF THEIR FEASIBILITY STUDY.

ONLY

	SUMMARY	
	BEAMS	COLUMNS
AL TIMBER GRADE	8 (3.4%)	9 (2.3%)
E	4 (1.7%)	2 (5.1%)
E	1 (0.4%)	3 (7.7%)
E	3 (1.3%)	0
UNGRADED:	216 (93.1%)	25 (64.1%)
EMENTS GRADED:	**16 (6.9%)**	**14 (35.9%)**
TOTAL ELEMENTS:	232 (100%)	39 (100%)

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No.	Date	Description	By

HOOSAC DOCKS

CHARLESTOWN, MA

Project

FLOOR 4 TIMBER GRADING

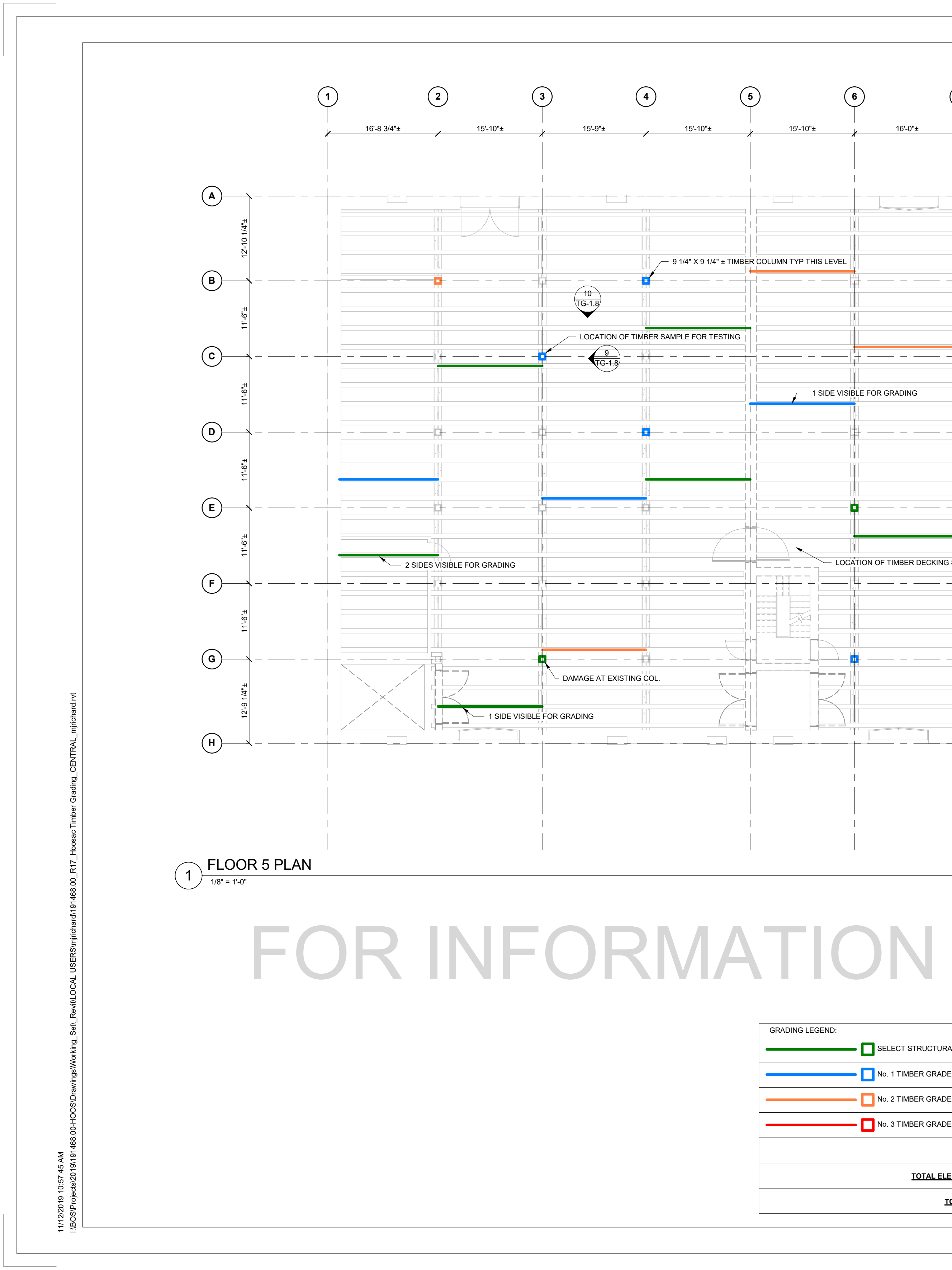
Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Drawing No.

TG-1.4

Seal



1
2
3
4
5
6
16'-8 3/4"±
15'-10"±
15'-9"±
15'-10"±
15'-10"±
16'-0"±
A
B
C
D
E
F
G
H
12'-10 1/4"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
12'-9 1/4"±
9 1/4" X 9 1/4" ± TIMBER COLUMN TYP THIS LEVEL
10
TG-1.8
LOCATION OF TIMBER SAMPLE FOR TESTING
9
TG-1.8
1 SIDE VISIBLE FOR GRADING
2 SIDES VISIBLE FOR GRADING
LOCATION OF TIMBER DECKING
DAMAGE AT EXISTING COL.
1 SIDE VISIBLE FOR GRADING
1
FLOOR 5 PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTURA
No. 1 TIMBER GRADE
No. 2 TIMBER GRADE
No. 3 TIMBER GRADE
TOTAL ELE
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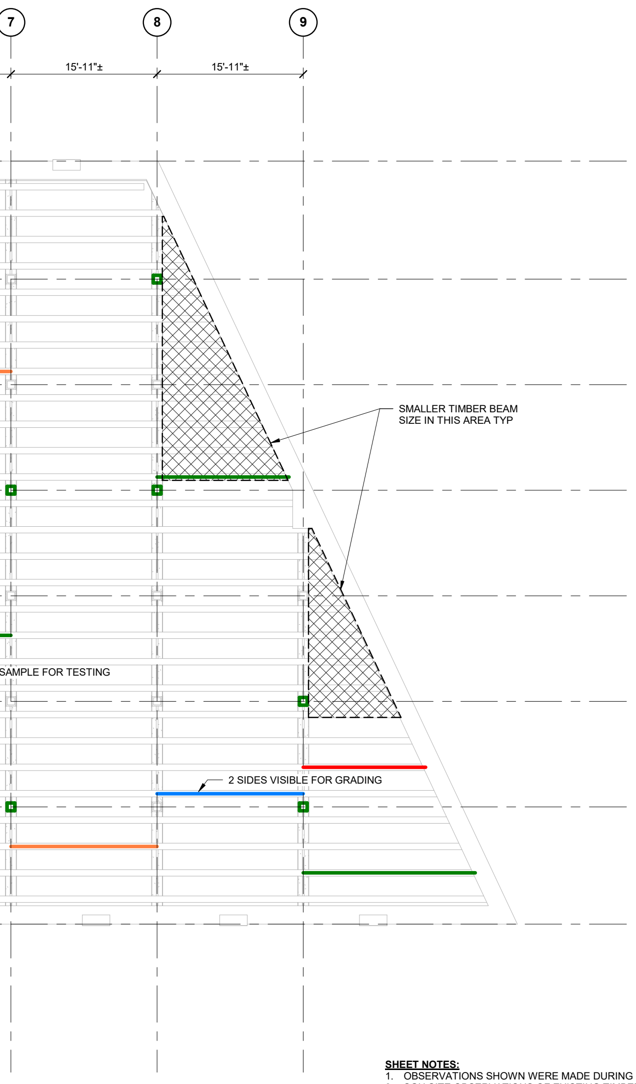

SHEET NOTES:

1. OBSERVATIONS SHOWN WERE MADE DURING SGH SITE VISITS ON 09, 15, & 18 OCTOBER 2019.
2. SGH SITE OBSERVATIONS OF EXISTING TIMBERS ARE LIMITED AND SGH DID NOT CONDUCT A FULL TIMBER GRADING OR VISUAL SURVEY OF THE ENTIRE EXISTING BUILDING.
3. THE VISUAL GRADING OF EXISTING TIMBERS WAS BASED ON LIMITED OBSERVATIONS OF ALL ACCESSIBLE TIMBER SURFACES AT THE TIME OF SGH'S SITE VISIT. PARTIALLY OBSTRUCTED TIMBERS, HEAVILY PAINTED TIMBERS, AND INACCESSIBLE SURFACES COULD NOT BE GRADED OR GRADED FULLY. EXISTING TIMBERS COULD ONLY BE REVIEWED BASED ON EXPOSED TIMBER FACES. PORTIONS OF TIMBERS ENCLOSED OR COVERED BY FINISHES OR OTHER MATERIAL ARE NOTED TO THE BEST EXTENT POSSIBLE.
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6. BEAMS SHOWN ON PLAN AT A SPECIFIC FLOOR LEVEL ARE VISIBLE WHEN STANDING ON THE FLOOR LEVEL BELOW AND LOOKING UP. COLUMNS SHOWN ARE VISIBLE WHEN STANDING ON THE NOTED FLOOR LEVEL.
7. SEE ARCHITECTURAL/STRUCTURAL DRAWINGS FOR PROJECT AREAS OUTSIDE OF SGH SCOPE OF WORK.
8. THE PROJECT STRUCTURAL ENGINEER OF RECORD (SER) IS RESPONSIBLE FOR SURVEYING THE CONDITION OF EXISTING STRUCTURAL MEMBERS TO REMAIN AS PART OF THEIR FEASBILITY STUDY.

ONLY

	SUMMARY	
	BEAMS	COLUMNS
L TIMBER GRADE	8 (3.4%)	8 (20.5%)
	4 (1.7%)	4 (10.3%)
	4 (1.7%)	0
	1 (0.4%)	0
UNGRADED:	215 (92.7%)	26 (66.7%)
MENTS GRADED:	**17 (7.3%)**	**13 (33.3%)**
OTAL ELEMENTS:	232 (100%)	39 (100%)

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HOOSAC DOCKS

CHARLESTOWN, MA

Project

FLOOR 5 TIMBER GRADING

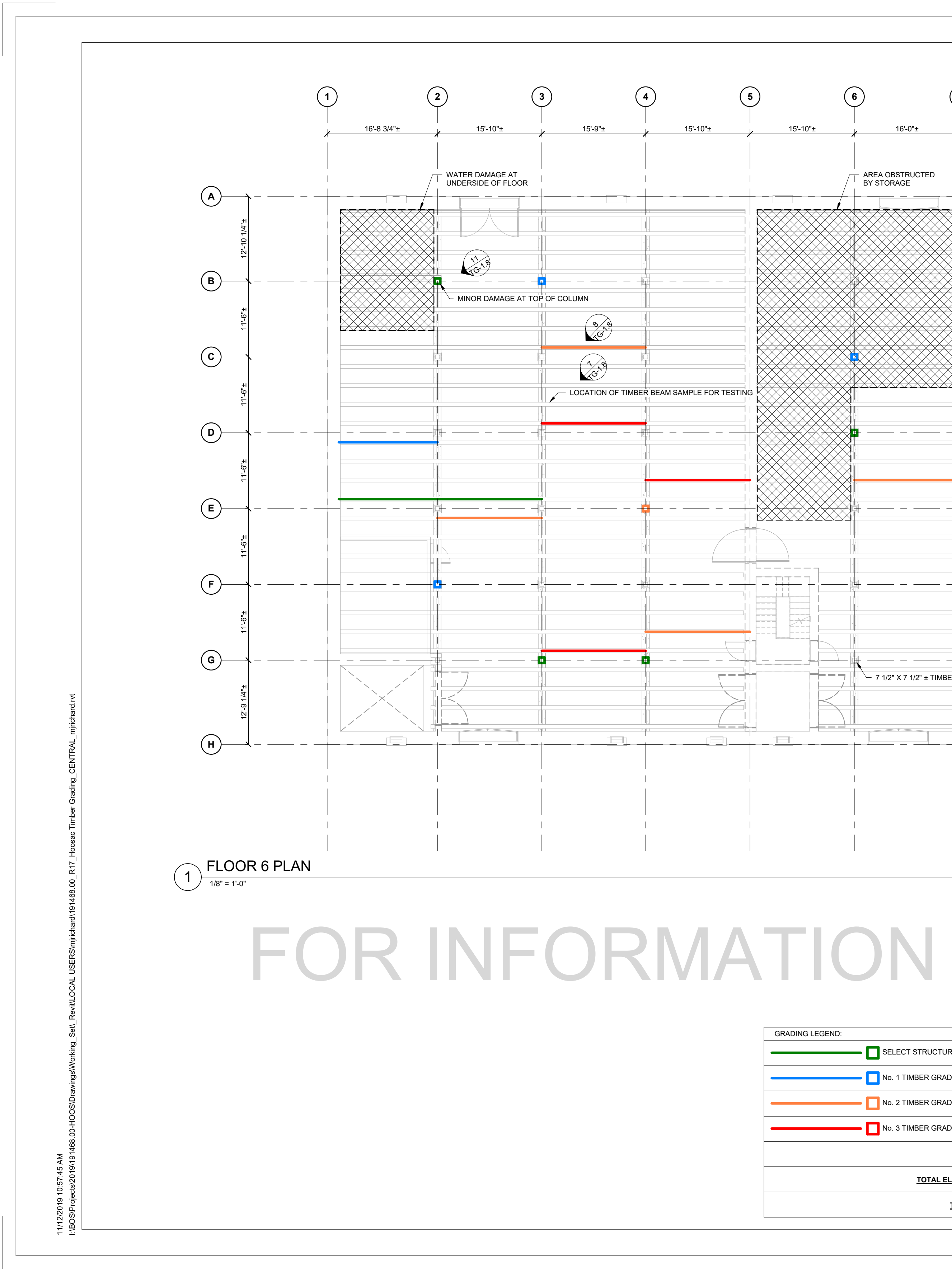
Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Seal

Drawing No.

TG-1.5



WATER DAMAGE AT UNDERSIDE OF FLOOR
AREA OBSTRUCTED BY STORAGE
MINOR DAMAGE AT TOP OF COLUMN
LOCATION OF TIMBER BEAM SAMPLE FOR TESTING
7 1/2" X 7 1/2" ± TIMBE
16'-8 3/4"±
15'-10"±
15'-9"±
15'-10"±
15'-10"±
16'-0"±
12'-10 1/4"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
12'-9 1/4"±
11 TG-1.8
8 TG-1.8
7 TG-1.8
1 FLOOR 6 PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTUR
No. 1 TIMBER GRAD
No. 2 TIMBER GRAD
No. 3 TIMBER GRAD
TOTAL EL
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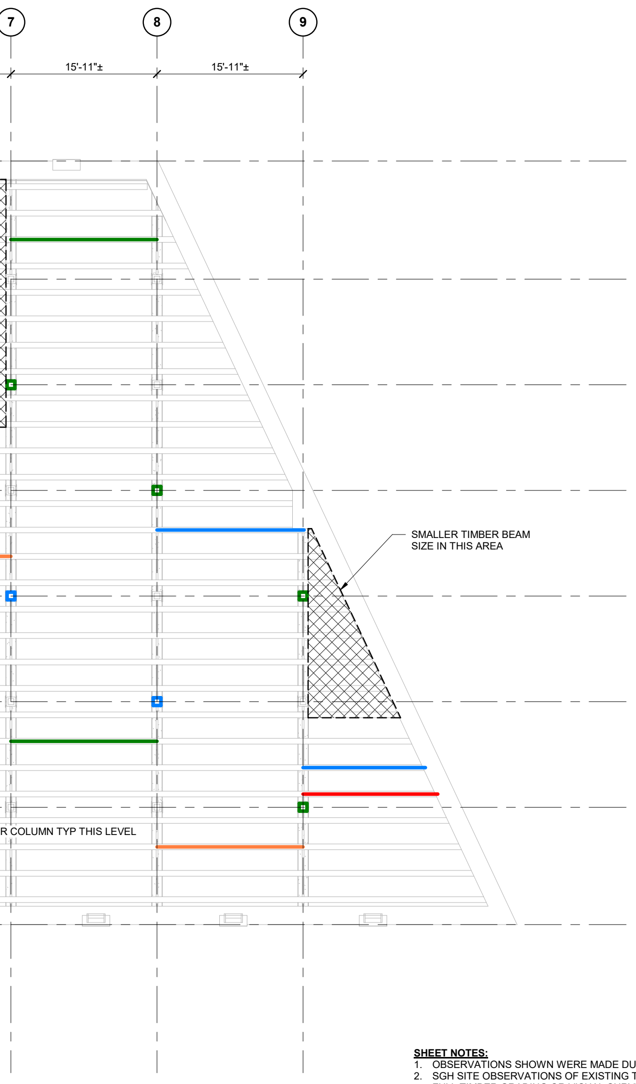

SHEET NOTES:
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ONLY

	SUMMARY	
	BEAMS	COLUMNS
AL TIMBER GRADE	4 (1.7%)	8 (20.5%)
E	3 (1.3%)	5 (12.8%)
E	4 (1.7%)	1 (2.6%)
E	5 (2.2%)	0
UNGRADED:	216 (93.1%)	25 (64.1%)
EMENTS GRADED:	**16 (6.9%)**	**14 (35.9%)**
TOTAL ELEMENTS:	232 (100%)	39 (100%)

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No.	Date	Description	By

HOOSAC DOCKS

CHARLESTOWN, MA

Project

FLOOR 6 TIMBER GRADING

Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Drawing No.

TG-1.6

Seal


1 2 3 4 5 6
16'-8 3/4"±
15'-10"±
15'-9"±
15'-10"±
15'-10"±
16'-0"±
OBSERVED WATER STAINING
OBSERVED WATER STAINING
A B C D E F G H
12'-10 1/4"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
11'-6"±
12'-9 1/4"±
12
TG-1.8
1
ROOF PLAN
1/8" = 1'-0"
FOR INFORMATION
GRADING LEGEND:
SELECT STRUCTUR
No. 1 TIMBER GRAD
No. 2 TIMBER GRAD
No. 3 TIMBER GRAD
TOTAL EL
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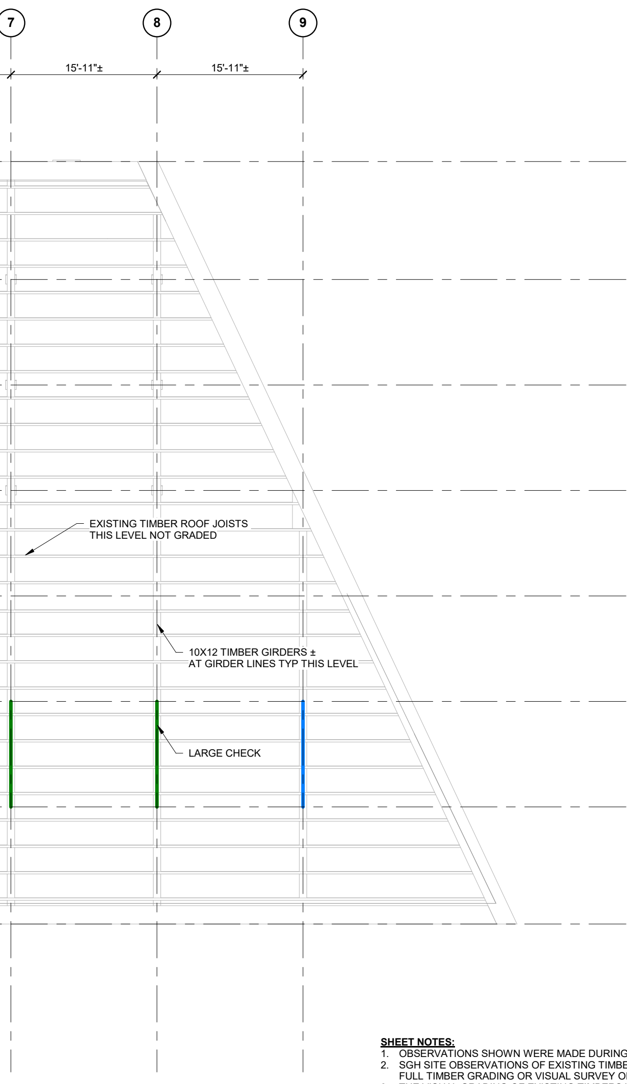

SHEET NOTES:

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	SUMMARY	
	JOISTS	GIRDERS
AL TIMBER GRADE	0	5 (11.1%)
E	0	1 (2.2%)
E	0	1 (2.2%)
E	0	0
UNGRADED:	232	38 (84.4%)
EMENTS GRADED:	**0**	**7 (15.6%)**
TOTAL ELEMENTS:	232	45 (100%)

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HOOSAC DOCKS
CHARLESTOWN, MA

Project

ROOF TIMBER GRADING

Drawing Title

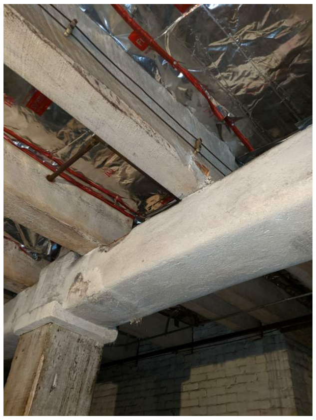
Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Drawing No.

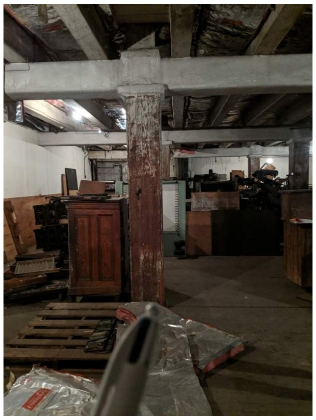
TG-1.7

Seal

1 (E) COND. NO. 3 GRADE TYP

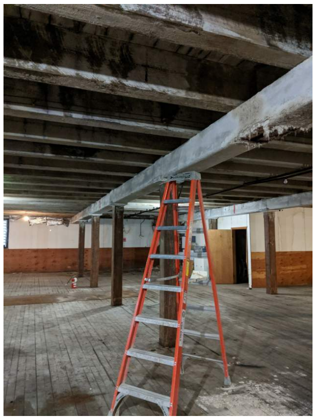


2 LEVEL 3 - BEAM SAMPLE LEVEL 4



3 (E) COND. LEVEL 3 COL. SAMPLE

6 (E) COND. COL. DAMAGE TYP



7 LEVEL 5 AT BEAM SAMPLE ABOVE

8 LEVEL 5 - BEAM SAMPLE LEVEL 6

11 (E) COND. MINOR DAMAGE COL. CAP

12 (E) COND. WATER STAINING AT ROOF

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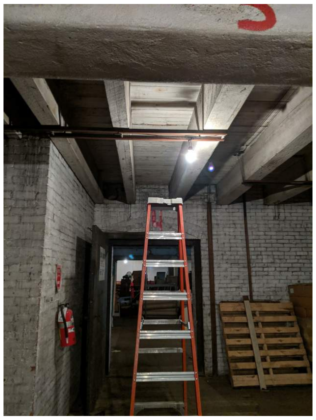
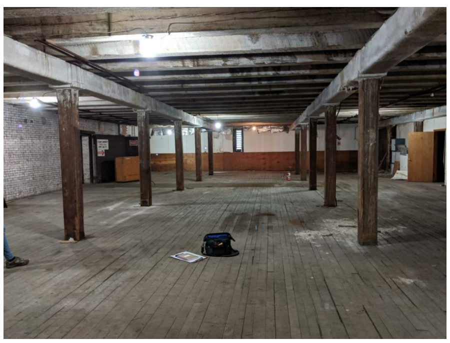
4 LEVEL 3 COL. SAMPLE



5 LEVEL 4 - DECKING SAMPLE AT LEVEL 5

9 LEVEL 5 COL. SAMPLE



10 (E) COND. LEVEL 5

R
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LY

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HOOSAC DOCKS

CHARLESTOWN, MA

Project

EXISTING CONDITIONS PHOTOS

Drawing Title

Project No. 191468	Checked SGH	Date 11/12/2019
Drawn MTW/MJR	Approved MJR	Scale As indicated

Seal

Drawing No.

TG-1.8

APPENDIX D

Laboratory Report – Brick Compressive Strength Testing Results

SIMPSON GUMPERTZ & HEGER

Engineering of Structures
and Building Enclosures

SHEET NO. ____

PROJECT NO. 191468.00

DATE 24 Oct 19

CLIENT Jacobs

BY ZJSvec

SUBJECT ASTM C 67 Compression Data

CHECKED BY NFPerkins

Sample	Surface	Width (in.)		Length (in.)		Bearing Surface Area (in.^{2})	Maximum Load (lbf)	Compressive Strength (psi)
E-2.1-MID	Top	3.663	3.717	4.067	3.968	14.80	116186	7850
	Bottom	3.772	3.717	3.944	3.948			
	Average	3.717		3.982				
E-2.1-INT	Top	3.585	3.710	4.005	4.020	14.77	118364	8020
	Bottom	3.727	3.646	4.091	3.992			
	Average	3.667		4.027				
N-2.1-MID	Top	3.287	3.716	3.742	4.002	12.85	52047	4050
	Bottom	3.253	3.717	2.901	4.069			
	Average	3.493		3.679				
N-2.1-INT	Top	3.736	3.672	4.008	4.080	14.46	60912	4210
	Bottom	3.320	3.712	3.822	4.107			
	Average	3.610		4.004				
S-2.1-MID	Top	3.769	2.578	3.716	3.822	13.75	47794	3480
	Bottom	3.815	3.815	4.125	4.081			
	Average	3.494		3.936				
S-2.1-INT	Top	3.730	3.757	4.115	4.293	15.50	69527	4480
	Bottom	3.721	3.546	4.173	4.233			
	Average	3.689		4.204				
W-2.1-MID	Top	3.747	3.741	4.149	4.052	15.28	54490	3570
	Bottom	3.744	3.747	4.035	4.087			
	Average	3.745		4.081				
W-2.1-INT	Top	3.760	3.694	3.945	3.857	13.24	53744	4060
	Bottom	2.807	3.753	3.584	3.732			
	Average	3.504		3.780				
S-2.2-MID	Top	3.761	3.040	3.211	4.054	13.11	41279	3150
	Bottom	3.611	3.795	3.609	3.890			
	Average	3.552		3.691				
S-2.2-INT	Top	3.678	3.747	3.981	3.982	15.21	79633	5240
	Bottom	3.706	3.728	4.259	4.155			
	Average	3.715		4.094				
E-4.1-MID	Top	3.743	3.742	4.075	4.075	15.16	68820	4540
	Bottom	3.764	3.743	3.999	4.033			
	Average	3.748		4.046				
W-4.1-MID	Top	3.262	3.740	3.736	3.319	13.66	39564	2900
	Bottom	3.741	3.790	3.947	4.032			
	Average	3.633		3.759				

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Engineering of Structures and Building Enclosures

SHEET NO.
PROJECT NO. 191468.00
DATE 24 Oct 19
BY ZJSvec
CHECKED BY NFPerkins

CLIENT Jacobs
SUBJECT ASTM C 67 Compression Data

Sample	Surface	Width (in.)		Length (in.)		Bearing Surface Area (in.²)	Maximum Load (lbf)	Compressive Strength (psi)
W-4.1-INT	Top	3.710	3.687	4.149	4.104	15.29	40367	2640
	Bottom	3.657	3.684	4.144	4.202			
	Average	3.685		4.150				
E-6.1-MID	Top	3.741	3.792	4.066	4.042	14.99	95346	6360
	Bottom	3.770	3.682	4.051	3.848			
	Average	3.746		4.002				
E-6.1-INT	Top	3.492	3.675	4.103	4.025	14.81	39484	2670
	Bottom	3.512	3.662	4.177	4.214			
	Average	3.585		4.130				
N-6.1-MID	Top	3.675	3.699	3.893	3.959	14.37	63308	4400
	Bottom	3.710	3.697	3.859	3.847			
	Average	3.695		3.890				
N-6.1-INT	Top	3.712	3.660	3.980	3.816	14.60	56762	3890
	Bottom	3.644	3.598	4.153	4.041			
	Average	3.654		3.998				
S-6.1-MID	Top	3.717	3.689	4.024	4.046	14.87	90239	6070
	Bottom	3.659	3.661	4.061	4.027			
	Average	3.682		4.040				
S-6.1-INT	Top	3.523	3.032	3.869	3.841	13.32	75150	5640
	Bottom	3.639	3.570	3.896	3.880			
	Average	3.441		3.872				
W-6.1-MID	Top	2.583	3.705	1.911	3.737	11.24	59723	5320
	Bottom	3.720	3.710	3.719	3.738			
	Average	3.430		3.276				
W-6.1-INT	Top	3.228	3.704	3.257	4.155	14.11	71981	5100
	Bottom	3.744	3.749	4.128	4.116			
	Average	3.606		3.914				
S-6.2-MID	Top	3.184	3.061	4.008	3.900	13.43	59621	4440
	Bottom	3.682	3.710	3.917	3.933			
	Average	3.409		3.940				
S-6.2-INT	Top	3.721	3.705	4.098	4.103	14.61	75726	5180
	Bottom	3.728	3.346	3.782	4.139			
	Average	3.625		4.031				
E-4.1-INT	Top	4.250	3.654	3.727	4.199	15.64	65786	4210
	Bottom	4.220	3.708	3.744	4.139			
	Average	3.958		3.952				

APPENDIX E

Laboratory Report – Historic Mortar Analysis

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

LABORATORY REPORT

Date: 20 November 2019

By: Martin J. Schmidheiny and Sidney W. Carter

Project: 191468 – Condition Assessment and Material Testing, Hoosac Building, Charlestown Navy Yard, Charlestown, MA

Subject: Laboratory Testing of a Historic Mortar Sample

At your request, we conducted petrographic examinations, insoluble residue determinations, and loss on ignition analyses on four mortar samples from the historic Charlestown Navy Yard in Boston, Massachusetts to evaluate the general composition of the mortar and the proportions of constituents, including the binder type(s) and proportion (s), (e.g., lime, lime and cement, or cement), the aggregate (sand) proportion, and the volumetric ratio of binder to aggregate. You also asked us to identify the closest contemporary mortar type as defined by ASTM C270 – Standard Specification for Mortar for Unit Masonry (e.g., Type M, S, N, O).

Sample Description

The samples submitted for laboratory testing consist of mortar fragments from four different representative areas of three elevations on brick masonry (N-2.1, W-2.1, S-6.1, and S-6.2; Photos 1 through 5). The samples generally exhibit a very light gray paste color and contains primarily colorless, translucent sand particles, with a lesser amount of sand particles that exhibit white, brown, black, pink, and orange colors. The mortar samples contain rounded inclusions of white-colored, friable material, some of which are relatively large (up to 5/8 in. in diameter; Photo 5). In addition, the mortar samples contain rounded inclusions of grayish-brown-colored, friable material. The exposed exterior mortar surfaces, as well as the mortar surfaces in direct contact with the brick, exhibit a slightly darker color than freshly created fracture surfaces on the mortar. We observed reddish-colored brick dust on some of the surfaces of the mortar samples. The mortar samples appear to represent full joint thickness, ranging from 1/2 in. to 1-1/4 in. thick, with an average nominal thickness of 1/2 in. to 3/4 in.

Analytical Methods

We examined the mortar sample with the aid of a reflected-light stereomicroscope at magnifications of 7X to 115X. We also prepared a blue-dyed epoxy-injected, ultrathin (20 µm to 25 µm) section of a selected fragment of each mortar sample. We examined the ultrathin sections with the aid of a transmitted-polarized-light microscope at magnifications of 12.5X to 400X.

In addition, we crushed and ground portions of the sample to a fineness of less than 50 mesh for insoluble residue analysis to determine the volumetric aggregate and binder constituent

SIMPSON GUMPERTZ & HEGER INC.
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proportions in the hardened mortar. As described by ASTM C1324 (Subsection 9.4.1), the insoluble residue determined by this testing “is considered to be the siliceous components of the aggregate used in the mortar.”

We also tested the crushed and ground portions of the sample for loss on ignition to evaluate the amounts of free moisture, combined water, and carbonates in the sample. We determined the loss on ignition at three temperature points: 110°C, 550°C, and 950°C. As described by ASTM C1324 (Subsection 9.5.1), the loss at 110°C is assumed to be “free moisture”; the loss from 110°C to 550°C is assumed to be “combined water”; and the loss from 550°C to 950°C is assumed to be “carbonates and carbonation.”

We analyzed the mortar samples in accordance with the petrographic methods, insoluble residue, and loss on ignition sections of ASTM C1324 – Standard Test Method for Examination and Analysis of Hardened Masonry Mortar, which incorporates applicable procedures of ASTM C856 – Standard Practice for Petrographic Examination of Hardened Concrete.

Petrographic Examination and Analytical Determinations

We observed the following during our petrographic examination and analytical determinations:

- The mortar binders are mostly composed of hydrated lime (Photos 6 through 8). In our examination of the ultrathin sections, we observed that the rounded inclusions of white-colored, friable material are masses of poorly mixed lime (lime balls; Photo 5).

- We also observed trace amounts of belite (dicalcium silicate) grains and small clusters of belite in the lime matrices, which we ascribe to a minor component of a crude natural cement in the mix.

- Round lime balls constitute a significant part of the binder matrix (Photos 6 through 8). The round lime balls are indicative of incomplete mixing, which is reflected in the relatively poorly mixed binder and aggregate in the four mortar samples. We observed some variations in paste density in the mortars (Photo 6).

- The mortars are moderately friable and exhibit a moderately well-developed binder-to-aggregate bond.

- In our examination of the ultrathin sections, we observed that the rounded inclusions of grayish-brown-colored, friable material contain occasional possible alite (tricalcium silicate) particles with apparent hydration rims, occasional small belite clusters, fine aggregate particles, and remnant lime masses in a matrix of indeterminate composition (Photo 9). These inclusions exhibit a range of sizes and are unevenly distributed. The inclusions are anomalous for historic mortars in terms of both microstructure and composition, and we tentatively identify these inclusions as either over-burned and under-crushed raw feed, or as remnants of previous mortar incorporated into the mix.

- Paste carbonation is limited to the outer 10 mils of the mortar in Samples W-2.1 and N-2.1, and to the outer 50 mils in Samples S-6.1 and S-6.2. Samples S-6.1 and S-6.2 show extensive partial carbonation of the interior lime binder.

- The mortars contain natural siliceous sand as aggregate, which is composed of mineral grains of quartz and feldspar and rock fragments of granite, quartzite, and granitic gneiss.

- Based on our petrographic examination, insoluble residue determination and loss on ignition analysis, we estimate the relative constituent proportions of the mortar sample as follows:

Volumetric Proportions of the Mortar Sample	
Constituent	**Part**
Natural Cement	less than 1/4
Lime	1
Sand	2
Nominal Binder-to-Aggregate Ratio	1:2

- Based on binder characteristics and analytical results, the mortar is closest to a modern ASTM C270 Type O cement-lime, although the analyzed mortar contains less cement and is slightly richer in binder-to-aggregate ratio than modern ASTM C270 Type mortars.

- The mortar sample is intact and does not exhibit deterioration, such as by alkali-silica reaction (ASR), freeze-thaw other distress mechanisms.

DISCUSSION

Composition of Historical Mortars

Early American mortars (1700s to late 1800s) were typically mixtures of lime putty and sand, or straight lime-sand mixtures, as Portland cement was not discovered until 1824 in Leeds, England. Natural cements were developed in the early 1800's and used during the middle 1800's to early 1900's. Portland cement was not widely commercially available in the United States masonry market until the very late 1800's.

Historical, turn-of-the-century mortars varied widely in the proportions of cement, lime, and sand. These mortars were straight lime mixtures or included varying amounts of natural or portland cement. Lime slowly gains strength with time through the absorption of CO_2, which converts the lime back into limestone; whereas cements are hydraulic and harden as a result of the hydration reactions with the cement binder. A higher 1:2 binder to aggregate ratio would tend to result in a stronger mortar than a more traditional 1:3 binder to aggregate ratio.

At the turn of the 20th century, there was no standardized nomenclature for mortars. In 1944, designations based on strength performance were established. The first designations were A-1, A-2, B, C, and D. Type A-1 mortars contained a higher percentage of Portland cement and achieved higher compressive strength (2,500 psi) as compared with Type D mortars that contained more lime and achieved on average a compressive strength of 75 psi at twenty-eight days. Modern mortars such as ASTM C270 Types M, S, N, O, and K were not introduced until after 1954, yet they have similar proportions and strengths as the former designations.

However, ASTM C270 – Standard Specification for Mortar for Unit Masonry remains the most widely used and widely received standard for mortar, even in historic preservation guidelines, and literature, such as the National Park Service publication "Preservation Briefs 2: Repointing Mortar Joints in Historic Masonry Buildings." Thus, in our conclusions, we equate the existing mortars to mortar types defined by ASTM C270. ASTM C1713 – Standard Specification for Mortars for Repair of Historic Masonry is a newer ASTM standard that is specifically tailored toward historical masonry mortar composition and its repointing.

CONCLUSIONS

Based on the results of our laboratory analyses, we conclude the following:

- The mortar is composed of a lime binder with siliceous sand aggregate. The mortars contain a trace amount of natural cement, which is unequally distributed in the binder.

- The relative mortar proportions are estimated to be less than a quarter-part natural cement and one-part lime as binder to two-parts sand, yielding a nominal binder-to-aggregate ratio of 1:2.

- The mortar sample is intact and does not exhibit any distress mechanisms.

- Although the mortar is historic and, therefore, not entirely equivalent to a modern ASTM C270 mortar, we estimate that the mortar is closest to an ASTM C270 Type O cement-lime mortar in terms of composition, although the binder to aggregate ratio of 1:2 is higher than any contemporary ASTM C270 mortar, as well as higher than the traditional 1:3 ratio for most historic mortars. The higher 1:2 binder to aggregate ratio would tend to result in a stronger mortar than if the more traditional 1:3 binder to aggregate ratio were used.

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Photo 1

Overview photo of Sample N-2.1 in the condition received for testing.

Photo 2

Overview photo of Sample W-2.1 in the condition received for testing.

Photo 3

Overview photo of Sample S-6.1 in the condition received for testing.

Photo 4

Overview photo of Sample S-6.2 in the condition received for testing.

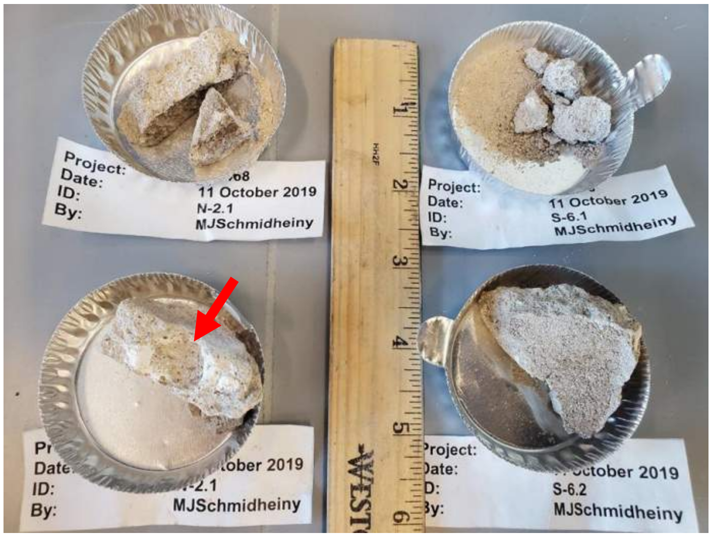

Photo 5

Overview photo of the mortar fragments selected for examination. The red arrow marks a particularly large rounded inclusion of light-colored, friable material in a mortar fragment from Sample W-2.1.

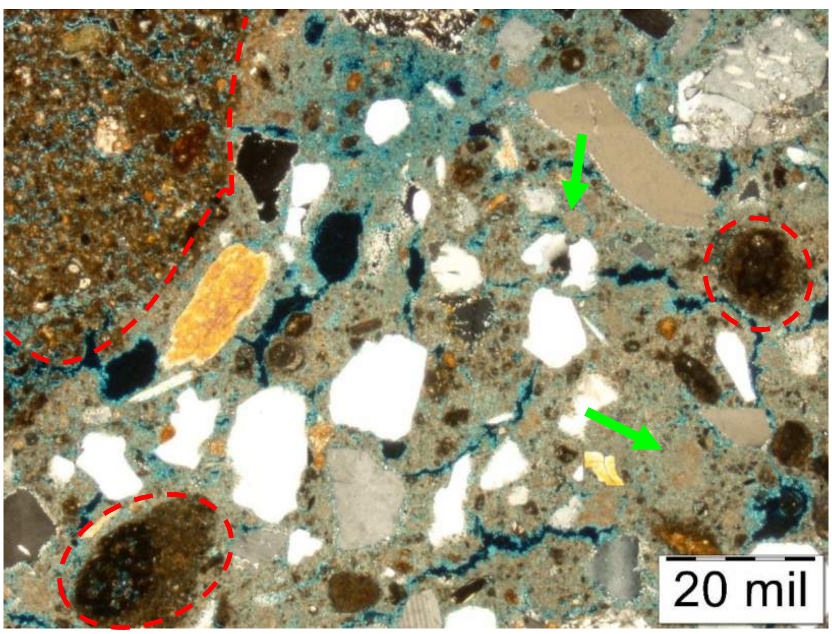

Photo 6

Thin section photomicrograph of Sample N-2.1, depicting the typical microstructure, including anomalous inclusions containing natural cements (bounded by red dashed lines), lime masses (green arrows), and partially carbonated binder primarily composed of hydrated lime. Note the variable porosity of the binder structure, as indicated by the variable saturation of blue-dyed epoxy used in thin section preparation.

(Cross polarized light).

SGH Project 191468 / November 2019

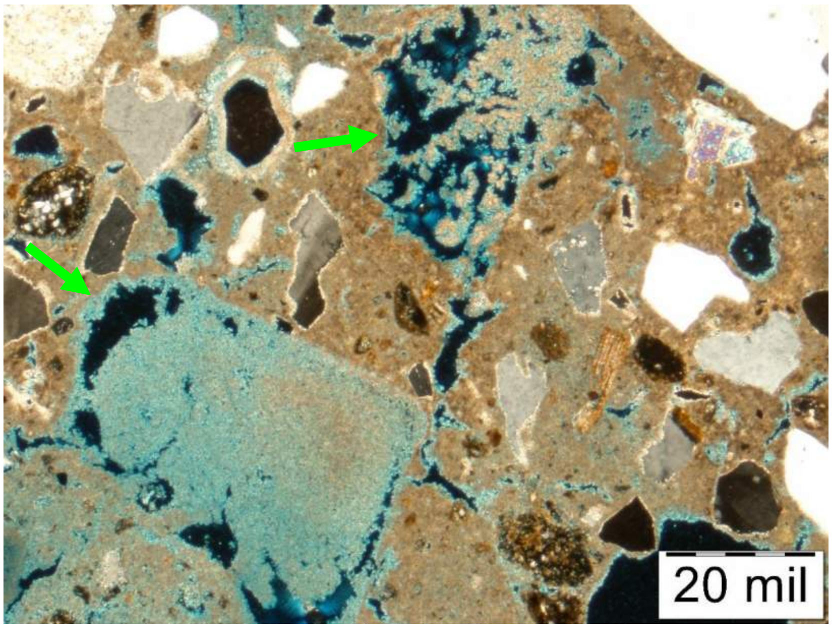

Photo 7

Thin section photomicrograph of Sample S-6.1, depicting the typical microstructure, including relatively large, partially reacted lime masses (green arrows) in a carbonated lime binder.

(Cross polarized light).

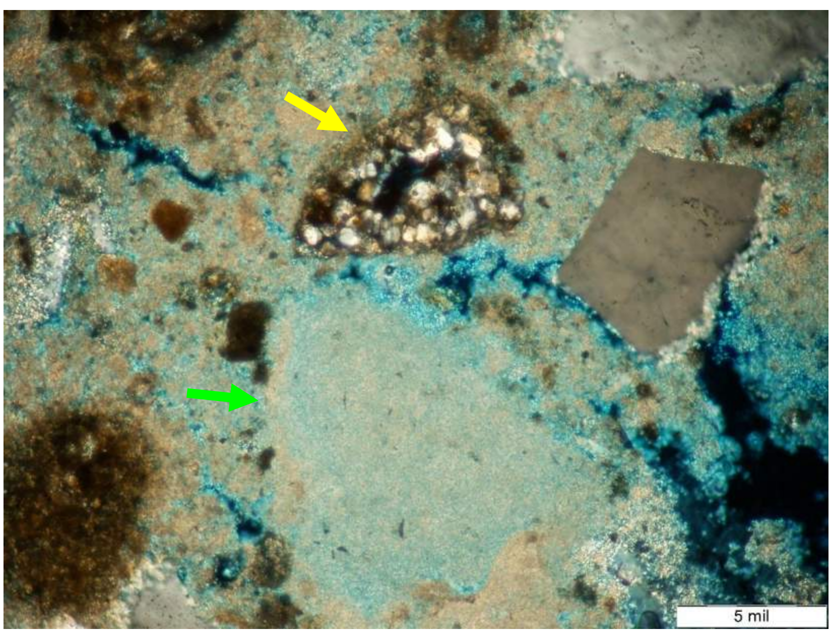

Photo 8

Photomicrograph of Sample W-2.1, showing a small cluster of belite particles (yellow arrow) and a lime mass (green arrow) in a lime binder.

(Cross polarized light).

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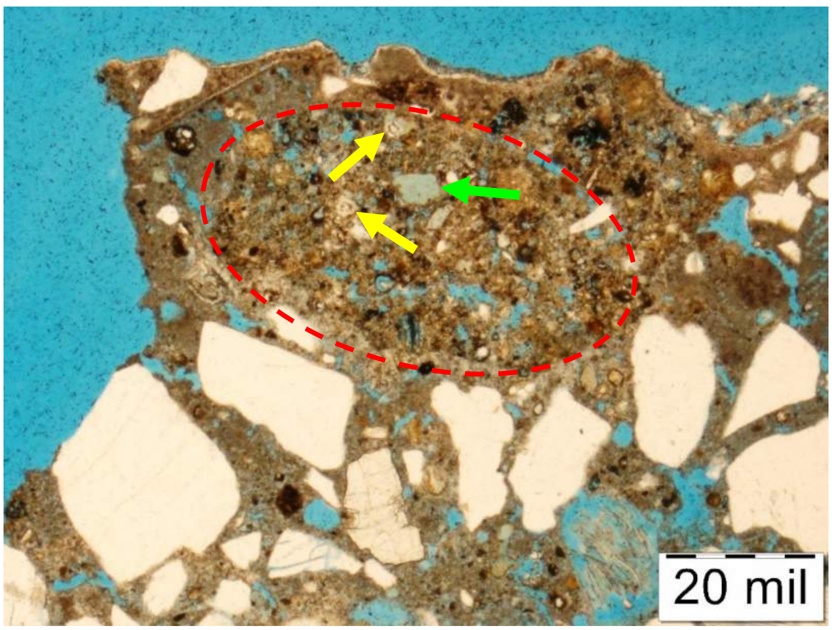

Photo 9

Thin section photomicrograph of Sample S-6.2, depicting an anomalous inclusion (encircled by red dashed line) containing possible alite particles with hydration rims (yellow arrows) and lime masses (green arrow).

(Plane polarized light).

SGH Project 191468 / November 2019

APPENDIX F

Summary of Wood Species Identification Results

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures

CLIENT Jacobs / Hoosac Docks - Charlestown, MA

SUBJECT Wood Species Identification for Timber Beam, Column, and

Objective: Summary of wood species determination for SGH Project 19

Notes: Samples were collected on site by Michael Richard and Hele
Sample were examined by Michael Richard on 11, 16, 21, &

While every effort is made to identify the noted wood sample
it is understood, since wood is an organic material, that woo
species and can also be influenced by a number of external
reaction wood, fungal growth, etc.) which may affect the ide

Specimen Number	Location Description	Component
3B	Structural timber beam sample taken from underside of Level 4 while standing on Level 3 below	Timber Beam
3C	Structural building column at Level 3	Timber Column
4D	Timber floor decking sample taken from underside of Level 5 flooring while on Level 4 below	Timber Floor Decking
5B	Structural timber beam sample taken from underside of Level 6 while standing on Level 5 below	Timber Beam
5C	Structural building column at Level 5	Timber Column

Page

SHEET NO.	1 of 1
PROJECT NO.	191468.00
DATE	25 Oct 19
BY	MJRichard
Decking Samples CHECKED BY	JDLanglois

91468

ena Currie of SGH on 09 October 2019.
22 October 2019.

es using gross and minute anatomical features,
d features can vary/overlap amongst similar
factors during tree growth and final use (e.g.
nfication process.

Wood Species Determination
Hard pine, most likely southern pine (Pinus spp.) given building age (1870s) and location (Northeast).
Hard pine, most likely southern pine (Pinus spp.) given building age (1870s) and location (Northeast).
Most likely eastern spruce (Picea spp.). Less likely larch (Larix spp.)
Hard pine, most likely southern pine (Pinus spp.) given building age (1870s) and location (Northeast).
Hard pine, most likely southern pine (Pinus spp.) given building age (1870s) and location (Northeast).

1 of 1

Appendix H. ASCE 41-17 Checklist

Table 17-36. Collapse Prevention Structural Checklist for Building Types URM and URMa

Status	Evaluation Statement	Tier 2 Reference	Commentary Reference
Low and Moderate Seismicity			
Seismic-Force-Resisting System			
C NC N/A U	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2.	5.5.1.1	A.3.2.1.1
C NC N/A U	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than 30 lb/in.^{2} (0.21 MPa) for clay units and 70 lb/in.^{2} (0.48 MPa) for concrete units.	5.5.3.1.1	A.3.2.5.1
Connections			
C NC N/A U	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7.	5.7.1.1	A.5.1.1
C NC N/A U	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers.	5.7.1.3	A.5.1.2
C NC N/A U	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls.	5.7.2	A.5.2.1
C NC N/A U	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support.	5.7.4.1	A.5.4.1
High Seismicity (Complete the Following Items in Addition to the Items for Low and Moderate Seismicity) Seismic-Force-Resisting System			
C NC N/A U	PROPORTIONS: The height-to-thickness ratio of the shear walls at each story is less than the following: Top story of multi-story building 9 First story of multi-story building 15 All other conditions 13	5.5.3.1.2	A.3.2.5.2
C NC N/A U	MASONRY LAYUP: Filled collar joints of multi-wythe masonry walls have negligible voids.	5.5.3.4.1	A.3.2.5.3
Diaphragms (Stiff or Flexible)			
C NC N/A U	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length.	5.6.1.3	A.4.1.4
C NC N/A U	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft (2.4 m) long.	5.6.1.3	A.4.1.6
Flexible Diaphragms			
C NC N/A U	CROSS TIES: There are continuous cross ties between diaphragm chords.	5.6.1.2	A.4.1.2

continues

Table 17-36 *(Continued)*. Collapse Prevention Structural Checklist for Building Types URM and URMa

Status	Evaluation Statement	Tier 2 Reference	Commentary Reference
C NC N/A U	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered.	5.6.2	A.4.2.1
C NC N/A U	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing.	5.6.2	A.4.2.2
C NC N/A U	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1.	5.6.2	A.4.2.3
C NC N/A U	OTHER DIAPHRAGMS: The diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing.	5.6.5	A.4.7.1
Connections			
C NC N/A U	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. before engagement of the anchors.	5.7.1.2	A.5.1.4
C NC N/A U	BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters have independent secondary columns for support of vertical loads.	5.7.4.4	A.5.4.

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

Table 17-37. Immediate Occupancy Structural Checklist for Building Types URM and URMa

Status	Evaluation Statement	Tier 2 Reference	Commentary Reference
Very Low Seismicity			
Seismic-Force-Resisting System			
C NC N/A U	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2.	5.5.1.1	A.3.2.1.1
C NC N/A U	SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than 30 lb/in.^{2} (0.21 MPa) for clay units and 70 lb/in.^{2} (0.48 MPa) for concrete units.	5.5.3.1.1	A.3.2.5.1
Connections			
C NC N/A U	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7.	5.7.1.1	A.5.1.1
C NC N/A U	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers.	5.7.1.3	A.5.1.2
C NC N/A U	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls, and the connections are able to develop the lesser of the shear strength of the walls or diaphragms.	5.7.2	A.5.2.1
C NC N/A U	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support.	5.7.4.1	A.5.4.1
Foundation System			
C NC N/A U	DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil.		A.6.2.3
C NC N/A U	SLOPING SITES: The difference in foundation embedment depth from one side of the building to another does not exceed one story high.		A.6.2.4

continues

Table 17-37 *(Continued)*. Immediate Occupancy Structural Checklist for Building Types URM and URMa

Status	Evaluation Statement	Tier 2 Reference	Commentary Reference
Low, Moderate, and High Seismicity (Complete the Following Items in Addition to the Items for Very Low Seismicity) Seismic-Force-Resisting System			
C NC N/A U	PROPORTIONS: The height-to-thickness ratio of the shear walls at each story is less than the following: Top story of multi-story building 9 First story of multi-story building 15 All other conditions 13	5.5.3.1.2	A.3.2.5.2
C NC N/A U	MASONRY LAYUP: Filled collar joints of multi-wythe masonry walls have negligible voids.	5.5.3.4.1	A.3.2.5.3
Diaphragms (Stiff or Flexible)			
C NC N/A U	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 15% of the wall length.	5.6.1.3	A.4.1.4
C NC N/A U	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 4 ft (1.2 m) long.	5.6.1.3	A.4.1.6
C NC N/A U	PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities.	5.6.1.4	A.4.1.7
C NC N/A U	DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension.	5.6.1.5	A.4.1.8
Flexible Diaphragms			
C NC N/A U	CROSS TIES: There are continuous cross ties between diaphragm chords.	5.6.1.2	A.4.1.2
C NC N/A U	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered.	5.6.2	A.4.2.1
C NC N/A U	SPANS: All wood diaphragms with spans greater than 12 ft (3.6 m) consist of wood structural panels or diagonal sheathing.	5.6.2	A.4.2.2
C NC N/A U	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft (9.2 m) and aspect ratios less than or equal to 3-to-1.	5.6.2	A.4.2.3
C NC N/A U	NONCONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete consist of horizontal spans of less than 40 ft (12.2 m) and have aspect ratios less than 4-to-1.	5.6.3	A.4.3.1
C NC N/A U	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing.	5.6.5	A.4.7.1
Connections			
C NC N/A U	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. (3 mm) before engagement of the anchors.	5.7.1.2	A.5.1.4
C NC N/A U	BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters have independent secondary columns for support of vertical loads.	5.7.4.4	A.5.4.5

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

Existing USSCM Space Allocation

The following diagrams are takeoffs of the existing USSCM spaces from Buildings 22 and 28. These NSF numbers are what are included in the Housing Plan's "Existing Unit Size" column and used to produce Possible Alternative #1. The Revit model developed here was provided to Marble Fairbanks by Jacobs in the summer of 2019.

1st Floor 2nd Floor 3rd Floor

BREAK ROOM, 200 NSF

1st Floor 2nd Floor 3rd Floor

CATALOG PROCESSING & PHOTOGRAPHY SPACE, 430 NSF

1st Floor 2nd Floor 3rd Floor

CATERER'S SERVING PANTRY / KITCHEN, 244 NSF

1st Floor 2nd Floor 3rd Floor

COLLECTIONS, STORAGE, & ARCHIVES, 2076 NSF

1st Floor　　2nd Floor　　3rd Floor

EXHIBIT SPACE, 9299 NSF

1st Floor　　2nd Floor　　3rd Floor

LIBRARY & READING ROOM, 916 NSF

1st Floor 2nd Floor 3rd Floor

MEETING SPACE, 325 NSF

1st Floor 2nd Floor 3rd Floor

OFFICE SUPPLIES & PRINTING, 98 NSF

1st Floor 2nd Floor 3rd Floor

OFFICES, 3611 NSF

1st Floor 2nd Floor 3rd Floor

RETAIL & RETAIL STORAGE, 1681 NSF

1st Floor 2nd Floor 3rd Floor

SHIPPING & RECEIVING, 259 NSF

1st Floor 2nd Floor 3rd Floor

STORAGE, 1507 NSF

1st Floor 2nd Floor 3rd Floor

THEATER, 1296 NSF

1st Floor 2nd Floor 3rd Floor

WORKSHOP, 421 NSF

Meeting Minutes and Project Schedule

marble fairbanks
20 jay street suite 202 brooklyn ny 11201 usa tel 212.233.0653 marblefairbanks.com

Meeting Minutes: Feasibility Study, Programming Review

Project: Hoosac Stores Feasibility Study

Meeting Date: 18 October 2019
9:00 a.m.

Issued By: Jason Roberts

Issue Date: 05 November 2019

Location: GoTo Meeting hosted by MFA

Present:

Christina Briggs (CB)	National Parks of Boston (NPB)
Patrick Sbardelli (PS)	General Services Administration (GSA)
Jason Roberts (JR)	Marble Fairbanks Architects (MFA)

Distribution: Christina Briggs, Patrick Sbardelli

Note: For clarity, the meeting discussion has been summarized by topic and not necessarily in the order it was discussed.

Item	Action	Description
1		Introduction
1.1		MFA explained that the purpose of the call was to give an update on the material and structural testing going on at the site and to confirm assumptions made in the Workplace Recommendation Report and PDS Submission #2 around programming for the future Hoosac Stores.
2		Updates from the Site Investigations
2.1		MFA noted that material sampling and boring was wrapping up in the next day or so. Material would then be sent to the labs for testing and documentation.
2.2		NPB expressed a desire to get a preliminary read on the results of the testing prior to a public event being held on December 5th. MFA noted that this would be discussed at the on-site meeting with the team in early November.
3		Programming
3.1		NPB confirmed that the Future Workplace Standards laid out in the WRR were still valid. There was a desire to standardize office/workstation sizes and limit the number of private offices.
3.2		NPB noted that any space requested made by the USSCM needed to be vetted by Parks first.
3.3		NPB noted that the 1:1 relationship set up by the WRR relating workspace to support spaces was still valid.
3.4		NPB stated that the Hoosac Building would no longer house the NEMS program as indicated in the WRR test fits and programming matrix.
3.5		NPB noted that the Hoosac Building needed to accommodate curatorial space. CB would send updated numbers on this requirement.
3.6		NPB commented that the VEEA has restructured. There may be more need for workstations and less touchdown spaces. CB would provide an updated org chart of this directorate.

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3.7		NPB noted that USSCM needs a distinct identity within the building and mixing their program and staff with Parks (as shown in the WRR Test Fits) probably would not work. The USSCM do see an advantage to shared curatorial and support spaces.
3.8		NPB noted that there would need to be two reading rooms.
3.9		NPB noted that, unlike the USSCM, they were not looking to grow. If anything, their departments would restructure (and types of spaces would change) but maintain approximately the same number of people.
3.10		NPB noted that the space should be designed to accommodate all of the positions (both filled and vacant) in the various org charts, as per the WRR test fits.
3.11		MFA asked if there were any “wish list” programs desired in the Hoosac if space could be accommodated. NPB noted that there have been ideas of a restaurant (perhaps on the roof), a ground level café open to the waterfront, an expanded theater, and a “climatron.”
4		Additional Interviews
4.1		NPB noted that the stakeholders would be generally the same as those indicated in the WRR and no additional interviews would be necessary by the design team.
5		Zoning
5.1		MFA noted that zoning variances would have to be obtained for any work done to the Hoosac site because the existing building is overbuilt.
5.2		CB would reach out to Chris Bush at BPDA about appropriate next steps regarding the project.
5.3		CB noted that Parks is still deciding on whether they should approach BPDA with this single project or this project as part of a larger master plan.
5.4		NPB agreed that they want to create a project that meets their programmatic needs and make justifications to BPDA based on that.
6		Moving Forward
6.1		MFA will set up an in-person, on-site meeting to review preliminary results from the material and structural testing, review precedents for building new space within existing buildings, review approaches to waterfront resiliency, and develop decision drivers that will be used to evaluate future design alternatives.
6.2		NPB noted that the on-site workshop to develop Possible Alternatives would need to take place after the new year because staff would not be around before the holiday. MFA will provide an updated schedule indicating this.

These minutes will become part of the official project record unless corrections or additions are brought to the Architect's attention within seven days of the date of issue.

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Meeting Minutes - Feasibility Study: Initial Findings, Precedents, and Decision Drivers

Project: Hoosac Stores Feasibility Study **Meeting Date:** 08 November 2019 9:00 a.m.

Issued By: Jason Roberts **Issue Date:** 21 November 2019

Location: Building 107, Second Floor Meeting Room

Present:

Christina Briggs (CB)	National Parks of Boston (NPB)
Michael Creasey (MC)	National Parks of Boston (NPB)
Lance Kasparian (LK)	National Parks of Boston (NPB)
Ruth Raphael (RR)	National Parks of Boston (NPB)
David Vecchioli (DV)	National Parks of Boston (NPB)
Brian Miskell (BM)	USS Constitution Museum (USSCM)
David Choi (DC)	Jacobs Engineering Group (Jacobs)
Joe Lin (JL)	Jacobs Engineering Group (Jacobs)
Anne McKinnion (AM)	Jacobs Engineering Group (Jacobs)
Collin Sabin (CS)	Jacobs Engineering Group (Jacobs)
Scott Marble (SM)	Marble Fairbanks Architects (MFA)
Jason Roberts (JR)	Marble Fairbanks Architects (MFA)

Distribution: Christina Briggs, Patrick Sbardelli, David Choi

Note: For clarity, the meeting discussion has been summarized by topic and not necessarily in the order it was discussed.

Item	Action	Description
1		Introduction
1.1		MFA described that the goal of this presentation was to review preliminary findings from the physical testing happening at the Hoosac Stores, review issues of resiliency that will need to be addressed with the project and walk through building precedents of how existing buildings have been adapted for new use, and finally talk through project challenges and the decision drivers that will be used to evaluate the “possible alternatives” in the upcoming workshop in January.
2		Structural and Material Testing and Review
2.1		Jacobs described the visual assessment and brick coring their team performed to analyze the building’s existing material. It was concluded that the structure is in better shape than originally thought, except for the roof which has suffered water damage and needs to be replaced. It was noted that while the compression tests for the brick indicate good to excellent compressive capacity, the bottom four feet of brick along the north façade of the building would likely need to be replaced because it has degraded over time due to salting that takes place along the Freedom Trail in the winter.
2.2		Jacobs went on to describe the boring process that took place to develop the preliminary geotechnical report. This report found that the existing timber piles are permanently under the groundwater table and not exposed to oxygen so they could be generally accepted to last indefinitely. It is expected that the existing footings can still

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		carry the original vertical loads which would have been much higher than any program currently being proposed for the building.
2.3		Jacobs noted that the stacked granite stones that sit atop the piles are good at carrying gravity loads but cannot resist lateral loads. Therefore, retrofitting the building would need to address lateral structuring. Jacobs noted that Massachusetts Building Code does not allow brick walls to serve as a lateral system.
2.4		Jacobs advised against excavations that disturb the stacked granite stones.
2.5		Jacobs discussed three possible structural remediation strategies that could address the lateral stability issue: shear wall construction, buckling restrained braced frames in-line with the existing column grid (inside the building), and buckling restrained braced frames at the perimeter of the building.
2.6		In the shear wall option, four new concrete walls would surround a new elevator and stair core. Existing floors would need to be carefully linked between old and new. These walls would bear on new micropiles that would need to go between the existing stacked granite pile caps. Jacobs noted that getting the machine inside of the building with the low existing floor-to-floor heights would be tricky.
2.7		In the in-line braced frame option, frames could be inserted throughout the building to provide lateral stability.
2.8		In the perimeter braced frame option, frames would be placed at the perimeter to provide lateral stability.
2.9		Jacobs noted that liquefaction of the soil is not a concern.
2.10		Jacobs noted that a large part of the building's overall dead load comes from the existing brick walls.
2.11		NPB asked if an additional floor or two could be added to the building. Jacobs said that it would probably be OK with the existing gravity load structural capacity, but any design would need to be reviewed and confirmed.
2.12		NPB asked about the possibly of removing existing portions of the floorplate. Jacobs said this would be possible as long as the existing structure is tied back to the lateral members.
2.13		Jacobs noted that they would need to vet any design with MFA's security consultant for issues around security.
2.14		MC asked about how the building's structure would be affected due to sea level rise. Jacobs responded that because the building is built on piles that are below the groundwater level, this should not affect the structure. The slab on grade would be the only thing affected so this would need to be tied to the structure. DC would follow up with the geotechnical engineer on this question.
2.15		Jacobs asked NPB if they knew if they owned the property along the Freedom Trail to the north of the building. NPB would investigate this.
3		Resiliency and Building Precedents
3.1		MFA began this section of the presentation by talking about issues of environmental resiliency. SM noted that the Hoosac Stores exist in the FEMA flood zone and that rising sea levels and climatic events will need to be addressed in the planning and design of any new building project.
3.2		SM noted that the Hoosac's first floor is approximately four feet higher than the surrounding land (approximately 19' above the Boston City Base, BCB).
3.3		MFA showed a precedent project also located in the Navy Yard, Spaulding Rehabilitation Hospital, which took a very conservative approach to resiliency and located their main floor at 19' above BCB. This seems to indicate that, while the ground plane around the Hoosac Building will be susceptible to water events, the first floor would face more minimal danger than originally thought.

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3.4		MFA went through resiliency strategies that included blocking the water (which could be a part of a larger master plan strategy) or dry floodproofing. Precedents were reviewed, including the Whitney Museum in New York City which includes deployable fortification against flooding. NPB noted that these strategies of blocking the water are being deployed in the Seaport currently. Issues of where these devices are stored and who deploys them were discussed. SM noted that punched openings at the ground level that could be locally, and temporarily, protected with flood panels was also an option.
3.5		MFA explored five different approaches to keeping the existing Hoosac structure while adding new program. These included: • Working with the existing building • Adding additional floor(s) • Removing the interior, retaining the exterior • Adding an exterior enclosure • Utilizing the adjacent lot Each of the approaches was accompanied by built precedent studies.
3.6		NPB noted that the precedent showing a complete replacement of a building's existing façade could be used as an "aha moment" relating visitors entering the building to the USS Constitution.
3.7		CB expressed familiarity with the idea of popping up the roof and referenced the "Converse Building" in Boston.
3.8		MC questioned the reason to keep the shell of the building, from a historic preservation perspective.
3.9		MC questioned the additional cost that would be involved in keeping the existing building.
3.10		RR believed they had some flexibility in terms of historic preservation, and CB noted that she did not get the impression that locals would have an issue with tearing it down. LK was not comfortable with just starting over and noted that NHPA review is a consultation process. Information needs to be gathered, consultation needs to occur, mitigation must be discussed, and justification needs to be made.
3.11		MC noted that Parks has done creative things with tough buildings, and SM noted that there is a sustainability question that comes into play in tearing down old buildings.
3.12		NPB agreed that the "exterior enclosure" option did not make sense.
4		Project Challenges and Decision Drivers
4.1		MFA explained that this portion of the presentation would look at what the biggest project challenges would be outside of the physical structure itself and what the decision drivers would ultimately be that would be used to evaluated the "proposed alternatives" in the upcoming on-site meeting.
4.2		MFA noted that the existing Hoosac building is already overbuilt according to modern zoning and that variances would need to be obtained for FAR, height, open space, and parking. MC noted that federal property trumps zoning, but Parks still has the desire to be cognizant of style, mass, and context as they relate to the neighbors. He noted that the GSA is good at driving this process through. CB added that the community understands that this site will be built on.
4.3		MC wants to take a common sense, comfortable approach to the building strategy here, wait until a design has been produced, and present it to BPDA then. He noted that views to the water are important and that a viewshed model would be desired to explain how views would be affected from surrounding properties. He noted that even views at the lower level (such as through the building and to the water) would be important for neighbors to understand.

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4.4		MFA noted that the program for NPB and the associated shared program seemed to be in a good place, but the space occupied by the museum and the lease out space was still being settled. NPB noted that they needed to work with the museum to set a cost to the amount of square footage they are requesting and set priorities.
4.5		MFA reviewed 15 decision drivers with the group.
4.6		NPB noted that "Collection Preservation and Protection" should be added to the list but MC noted that this could be rolled into "Ability to Meet Program" or "Workplace Innovation."
4.7		MC noted that "Context" or "Cultural Landscape" should be added to the list. This would be like "User Experience" but for the space outside of the walls of the Hoosac Stores.
4.8		CB noted that they would need to focus on and define what exactly is the "User Experience."
5		Schedule
5.1		MFA noted that they would like to have the next on-site meeting sometime during the first full week of January (pushed back from an original proposed date in mid-December) but that NPB travel schedules during that time may push that to the following week. CB would confirm dates and times that work with everyone from NPB, USSCM, and the Navy.

These minutes will become part of the official project record unless corrections or additions are brought to the Architect's attention within seven days of the date of issue.

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Meeting Minutes - Feasibility Study: Decision Drivers and Possible Alternatives

Project:	Hoosac Stores Feasibility Study	**Meeting Date:**	17 January 2020 9:00 a.m.
Issued By:	Jason Roberts	**Issue Date:**	07 February 2020

Location: USSCM, Building 22/28, Figgie Theater

Present:

Christina Briggs (CB)	National Parks of Boston (NPB)
Steve Carlson (SC)	National Parks of Boston (NPB)
Michael Creasey (MC)	National Parks of Boston (NPB)
Timothy Crofeau (TC)	National Parks of Boston (NPB)
John Curwen (JC)	National Parks of Boston (NPB)
Dan Gagnon (DG)	National Parks of Boston (NPB)
Celena Illuzzi (CI)	National Parks of Boston (NPB)
Lance Kasparian (LK)	National Parks of Boston (NPB)
Beth Law (BL)	National Parks of Boston (NPB)
Ruth Raphael (RR)	National Parks of Boston (NPB)
Liza Stearns (LS)	National Parks of Boston (NPB)
David Vecchioli (DV)	National Parks of Boston (NPB)
Bob Wilbur (BW)	National Parks of Boston (NPB)
Robert Kiihne (RK)	USS Constitution Museum (USSCM)
Frank Morse (FM)	USS Constitution Museum (USSCM)
Pat Mouss (PM)	USS Constitution Museum (USSCM)
Steve O'Leary (SO)	USS Constitution Museum (USSCM)
Anne Grimes Rand (AR)	USS Constitution Museum (USSCM)
Ed Sevilla (ES)	USS Constitution Museum (USSCM)
Sarah Watkins (SW)	USS Constitution Museum (USSCM)
Jessica Stabbins (JS)	USS Constitution Museum (USSCM) / HDR
Chad Reilly (CR)	HDR
Andrew Broyles (AB)	Navy
Nathaniel Shick (NS)	Navy
David Choi (DC)	Jacobs Engineering Group (Jacobs)
Joe Lin (JL)	Jacobs Engineering Group (Jacobs)
Collin Sabin (CS)	Jacobs Engineering Group (Jacobs)
Judith Bouven (JB)	General Services Administration (GSA)
Patrick Sbardelli (PS)	General Services Administration (GSA)
Scott Marble (SM)	Marble Fairbanks Architects (MFA)
Karen Fairbanks (KF)	Marble Fairbanks Architects (MFA)
Jason Roberts (JR)	Marble Fairbanks Architects (MFA)

Distribution: Christina Briggs, Patrick Sbardelli

Note: For clarity, the meeting discussion has been summarized by topic and not necessarily in the order it was discussed.

Item	Action	Description
1		Introduction

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1.1		MFA described that the goal of this presentation and workshop was to review the final findings from the physical testing that occurred on the Hoosac Stores building and review, discuss, and collectively evaluate 16 alternative massing and programmatic strategies to the site by scoring them against various Decision Drivers. Ultimately, five options would be chosen as Possible Alternatives for the design team to further refine and cost out.
2		Structural and Material Testing and Review
2.1		Jacobs noted that the final findings of the physical testing did not significantly differ from the preliminary findings they presented in the “Initial Findings, Precedents, and Decision Drivers” presentation on November 8, 2019. (Refer to those Minutes for more information)
2.2		USSCM had a concern about environmental conditioning as it related to the existing masonry walls of the Hoosac as well as the existing floor-to-floor heights. MFA noted that environmental conditioning of sensitive areas would need to be considered in any renovation project and floor-to-floor heights in any Alternate with “new” space would need to be considered built to suit. Portions of the existing Hoosac Stores building were considered to be double-height space in every Alternative proposed.
3		Decision Drivers
3.1		MFA discussed the development of seven Decision Drivers that would be used to evaluate each of the Alternates presented. These seven were paired down from a much larger list presented in the “Initial Findings, Precedents, and Decision Drivers” presentation on November 8, 2019. These Drivers included: • “Wow factor” (Exterior Expression) • User Experience - Exterior to Interior sequence • Historic Sensitivity/Conservation • Ability to Meet Program • Program Distribution • Flexibility of Use Over Time (Adaptability) • Phasing MFA noted that each Alternate would be scored on a scale of 1-5 (with 5 being the highest) and these results would be compiled onto a spider diagram as a way to compare options. MFA noted that this evaluation was to instigate conversation and that the “highest scoring” options would not necessarily be the five Possible Alternatives chosen in the end to be developed further.
4		Program Breakdown
4.1		MFA noted that the program used in developing the Alternates began with the Housing Plan developed in the Workplace Recommendation Report but noted that this did not accommodate any desired growth by the USSCM.
4.2		Through discussions with NPS during the Feasibility Study, NEMS was removed from the program. It was also decided that, where the test fits could accommodate it, the USSCM museum program should target 60,000 GSF. Any space available in the Alternate beyond the space reserved by the Orientation space, NPS, and the USSCM would be used as leasable square footage.
5		Possible Alternatives
5.1		MFA introduced the sixteen Alternates grouped into the following categories: • BASELINE: Workplace Recommendation Report

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		• ALTERNATIVE 1: Add Additional Floor • ALTERNATIVE 2: Add Multiple Floors • ALTERNATIVE 3: Partial Removal of Interior, Retain Exterior • ALTERNATIVE 4: Utilize Adjacent Lot - Discrete New Building • ALTERNATIVE 5: Utilize Adjacent Lot - Integrated New Building • ALTERNATIVE 6: Utilize Adjacent Lot - All New Construction Each category was accompanied by a concept diagram, precedent imagery, and the Alternates. Each Alternate included views of the massing from both Constitution Road and the water, a programmatic axonometric diagram, and a spider diagram in which MFA evaluated the option against the Decision Drivers.
5.2		In reviewing the Alternates, the client group had the following general questions and comments: • The group asked what the driver was when it came to height. NPS noted that it would be a negotiation with the neighbors and that the process that the group is going through now is important to demonstrate to the neighbors that multiple options have been discussed and evaluated. • It was generally agreed that any expansion going up should be limited to two floors. • NPS noted that any expansion toward the water would have to address the issue of environmental resiliency. MFA noted that the adjacent Spalding Hospital was built at a similar elevation as the existing first floor of the Hoosac Stores and was built with issues of resiliency in mind. • MFA noted that any “new” construction would be built to suit and would have floor-to-floor heights appropriate for the program dedicated to that space. • NPS noted that getting the public higher up into the building would be a challenge. • Questions: Who has water exposure? How does the museum connect with the Orientation space? Does the museum need to have good representation on the first floor? What happens to visitors when they get off of the ship? • NPS raised a concern that if the building sat too close to the water there would not be room for outdoor activities. • NPS was concerned about the Alternates showing a ground floor of curtain wall (glass). MFA noted that these were just diagrams that talked about having transparency at the first floor. • NPS noted that the lot to the east of the building was an important setup between the building and the ship. It’s an ideal outdoor space (not for building; it’s important to keep the view through the gates). It would be a temporary space; nothing built here permanently. The Navy doesn’t like the idea of having something built so close to Buildings 4/5. This would be where you exit orientation and board the ship. • NPS noted that people are not arriving from a single direction. They are coming from the bus, the Freedom Trail, the water shuttle, etc. • NPS noted that it was important to think about the seasons as one thought about the approach to the building. • NPS noted that the space is not just orientation to the Navy Yard but also to the Freedom Trail. • The group noted that it’s important that any scheme must have a way of getting objects in and out of the building. • USSCM noted that is was important to delineate between public and private spaces within the museum.

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		• SC noted that there could be a common research room between Parks and the USSCM. • The group did not know what would be the better experience: the museum then the ship or the ship then the museum. There is a huge opportunity here to build a better experience. • AR noted that when the ship is in dry dock, the museum sees half the visitors it normally experiences. • The group noted that when you exit the museum and enter the yard, you want to encourage, but not require, a certain experience. • The group agreed that the ground floor is critical to the visitor experience. A passageway through the building is important. • The group noted that any leasable space in the project needs to be considered holistically so it does not obscure access points. • NPS questioned if a portion of the project was a developer project if they would need to comply with regulations that the Parks are exempt from. • The Navy expressed concerns about access to parking.
5.3		After the large group discussion, the group split into five smaller groups and evaluated each Alternate together. Each group produced their own spider diagram using the Decision Drivers as a guideline.
5.4		Once the groups finished this exercise, the Alternates were re-presented and the spider diagrams that each group developed were used to discuss each Alternate. The following were comments on specific Alternates: • Baseline: The group ranked this highly in terms of Historic Preservation, but it did not offer much for the museum in terms of growth and flexibility. • 1A: The lack of leasable square footage is a big deal here. If the museum has to pay for seismic bracing to bring the existing building up to code, it's a non-starter. • 1B: The group thought that this was an interesting addition and a good utilization of the space. The new space could be multi-height to accommodate mast/exhibits. • 2A: The group felt that this addition was too extreme and thought one to two additional floors would be more contextual. There was also a concern that the building could not be phased. Having museum space below leasable space was not ideal (leaks). The Navy noted that having leasable space overlooking Building 4/5 was also not ideal. It was noted that the views at the top of the building were not just about the water but about the whole, 360-degree view. • 2B: This Alternate had similar comments to Alternate 2A. • 3A: USSCM had an issue with the museum being too "vertical." There was also a concern about new floors lining up with existing floors. • 3B: Comments on this scheme were similar to comments about Alternate 3A. There was also a concern about this option going too tall. • 3C: The group appreciated keeping this option limited to a vertical expansion of two stories though they thought cutting into the existing building started to affect its Historic Perseveration score. The group thought the program distribution worked well here and the higher floor heights in the new spaces would work well. This Alternate also provided a ground floor lease option. NPS noted that it did not need double-height space; this would be better suited in the museum. The adjacent lot could be built on in the future in this Alternate. • 4A: NPS noted that their space felt crammed into a narrow vertical floor plate that didn't work well. There were questions about where parking would reside.

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		There was also concern that the first thing visitors saw coming down the Freedom Trail was the leasable space. The question was raised: “How do you end up creating a gateway or entrance that doesn’t enter through commercial space?” • 4B: USSCM felt as though the museum experience here was too “long,” and the programmatic distribution took water views away from the leasable space. • 5A: The group generally scored Phasing low on this Alternate. There were questions as to why you would keep the existing Hoosac Stores building with such a radical intervention. USSCM space on 5-6 floors was determined to be unsustainable; there may be more of an advantage to keeping the museum on few floors. • 5B: Similar comments to those in Alternate 5A • 5C: USSCM felt that this was a more successful distribution of the museum. This gave visitors multiple ways of accessing the ground floor, though multiple points of access would produce challenges for wayfinding. The group agreed that retail or café space on the ground floor would be successful. • 5D: The group noted that there needed to be a distinction between the NPS/USSCM space and the leasable space. This scheme compromises the historic structure. The building should not be a barrier to the water; having openings is important. The “amenity” of the landscape is important. • 5E: This group noted that in this Alternate phasing and flexibility went hand in hand: This scheme could give the developer time to build out the lot next door before or after the renovation of the Hoosac Stores building. • 6A: NPS noted that, while there has been a historic option of tearing down the building and leaving the lot as open space, tearing down a historic building would look bad. MFA asked if the building were demolished could portions of it be reused in the façade. The Navy was concerned about the security of a new build out. The group question why MFA rated the “Wow Factor” of this option as a 4 instead of a 5; MFA noted that this Alternate lacked the interesting quality of integrating old and new.
5.5		The group decided to further develop the following five Possible Alternates: • Baseline • 3C • A version of Alternate 4 • A version of Alternate 5 • A version of Alternate 6
6		Schedule and Next Steps
6.1		MFA noted that the five Possible Alternates would be further developed over the next three weeks and Jacobs would provide a RoM costing to each. The first Feasibility Study submission would be issued on February 7, 2020.

These minutes will become part of the official project record unless corrections or additions are brought to the Architect's attention within seven days of the date of issue.

TASKS	9-Sep 1	16-Sep 2	23-Sep 3	30-Sep 4	7-Oct 5	14-Oct 6	21-Oct 7	28-Oct 8	2019 4-Nov 9
Project Start Up									
CONTRACT AWARD, NOTICE TO PROCEED, AND KICK-OFF	9/9								
CONTRACT AWARD AND NOTICE TO PROCEED									
KICK-OFF MEETING [3.1.1]	9/11								
FEASIBILITY STUDY									
Submission 1 (1+2+3): Existing Conditions, Needs Assessment, and Possible Alternatives									
INITIAL OUTLINE AND WORK ACTIVITIES		9/16							
PROPOSED EXECUTION AND SCHEDULE OF WORK ACTIVITIES PROVIDED TO CLIENT/USER [3.3.1]									
CLIENT/USER REVIEW AND COMMENT ON SCHEDULE; LOCK IN CRITICAL WORKSHOP DATES									
PROJECT GOALS AND REQUIREMENTS									
ON-SITE MEETING									11/8
EXISTING CONDITIONS INVESTIGATION [3.3.2.1]									
GENERAL [3.3.2.1.1] [1]									
ASSET CONDITIONS [3.3.2.1.2] [1]									
CUSTOMER HOUSING CONDITIONS [3.3.2.1.3]									
PROPOSED SITE CONDITIONS [3.3.2.1.4]									
NEEDS ASSESSMENT [3.3.2.2]									
INTERVIEWS [3.3.2.2.1] [2]									
ASSET GOALS AND NEEDS [3.3.2.2.2]									
CUSTOMER GOALS AND NEEDS [3.3.2.2.3]									
ENGINEERING STAGE 1: GEOTECHNICAL AND STRUCTURAL STUDIES, ON-SITE PROBES, AND INVESTIAGTIONS									
MOBILIZATION OF SUBCONTRACTORS, NPS STORAGE REQUIREMENTS									
NPS TO CLEAR AND PREP AREAS FOR BORING, BRICK CORING, AND MATERIAL SAMPLES									
BRICK CORING TO TAKE PLACE									
MATERIAL SAMPLING AND STUDY TO TAKE PLACE									
BORING AND SOIL TESTING TO TAKE PLACE									
JACOBS GEOTECHNICAL EVALUATION									
SGH TO ANALYZE MATERIAL TEST RESULTS									
JACOBS STRUCTURAL EVALUATION									
JACOBS TO RECOMMEND SOLUTIONS BASED ON TESTING									
BETA TO CONDUCT GPR OF SITE, DELIVER REPORT									
PAL TO DELIVER HISTORIC REPORT ON HOOSAC LOT									
REPORT FROM JACOBS TO MFA DESCRIBING VIABILITY OF RETAINING EXISTING HOOSAC BUILDING									
POSSIBLE ALTERNATIVES									
DEVELOP POSSIBLE ALTERNATIVES									
DEVELOP MATERIAL FOR ON-SITE WORKSHOP									
DEVELOP TECHNICAL ANALYSIS [3.4.1]									
ENGINEERING STAGE 2: SYSTEMS CONCEPTS, COSTING									
ON-SITE WORKSHOP: POSSIBLE ALTERNATIVES									
IDENTIFY FIVE SELECT POSSIBLE ALTERNATIVES [3.3.3]									
DEVELOP AND COST OUT FIVE POSSIBLE ALTERNATIVES									
DELIVERABLES SUBMITTED TO CLIENT/USER									
CLIENT/USER REVIEW AND COMMENT									
CLIENT/USER/DESIGN TEAM SELECT THREE VIABLE ALTERNATIVES [3.3.3.1]									
RESPOND TO AND INCORPORATE CLIENT/USER COMMENTS [3.8.2]									
Submission 2 (4+5+6): Viable Alternatives, Preferred Alternative, and Final Report									
VIABLE ALTERNATIVES									
DEVELOP THREE VIABLE ALTERNATIVES [3.3.4]									
DEVELOP MATERIAL FOR ON-SITE WORKSHOP									
DEVELOP TECHNICAL ANALYSIS [3.4.2]									
DEVELOP FINANCIAL ANALYSIS [3.5.2]									
DEVELOP IMPLEMENTATION SCHEDULE [3.6.2]									
ENGINEERING STAGE 3: SYSTEMS DEVELOPMENT									
ON-SITE WORKSHOP: VIABLE ALTERNATIVES AND COMPARATIVE ANALYSIS [3.3.4.1] [5]									

																		2020									
11-Nov	18-Nov	25-Nov	2-Dec	9-Dec	16-Dec	23-Dec	30-Dec	6-Jan	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May	18-May
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
			12/3																								
			12/3																								
			12/4												2/28												
									1/17																		
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															2/28												
																3/2				4/3							

									2019
	9-Sep	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	4-Nov
TASKS	1	2	3	4	5	6	7	8	9
SELECT PREFERRED ALTERNATIVE									
IDENTIFY PREFERRED ALTERNATIVE [3.3.4.2]									
DEVELOP TECHNICAL ANALYSIS [3.4.3]									
DEVELOP FINANCIAL ANALYSIS [3.5.3]									
DEVELOP IMPLEMENTATION SCHEDULE [3.6.3]									
PREFERRED ALTERNATIVE, IMPLEMENTATION, BUDGET, AND FINAL REPORT									
ON-SITE MEETING [5]									
DEVELOP PREFERRED ALTERNATIVE [3.3.5]									
SPACE PROGRAM REQUIREMENTS [3.3.5.1]									
FINAL REPORT DEVELOPMENT [3.3.6]									
DELIVERABLES SUBMITTED TO CLIENT/USER									
CLIENT/USER REVIEW AND COMMENT									
RESPOND TO AND INCORPORATE CLIENT/USER COMMENTS [3.8.2]									
CREATE PRESENTATION FOR NPS USE [3.1.2]									

Prepared by marble fairbanks

in-person meeting / visit [3.1.1] [3]
WebEx or GoTo meeting [3.1.1] [4]
client / user review period
phase / task
deliverables due

1 Tasks to reference PDS Submission #2
2 Interviews to be in-person or via WebEx or GoTo [TBD]
3 Site visits may be required outside of the ones noted on this schedule depending on the deliverable
4 Bi-weekly progress meetings shall be held via online or phone conference throughout the duration of the project
5 Exact date of on-site meeting / workshop to be confirmed with all parties

2020

11-Nov	18-Nov	25-Nov	2-Dec	9-Dec	16-Dec	23-Dec	30-Dec	6-Jan	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	2-Mar	9-Mar	16-Mar	23-Mar	30-Mar	6-Apr	13-Apr	20-Apr	27-Apr	4-May	11-May	18-May
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
																				4/3							
																					4/6						5/22
																								5/1			
																											5/22