Portland Company Complex
General Building Condition Report

performed for
City of Portland, Maine Planning Department
389 Congress Street
Portland, ME 04101

MARCH 26, 2015
SUPERSEDES REPORT DATED MARCH 11, 2015

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- March 26 revisions include edits to Executive Summary, Introduction, Recommendations and Conclusion to reflect comments from March 18, 2015 meeting with City of Portland, Greater Portland Landmarks, and CPB2.
- March 26 revisions also include renumbering of Appendix A, Appendix B, and Appendix C. Appendix A edits further compare Becker Structural Engineers and Resurgence Engineering and Preservation rating systems.

1.0 EXECUTIVE SUMMARY

The individual structures within the Portland Company complex that were included in the project scope are in generally poor condition due to deferred maintenance and, in some cases, inherent but correctable lack of stability against lateral forces and snow loads. The severity of deterioration varies from building to building; it also varies within any given building. In some cases, significant deterioration is quite localized; in other cases, the overall structure is in a state of significant disrepair.

Buildings in poor condition do not necessarily warrant demolition. The fact that a number of the buildings within the Portland Company Complex continue to be occupied – some by large assemblies for special events and some by business tenants – attests to the fact that most of the buildings are still serviceable and are in salvageable condition.

In our opinion, it is possible to address the identified structural and building envelope conditions in ways that retain each building's historic character and that are feasible from a cost perspective. To do so, however, will require case-by-case assessment, creative design solutions, and the involvement of consultants and contractors experienced in historic building rehabilitation.

At this site, business and assembly occupancies can continue as long as structural conditions are monitored while the owners develop their plans for the site. Structure and building envelope rehabilitation will be expensive, but may still be cost-competitive with new construction of the same volume and footprint within the existing framework. Historic rehabilitation tax credits could likely make rehabilitation costs more competitive with new construction. Whether one is building anew or rehabilitating the existing buildings, quality materials, detailing, and craftsmanship must be employed to withstand the formidable climatic conditions that occur on the waterfront.

Structural work needs to be performed on the roof and floor structures to increase snow and live load capacity, and to increase lateral stability. Building envelope improvements are necessary to create viable rehabilitated shells that can ward off the elements for decades to come. Other masonry rehabilitation strategies will be required to provide the structural continuity between roof, wall and foundation of the buildings.

After the buildings were assessed by Resurgence Engineering and Preservation in late December 2014, snow loads took a toll on two buildings, causing localized roof truss failure and roof rafter failure in Buildings 4 and 7, respectively. Prior to scheduled public events, the current owners stabilized these deficiencies, and in the case of Building 4, corrected or mitigated them.

We concur with many of the primary findings of Becker Structural Engineers' report as to the current condition of the individual buildings. However, the simplified construction techniques that characterize Buildings 1 and 4, together with the repetitive nature of many of the required repairs, make possible a relatively straightforward rehabilitation project for those two structures. Buildings 2 and 3 are more complicated and careful assessment will be necessary to deal with their structural complexities.

The linear, connected nature of Buildings 1 through 4 also presents an opportunity to improve lateral stability of the buildings within contemporary code requirements while making other repairs. The simple, modular nature of these long buildings allows for replication of the individual structural repair details. The exposed floor and roof structures provide easy access to make repairs. After additional structural inspection is completed, the limited hidden conditions lower the need to include large cost contingency factors for structural upgrades.

In summary, most of these exposed-frame industrial structures, with the exception of Buildings 2 and 3, are not that complicated when compared to many other historic commercial building rehabilitation projects undertaken in Portland and in Maine during the last quarter century.

In our opinion, three structures stand out as buildings presenting the greatest structural and building envelope challenges. The buildings in the most compromised condition include:

Building 7 (Car Shop)
Building 10 (Paint Shop) and
Building 11 (Pattern Storehouse).

We recommend that Building 11 remain unoccupied until the north (Fore Street) wall can be stabilized. The immediate safety concerns identified by Becker Structural Engineers at the wall between buildings 6A/6B, and of the overall condition of Building 10, are valid concerns and should be addressed as soon as possible, if they have not been already. Stabilizing the wall and roof framing between 6A and 6B can be performed as a stand-alone project prior to other rehabilitation of these buildings.

In any rehabilitation project, it is important to match existing buildings with compatible uses. Existing volumes, architectural complexity, and inherent structural limitations should all be considered to place proper occupancy types within any given building. Higher-risk occupancies (such as schools or other uses anticipating large assemblies) should be matched with buildings that can be strengthened to withstand increased structural loading factors with the least amount of structural intervention.

For purposes of this report we assume that the existing structures would be rehabilitated according to the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*. These Rehabilitation standards allow considerable leeway to perform less expensive repair or replacement, rather than strict – and more costly - restoration or conservation, of deteriorated structural framing elements, thereby making projects more economically feasible. The property's eligibility for the *National Register of Historic Places* also allows access to State and Federal Historic Preservation Tax credits, which can total up to 45% of qualified rehabilitation expenditures.

Building code advances in recent years have come to recognize that deficiencies in historic structures can be individually and specifically repaired, as opposed to replacing entire structural components. These advances can make structural rehabilitation easier and less expensive than comprehensive replacement.

2.0 INTRODUCTION

In November 2014, the City of Portland Planning Department solicited qualification submittals to provide a general building condition report for eight extant structures within the former Portland Company industrial complex at 58 Fore Street. Subsequently, the City increased the number of buildings to be studied to ten, adding Building 3 and Building 14. For each of the structures, the qualified team was asked to assess and provide a written report on the current conditions of the buildings' exterior envelope, structural systems(s) and potential for adaptive reuse, with a preliminary assessment of the relative expense to address current deficiencies in the building envelope and structural systems.

Alfred H. Hodson III, P.E. of Resurgence Engineering and Preservation, Inc. (RE&P) performed a structural evaluation of the Portland Company Complex. Richard Curtis, AIA performed additional building envelope assessment, and Ivan Myjer of Building and Monument Conservation performed masonry assessment. These three individuals completed the work required to inspect the identified buildings. The work scope did not include evaluation of any mechanical or electrical systems, accessibility issues, or life safety code requirements. Specific Buildings in the inspection scope include:

Building 1	Erecting Building	c.1918
Building 2	Machine Shop	c.1847
Building 3	Machine Shop	c.1847
Building 4	Foundry	c. 1895
Building 6B	Tank Shop	c. 1896-1904
Building 7	Car Shop	c. 1873,1904
Building 10	Paint Shop	c. 1873
Building 11	Pattern Storehouse	c. 1885
Building 14	Drafting Room and Storehouse	c. 1858-64
Building 15/16	Boiler House and Brass Foundry	c. 1858, 1864

Assessment of the majority of the buildings occurred on December 29 and 30, 2014. On subsequent return visits, Mr. Hodson and Mr. Curtis visited the site to confirm and discuss items following completion of a draft report, and Mr. Hodson assessed the remaining two buildings.

The intent of the evaluation and this report, for each building within the scope, is to:

a. Assess and provide a written report on the current condition of the building's individual exterior envelope, the current condition of the building's structural systems, and the building's potential for adaptive re-use.
b. Provide a preliminary budget of the relative expense to address current building envelope and structural system, including structural alterations and upgrades per IEBC 2009 requirements for a change of use, including the provisions included in Chapter 11 (Historic Structures), as well as upgrades to lateral force resisting systems and diaphragms for wind and seismic loads.
c. Review previous reports to understand past determinations of conditions, to compare them to current structural conditions. In particular, we reviewed a report prepared by Becker Structural Engineers (BSE) for the current property owners in March 2014, and worked both parallel and independent of their assessment to compare our findings with theirs;

Reporting Requirements in the Project Scope included:

d. Meet with the Planning Department and the city Historic Preservation Board to describe our findings *(not performed yet)*, and;
e. Submit a final report to City of Portland, Maine Planning Department.

Appendix A of this report provides tables and narrative explaining the rating systems used by Becker Structural Engineers and Resurgence Engineering and Preservation. Appendix B of this report provides photographs documenting the individual buildings and site. The report and appendices should be read in their entirety. Some photos shown in the appendices may indicate damage not specifically mentioned in the report. Appendix C includes a bibliography of sources used as part of this project.

Working within the same parameters as BSE did during their study, we did not consider building code requirements, egress, accessibility, flooding, ventilation, hazardous materials, fire safety and energy code. We did not perform invasive testing or formal structural analysis. We understand that more comprehensive structural and building envelope assessment, including invasive and nondestructive testing, is necessary to perform schematic design, understand building code requirements, and provide more refined cost opinions. Other conditions may exist beneath concealed surfaces that appeared sound or in areas that were not visible during the inspection. This is typical of any older building or complex of buildings facing potential rehabilitation.

For purposes of this report, the long axis of the Portland Company Complex faces north toward Fore Street, and south toward the waterfront. The west side faces the Hamilton Marine complex, and the east side faces the adjacent wooded hillside. This orientation is in keeping with the BSE and SCC reports.

Also for purposes of this report it is assumed that the existing structures would be rehabilitated according to the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*. These Rehabilitation standards allow considerable leeway to perform replacement, rather than strict restoration or conservation, of deteriorated structural framing elements, thereby making projects more economically feasible. (The property's eligibility for the National Register also allows for use of historic preservation tax credits. Preservation tax credits, which can total up to 45% of qualified expenditures, are intended to encourage investment in the rehabilitation of historic structures.)

We have not attended any presentations by Sutherland Conservation and Consulting or CPB2 Management, LLC, in order to retain objectivity in this study.

3.0 DOCUMENT REVIEW

3.1 Original Construction Documents

We were unable to review original construction documents of the Portland Company Complex. However, we understand some documents are available at Maine Historical Society. Any further assessment of the buildings should include review of these documents in order to compare specified materials with field conditions. This is important for any building rehabilitation project, in order to compare a designer's intent with what was constructed. Occasionally, archived drawings include notes made during construction to document specific construction changes and to provide insight into why those changes occurred.

3.2 Previous Studies and Historic Research

In accordance with the Request for Qualifications, we were provided access to two previous reports about the structural condition and history of the buildings in question, including the following:

- Evaluation of Existing Buildings at the Portland Company Property, March 28, 2014, by Becker Structural Engineers(BSE) Paul Becker, P.E., and Ethan Rhile, P.E.
- The Portland Company Historic Significance and Integrity; 2014, by Sutherland Conservation and Consulting (SCC), Scott T. Hanson, Amy Cole Ives, Matthew Corbett. We have not attended any of the presentations about the site that have been occurred since the report's publication.

We reviewed the BSE report to help understand their specific report format, narrative, and scope for purposes of defining our work scope. We worked both independently and in parallel with the BSE report. We reviewed the SCC report primarily to develop an understanding of the site's evolution and to gain an understanding of the relative age of the individual structures within the work scope.

We also performed a brief literature search to better understand some of the construction techniques used in several of the longer mill buildings. References reviewed included texts about late 19th and early 20th century construction design, materials, methods, and techniques. Appendix B lists a full bibliography of materials researched or reviewed for this report, including site surveys and maps available on the Maine Memory Network.

We viewed several historic maps online to view general conditions and layouts of the site, understanding that such maps included some artistic license and potential inaccuracies not found in formal survey maps or photographic images.

OBSERVATION, EVALUATION, RECOMMENDATIONS
4.0 General Observations and Evaluations

Site Considerations and Conditions:
The site surrounding the buildings in the work scope is an essentially flat, mostly paved site, with the exception of the north section of the site facing Fore Street. A steep drop from Fore Street to the ground level of the buildings rises from the west end of the site toward the east end, as Fore Street ascends Munjoy Hill toward the Eastern Promenade. This steeply-sloped topography has a direct impact upon Buildings 1 through 4 and Buildings 11 through 16 as stormwater runoff flows off the hillside toward these structures. The first floor of Building 11 sits below the exterior grade of the north wall of that structure. Buildings 14, 15 and 16 share a rubble stone masonry north wall that primarily serves as the Fore Street retaining wall.

The majority of the site surrounding the studied buildings is paved right up to the building perimeter walls. Perimeter site drainage around the buildings is likely not present or operational. We observed only a few catch basins near the buildings, but snowfall hampered a more comprehensive assessment.

At a site with buildings that predate sophisticated topographical surveys and largely available commercial photography, historic maps are often a key resource to determining site conditions. However, one must take into consideration any "artistic license" taken by the cartographer. An 1837 map by James Hall shows the site without any of the Portland Company structures. An 1851 map by H.F. Walling shows the ocean extending up to near the location of Buildings 6 and 7. The present-day Hamilton Marine site was a small cove. By 1857, the site is largely filled in, and several parallel rail tracks are shown extending eastward across the site along the present Eastern Promenade Trail and East Coast Greenway.

Beginnings of the Portland Company Complex indicated in an 1851 map by H.F. Walling. Note the cove area to the southwest of the complex, now filled in and occupied by Hamilton Marine and other structures.

Siting of the buildings with a generally east-west orientation creates shade on north-facing roof surfaces during the winter months. While south-facing roofs absorb sun and melt snow, north-facing roofs tend to keep snow longer, creating potential uneven snow loading conditions. Uneven snow loading is a cause of many winter roof failures, when the building is not able to sustain thrust loads created on the structure.

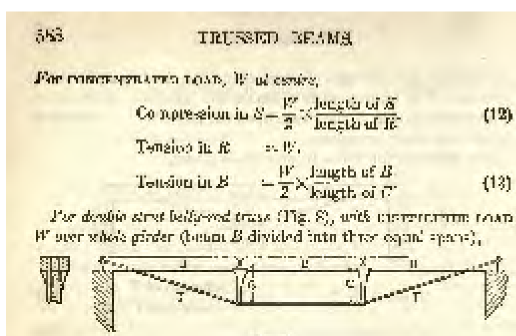
While the orientation would have minimal effect upon structures that generate their own heat, such as the Building 4 foundry, orientation would create more likely drift conditions on other buildings, as well as Building 4 since its closing as a foundry.

Structural Framing:

The structural framing of the different buildings provides insight into several generations of industrial construction. Heavy timber framing, cast iron hardware and loadbearing masonry walls support the oldest structures that date between 1847 and 1900. The heavy industrial truss construction in the timber-framed structures utilizes Queen Rod trusses (Queen Post trusses using two vertical iron rods to support the tie beam, instead of timber material) to create long, open spans in the work areas of Buildings 2, 3, and 6B. The shallow-pitched roofs of timber-framed Buildings 7, 10, and 11 used more standard post-and-beam techniques. Nineteenth-century builders already knew to use simpler, less efficient King Post trusses in smaller spans, such as in the roof of Building 14.

Queen Rod Truss in Building 6B (left); King Post Truss in Building 14 (right)

Building 2 and Building 3 utilize a 19th-century technique of suspending the second floor from the roof trusses to create more open space at that level. This technique has been observed in several buildings in Maine, and is a visual structural indicator of how the buildings have evolved over time as the Portland Company grew. Other structural features, such as the use of trussed girders (seen in Buildings 2 and 3) were commonly used to strengthen longer framing spans in accordance with formulas from handbooks.



TRUSSED BEAMS

For CONCENTRATED LOAD, *W* at centre,

$$\text{Compression in } S = \frac{W}{2} \times \frac{\text{length of } S}{\text{length of } R} \qquad (12)$$

$$\text{Tension in } R = W,$$

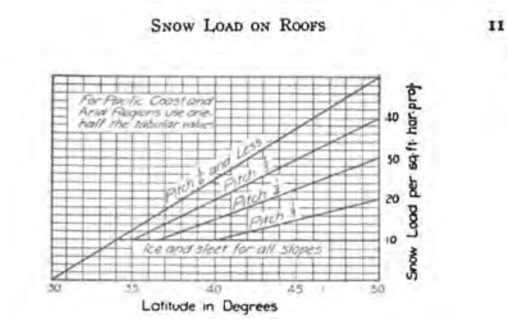
$$\text{Tension in } B = \frac{W}{2} \times \frac{\text{length of } B}{\text{length of } C} \qquad (13)$$

For double strut belly-rod truss (Fig. 8), *with* DISTRIBUTED LOAD *W over whole girder* (beam *B* divided into three equal spans),

FIG. 8

Illustration of "Double Strut Belly Rod Truss" from Architects and Builders Pocket Book, 14th ed. 1905.

Construction techniques changed with the advent of more readily available wrought iron and later, steel, toward the end of the 19th century. The buildings examined in this project scope illustrate the overlapping technological use of iron or steel structural framing beginning with the 1895 replacement Foundry (Building 4) and the 1918 replacement Erecting Building (Building 1). Each of these buildings is an example of steel (or iron) mill building construction, featuring a wide center bay supporting a rail crane, and side bays for other work processes.



1895 Steel Mill Building Construction in Building 4 (left) and c.1904 snow loading diagram from Ketchum text. Snow loading diagram in this text is based upon latitude in degrees, and upon roof pitch.

Windows and Doors:

<u>Overview:</u>

Buildings 1-4 have a very large proportion of glazed openings to the wall surfaces, likely due to the desire for abundant natural light and ventilation opportunities in these industrial/manufacturing buildings. The windows in the walls and clerestories are important architectural components of the complex, and should be maintained or replicated. Almost all of the windows have single pane glass, and due to the high proportion of glazed openings, they afford very little in terms of energy conservation. While there are fewer original, existing windows in the remaining buildings, they too are important architectural components of the complex and of the individual structures. The conditions of the windows vary from fair to very poor, and will demand attention to make the buildings usable for new purposes.

The many sizes and functions of doors in the complex reflect the varied requirements for the different manufacturing processes. Unfortunately, many of the larger original doors have been replaced with more recent doors after the site's period of significance. Like the windows, remaining doors from the period of significance for the site are important architectural components, and should be maintained, if possible, or recreated in kind to meet Park Service standards.

Energy Conservation:

<u>Overview:</u>

Section 101.4.2 (Historic buildings) of the 2009 International Energy Conservation Code (IECC) specifically states that: *"Any building that is listed in the State or National Register of Historic Places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a National Register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the National or State Registers of Historic Places either individually or as a contributing building to a historic district by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, are exempt from this code."*

This could seem to imply that the buildings at the Portland Company complex are totally exempt from any requirements for insulation, heating system performance and electricity use. However, the Commentary on the IECC makes it clear that if any additions, alterations or renovations are undertaken that are not classified as “historic” they should comply with Section 101.4.3 (Additions, alterations, renovations or repairs). This section requires that additions, alterations, renovations or repairs conform to the new construction requirements of the IECC. It further requires that additions, alterations, renovations or repairs not overload existing building systems.

What this all means for the Portland Company complex is that there are portions of the building envelope that may be affected by these provisions. For example, in the discussion on exemptions to the requirements, Section 101.4.3 requires that during reroofing activities, roofs without insulation where the sheathing is exposed during reroofing shall be insulated either above or below the sheathing.

Most of the buildings in the complex have no insulation at the walls or roofs. If reroofing is undertaken, it would be rational and more code compliant to add insulation to the roofs. By installing insulation on top of the roof decks, the existing framing could remain exposed on the interior. The requirement for roof insulation in Table 502.2(1) for insulation above the deck is R20, which could be achieved with about 3” of rigid insulation, which should not seriously alter the historic appearance of the exterior.

All of the buildings have solid brick exterior walls, with the brick exposed both inside and out. Insulation of these walls could only be accomplished by covering up the brick on the interior, which may or may not be desired, depending on the final uses. Section 101.4.3 does not require that mass exterior walls such as those in this property be insulated.

Brick Masonry Construction:

The brick masonry at the Portland Company is typical of 19^{th} and early 20^{th}-century construction. The masonry is unreinforced multi-wythe brick construction primarily bonded by lime-rich mortar. As masonry construction changed in the early 20^{th} century, stronger mortar mixes using Portland cement became a preferred construction material. Cement-rich mortar bonds the bricks in Building 1, the most recent structure. Cement-rich mortar is less flexible than lime-rich mortar. This property may have contributed to the cracking visible at the masonry piers in Building 1.

Loadbearing masonry supports most of the structures within the complex. However, the brick masonry in Building 4 serves only to enclose the structural steel frame that supports the roof.

All of the buildings suffer the effects of long-deferred maintenance. Roofs, gutters, flashings, downspouts and brick mortar joints generally require rehabilitation.

At all of the buildings suffer from deterioration of the brick masonry caused by rising damp related to poor site drainage and hardscape. The hardscape, in particular, often directs water towards the masonry rather than away from it, and traps water running down the building walls in the joint between the pavement and the foundation. Opening the pavement joints along the buildings may help the soil ventilate, if used in conjunction with gutters, downspouts, and catch basins in strategic locations.

4.1 Building 1 – Erecting Building, 1918

Building 1 – Erecting Shop, west Elevation

Structure and Building Envelope Description:

- 9,400 square foot footprint, single story with high center bay and clerestory (Photo #1.1)
- Five interior bays with an additional smaller bay near Building 2 west wall (Photo #1.2)
- Unreinforced multi-wythe brick masonry perimeter bearing walls on three sides
- A shared end wall with the older Building 2 brick masonry end wall
- Flat Warren steel roof trusses and steel I-beam purlins with wood board sheathing at high roof
- Flush-framed steel I-beam roof beams and purlins with wood board roof sheathing at low roofs
- Interior steel columns that support both the high bay and the low bay framing, typical of steel mill building construction
- Extensive steel-framed window glazing on west, north, and south walls
- Ballasted rolled asphalt (high roof) membrane roofing (low roofs)

Observations and Evaluation:

- Upper roof surfacing consists of ballasted rolled asphalt, in good to fair condition (Photo #1.3). On lower roofs, a membrane surface covers the roof. We could not determine if it was insulated, or to what extent. Insulation would likely be required on the roofs, especially if there is a goal to retain the visible structure inside the building.
- Roof framing consists of steel trusses and intermediate beams at the clerestory (Photo #1.4). The beams and trusses will need to be analyzed for snow load capacity, and the decking above the beams will need to be replaced at deteriorated areas. The existing board sheathing is a combination of edge bead and edge-and-center bead. We were not able to measure the sheathing thickness. The sheathing does not provide an adequate diaphragm to transfer lateral loads, and it likely does not have sufficient nailing to resist code-required wind uplift forces.
- At the high/low roof intersection, the steel columns are offset, effectively placing an eccentric load on the lower column. This construction technique was typical of mill building construction when travelling cranes occupied the center bay of the structure. The columns, and their connection details, will need to be analyzed to confirm stability in conformance with current codes.
- Large-scale steel frame windows allow significant natural light into the building. The single-pane glazing lacks significant thermal resistance, and would likely need to be replaced with more energy-efficient glazing to keep heat in during the colder months and to keep heat out during the warmer months. Most of the windows are in poor condition and would require extensive rehabilitation or replacement regardless of energy efficiency concerns. As the windows are an important architectural feature of the building, they will need to be rehabilitated to National Parks Service Standards.

- Many of the steel window lintels and precast concrete window sills (Photo #1.6) are damaged and will require replacement. Steel lintels may need to be enlarged to carry loads imposed by current building codes. If replaced, the lintels should be galvanized prior to installation and painted as historically appropriate.
- The building has three load-bearing masonry walls. At the east end of the building the structure ties into the older (c. 1847) end wall of Building 2, transferring both gravity and lateral loads into that wall and building. An additional partial shear wall could help transfer lateral loads at the end of Building 1, and keep the more ornate Building 2 wall gable end wall visible.
- Unreinforced brick masonry walls are in good to fair condition. The bricks are hard, well-fired, and set in a cement rich mortar. Much of the masonry requires repointing, particularly near the south elevation ground level.
- Large cracks exist in the north and south wall masonry near the west end of the building, most likely due to thermal expansion on the long structure (Photo #1.7). The walls at the northwest and southwest corners will need to be rebuilt to tie the three walls back together. Smaller cracks occur in the intermediate piers between the windows, where the side bay framing bears on steel lintels. The cement rich mortar may have induced some of this cracking if it was stronger than the surrounding brick masonry, and the building was restrained from thermal expansion.
- The bottom masonry on the north side of the building is in poor condition due to raised grade and likely saturation from snow accumulation, rising damp, and poor site drainage.

Adaptive Reuse Potential:

- The tall center structure provides opportunity to insert an independent structure inside to provide additional floor space while maintaining some of the open qualities of the building. Another option could be to insert a floor structure inside the building that helps to transfer gravity and lateral loads from the original building into engineered frames and foundations.
- Ground-level access provides potential to sustain a wide range of occupancies, including large-scale assembly, with minimal egress and accessibility issues.
- Space is relatively straightforward to subdivide. Subdividing the space could also improve the lateral rigidity of the structure.
- Reconstruction of the west elevation to its original appearance (Photo #1.8) would address identified deficiencies in the masonry and improve the overall lateral stability of the building.
- Open access to the structural components permits relatively simple structural strengthening techniques that will be repetitive in nature. Much of the structure is well exposed, which should allow for straightforward assessment for corrosion, rot or other potential structural damage.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing.
- Strengthen existing roof structure as required, particularly near potential drift areas.
- Strengthen existing roof structure as required to provide wind uplift resistance and to transfer lateral loads through roof.
- Repair or replace existing steel windows with thermally efficient units that meet National Park Service Standards.
- Repair or replace existing steel lintels with properly galvanized and painted or prepared and painted steel.
- Repair or replace precast concrete window sills.

- Rebuild the west elevation, wrapping around to the north and south elevations, to match period of historic significance and to strengthen lateral capacity of west end wall.
- Provide shear wall at east end of building as necessary.
- Provide lateral bracing as required to resist code-required lateral loads.

4.2 Building 2 – Machine Shop, 1847, 1905 (3d floor)


Structure and Building Envelope Description:

- 11,300 square foot footprint, three stories with overhanging third floor added in 1905 (above).
- Third floor overhangs for nearly the entire building length on the south side, and approximately half the building length on the north side. Cantilevered floor has little backspan.
- Building may have originally had gutters and downspouts (Photo #2.3), which were rendered obsolete when the third floor was added.
- Building has fifteen window bays and structural bays. Other supplemental columns, girders, and trusses have been added, likely to provide additional upper-floor and roof support as the third floor was added and the building responded to additional loads.
- Unreinforced multi-wythe brick masonry perimeter bearing walls on four sides
- A shared end wall with Building 1 and with Building 3. The west gable wall (Photo #2.6 through Photo #2.8) is a significant architectural feature of the building.
- Two rows of large iron columns and timber posts create 15 structural bays on the first-floor.
- Second floor framing is suspended from original roof framing, which later became the third floor (Photo #2-13).
- Fourteen rows of iron hanger rods pass through the third floor framing to the second floor framing. A few of the hanger rods have been relocated or are missing.
- Timber and iron or steel queen rod roof trusses support raised roof above the 1905 drafting offices. (Photo #2-20, #2-11, and #2-12). The third-floor office spaces extended beyond the masonry wall of the original structure, cantilevered from the first interior (former) attic joist and spanning over the masonry walls.
- Third-floor shed dormer cladding at north elevation consists of stamped metal sheeting in a clapboard pattern (Photo #2.6), while red rolled asphalt clads the South dormer. Areas of missing cladding exist all along the dormers.
- Extensive wood window glazing exists on north and south walls at bottom two stories; with wood windows boarded up on third floor. First floor windows are 25/25 divided light, second floor windows are 15/15 divided light, and third floor windows may have been 2/2 divided light, more common to the early 1900s.
- Roof surfacing partially observed, appears to be rubber membrane as visible from satellite photos and site observations.

Observations and Evaluation:

- Upper roof surfacing appears to consist of membrane. We could not access the upper roof.
- Roof framing consists of queen rod wooden trusses, with a single purlin that carries the junction of the sloped and shed roofs. The beams and trusses will need to be analyzed for snow load capacity, and the vertically-sawn, wide-board decking above the beams will need to be replaced at deteriorated areas. We were not able to measure the sheathing thickness. The sheathing does not provide an adequate diaphragm to transfer lateral loads, and it likely does not have sufficient nailing to resist code-required wind uplift forces.
- The roof structure originally supported the second floor with iron suspension rods to create wide-open first floor and second-floor space. At some point, possibly when the third floor was added, additional timber and iron posts were installed to provide additional second floor support.
- While the structure itself is somewhat regular, many variations in the framing details will require detailed assessment to adequately confirm the integrity of existing load paths. The building has undergone many subtle framing modifications as the building evolved.
- Large wood frame windows allow significant natural light into the building. The single-pane glazing lacks significant thermal resistance, and would likely need to be replaced with more energy-efficient glazing to keep heat in during the colder months and to keep heat out during the warmer months. Most of the windows are in poor condition and would require extensive rehabilitation or replacement regardless of energy efficiency concerns. As the windows are an important architectural feature of the building, they will need to be rehabilitated to National Parks Service Standards.
- Granite headers over the first and second floor windows are mostly in good condition. Several are cracked, and will require either epoxy-dowel repair or in-kind replacement.
- The building has four load-bearing masonry walls. At the east end of the building the structure ties into the end wall of Building 3, transferring both gravity and lateral loads into that wall and building. A roof truss near the west gable end carries much of the gravity load of the roof, but part of the Building 1 roof ties into the wall in other locations.
- The brick masonry exterior of the machine shop is constructed from well-fired bricks set in a mid-19th century lime mortar. The multi-wythe brick walls double in thickness on the interior to form piers that support the second floor beams. The masonry of Building 2 is in very good condition suffering only from the effects of deferred maintenance and poor site drainage. There are some areas of brick replacement that were completed with bricks and mortar that do not match the originals very well.
- It does not appear that the masonry exterior was ever completely repointed in the 20th century. The extremely weathered original lime mortar is visible in almost all of the joints. At the top of the building, there is very little mortar left between the bricks that form the outer wythe of the cornice. There is a real danger that bricks may start to fall out of the upper wall if remedial steps such as repointing and rebuilding of these areas are not undertaken in the near future.
- As with the other buildings at the complex there is a problem with site drainage that is affecting the first ten to twelve courses of brick above the foundation.
- On the east and west elevations, the brickwork starts to corbel outward in increments starting at one brick above the second floor lintels to form a cornice that is 20 courses high. On the north and south gable ends the brickwork corbels out to form a cornice that is 13 courses high.
- Additional openings at the first floor may have been punched into the south elevation of Building 2 when Building 1 was constructed. The original second floor windows of Building 2 are visible from inside Building 1, indicating that the wall between Buildings 1 and 2 is the original exterior wall of Building 2.
- Diamond shaped iron brick ties are visible at the location of the second floor beams on the east and west elevations.
- The top portion of the granite foundation is visible on the exterior, but not interior, of the building.

Adaptive reuse potential:

- This building is the most complex structure of all the buildings we assessed. Its size and height provide the most interesting options and potential views of the water in the complex.
- Second-floor open floor plan provides excellent assembly space, assembly occupancy (or educational occupancy), but assembly occupancy increases load factors on the existing structure. Supplemental posts on the first floor and improved lateral bracing can mitigate the increased load factors resulting from more intense occupancies.
- Ground-level access provides potential to sustain a wide range of occupancies, including large-scale assembly, with minimal egress and accessibility issues.
- Space is relatively straightforward to subdivide.
- Open access to the structural components permits relatively simple structural strengthening techniques that will be repetitive in nature. Structural strengthening will require the analysis of many different isolated framing conditions created as the building was modified over time.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing.
- Strengthen existing roof structure as required, particularly near potential drift areas. Provide wind uplift resistance and transfer lateral loads through the roof to the walls.
- Repair or replace existing steel windows with thermally efficient units that meet NPS Standards.
- Strengthen cantilevered third floor framing to adequately support contemporary code required loads and wind uplift resistance.
- Repair/replace existing steel lintels with properly galvanized and painted/prepared and painted steel.
- Repair or replace cracked granite window sills.
- Repair the bearing wall between Building 1 and Building 2, and Building 2 and Building 3.
- Test a sample of the original brick setting mortar to determine what kind of lime was used in the original mortar and if additives, such as natural cement, were used to make the mortar hydraulic.
- Repoint 100% of the exterior brickwork using a mortar that replicates the binder and aggregate in the original mortar as closely as possible.
- Remove and reset bricks that are loose at the cornice.
- Modify site drainage to drain water away from the base of the building.

4.3 Building 3 – Machine Shop, 1847

Structure and Building Envelope Description:

- 4,900+/- square foot footprint, two stories with second floor added sometime around 1895, according to the SCC report.
- Second floor walls constructed of multi-wythe brick masonry, and roof trusses supplemented with additional framing to create shallow pitched continuous shed dormers while maintaining the original monitor roof (Photo #3.7).
- Building has seven window bays and six interior structural bays. Supplemental columns, girders, and trusses have been added, likely to provide additional upper-floor and roof support as the second floor was added and the building responded to additional loads (Photo #3.5, Photo #3.6).
- Unreinforced multi-wythe brick masonry perimeter bearing walls on four sides, including the shared end walls with Building 4 and with Building 2.
- Timber and iron or steel roof trusses support additional lumber and rafter framing to support the raised roof above the second floor.
- Wood windows on north and south walls. First floor windows are 25/25 divided light, second floor windows are 10/10 divided light. These windows comprise a comparable surface area to wall ratio as those in the bottom two floors of Building 2, but less area than those in Building 1 and Building 4. Windows on first floor have granite lintels, while those at second floor have shallow arch brick masonry lintels.
- Roof surfacing partially observed, appears to be rubber membrane as visible from satellite photos and site observations.

Observations and Evaluation:

- Upper roof surfacing appears to consist of membrane. We could not access the upper roof.
- Similar to Building 2, roof framing consists of queen rod wooden trusses. The building was added onto by raising the second floor roof and landing on the existing bearing wall, unlike Building 2, which relied on cantilevered floor framing over the top of the bearing wall.
- The beams and trusses will need to be analyzed for snow load capacity, and the vertically-sawn, wide-board decking above the beams will need to be replaced at deteriorated areas. We were not able to measure the sheathing thickness. The sheathing does not provide an adequate diaphragm to transfer lateral loads, and it likely does not have sufficient nailing to resist code-required wind uplift forces.
- While the structure itself is somewhat regular, some variations in the framing details will require detailed assessment to adequately confirm the integrity of existing load paths. There are fewer structural bays and trusses, which means fewer potential differences in truss conditions. Techniques used in modifying the structure included the use of double strut belly-rod trusses, which stiffened the second floor girders.
- Wood frame windows allow significant natural light into the building. The single-pane glazing lacks significant thermal resistance, and would likely need to be replaced with more energy-efficient glazing to keep heat in during the colder months and to keep heat out during the warmer months. Most of the windows are in poor condition and would require extensive rehabilitation or replacement regardless of energy efficiency concerns. As the windows are an important architectural feature of the building, they will need to be rehabilitated to NPS Standards.
- Granite headers over the first floor windows are mostly in good condition. Several are cracked, and will require either epoxy-dowel repair or in-kind replacement. Arched masonry openings over second floor windows also require spot repairs and repointing.
- The building has four load-bearing masonry walls. At the east end of the building the structure ties into the end wall of Building 4, transferring both gravity and lateral loads into that wall and building.

A roof truss near the west gable end carries much of the gravity load of the roof, but part of the Building 2 roof ties into the wall in other locations.

- The brick masonry exterior is in fair condition, in need of widespread repointing and repair of loose and missing brick. Rising damp is a problem at Building 3, as it is at all structures.
- As with the other buildings at the complex there is a problem with site drainage that is affecting the first ten to twelve courses of brick above the foundation.

Adaptive reuse potential:

- This building is the second-most complex structure of all the buildings assessed in this project scope. The later addition of another floor to the building creates more discontinuities that need to be repaired. It's much smaller size and more "in-line" load path at the north and south walls makes it less complicated to rehabilitate than Building 2.
- Second-floor floor plan provides less than optimal assembly space because existing roof trusses interrupt each bay near the sides of the building. Office space could be a possible occupancy, with individual offices or rooms placed within each truss bay and a wider, open central space.
- Ground-level access provides potential to sustain a wide range of occupancies, including components large-scale assembly combined with the other adjacent buildings, with minimal egress and accessibility issues. This structure could perhaps serve as auxiliary space to neighboring Buildings 2 and 4, potentially including service and egress functions.
- Space is relatively straightforward to subdivide, if necessary on the upper floor.
- Open access to the structural components permits relatively simple structural strengthening techniques that will be repetitive in nature. Structural strengthening will require the analysis of many different isolated framing conditions created as the building was modified over time.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing.
- Strengthen existing roof structure as required, particularly near potential drift areas, and to resist wind uplift.
- Repair or replace existing wood windows with thermally efficient units that meet National Park Service Standards.
- Strengthen second floor framing to adequately support contemporary code required loads for the intended occupancy, if required.
- Repair or replace existing granite lintels at first floor level as required, and Repair or replace granite window sills (first floor) and wood sills (second floor).
- Repair the bearing wall between Building 2 and Building 3, and Building 3 and Building 4.
- Provide lateral bracing or reinforcement as required.
- Rehabilitate the masonry, paying specific attention to details between the first and second floors, and at the top plate of the second floor.

4.4 Building 4 – Foundry, 1895

Structure and Building Envelope Description:

- 16,500+/- square foot footprint, single story structure with center clerestory and continuous rooftop monitor. A part of the south part of the building is two stories, and ties into the more recent Building 5 along the east and south elevations.
- Building is a relatively early example of "steel mill building construction", and served the purpose as a foundry. Second floor walls along the south side of the building are constructed of multi-wythe brick masonry.
- Two rows of steel or iron columns support the side bay roofs and a continuous crane rail. A spliced upper column, outboard of the crane rail, is tied into longitudinal metal trusses.
- Building has unreinforced multi-wythe brick masonry perimeter screen (not bearing) walls on the north and south sides.
- A concrete masonry block wall replaced the brick masonry wall at building's east end. The east end was removed and replaced with a more recent extension incorporated into Building 5.
- North and south wall columns are partially exposed on the interior and exterior. The columns consist of four angles joined together with steel lacing bars.
- Extensive wood window glazing on north and south walls, clerestory, and monitor allow significant natural light into the building. First floor windows are double-width, with shallow arch tops and 16/16 light sash. Clerestory window sash are 30-light, single-sash windows that were likely operable
- Roof surfacing partially observed, appears to be metal roofing along the north side bay and rubber membrane on the upper bays and south side, as visible from satellite photos and site observations.

Observations and Evaluation:

- The building is a relatively early example of "steel mill building" construction, in which steel or iron becomes the primary roof support material. Texts written in that time period detail that the four-angle, laced lower columns are intended for "light loading" which would certainly be the case in a hot foundry structure.

COLUMNS.—The common forms of columns used in mill buildings are shown in Fig. 98. For side columns where the loads are not excessive, column (g) composed of four angles laced is probably the best. In this column a large radius of gyration about an axis at right angles to the direction of the wind is obtained with a small amount

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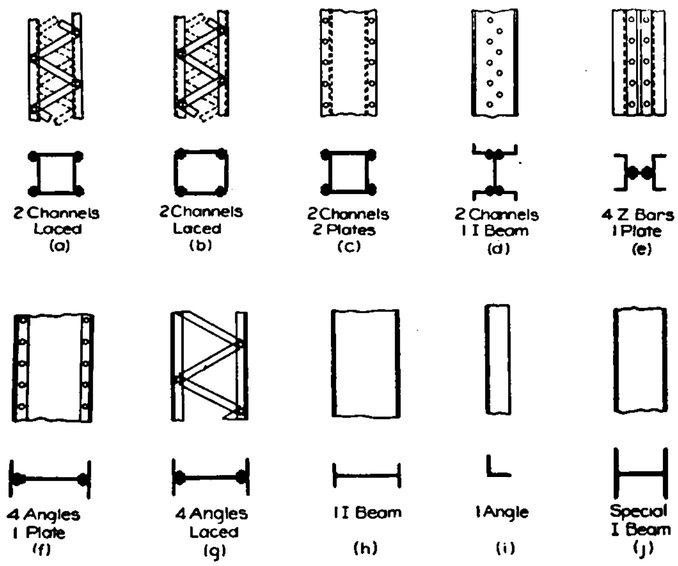
of metal. The lacing should be designed to take the shear, and should be replaced by a plate, (f) Fig. 98, where the shear is excessive, or where the bending moment developed at the base of the column requires the use of excessive flanges. The I beam column (h) makes a good side column where proper connections are made, and is commonly used for end columns (see Fig. 81). The best corner column is made of an equal legged angle with 4, 5 or 6-in. legs, (i) Fig. 98. Details for the bases of the three columns above described are shown in Fig. 99.



Types of Mill Building Columns form Milo Ketchum Text "The Design of Steel Mill Buildings". Column "g" (bottom row, second from left) is the type of column used in Building 4.

- The building design is similar in design to Building 1, if not completely similar in framing. Both buildings feature large banks of window glass to allow in natural light and provide ventilation. Building 1 relies upon interior bearing on masonry walls at the side bays, rather than on an iron or steel column exposed to external elements and rising damp. Later steel mill buildings, like Building 1, likely evolved from structural designs of earlier steel mill buildings, like Building 4, using more durable structural details.
- The laced angle side bay columns are in poor condition and have failed from a structural standpoint. They will need to be substantially repaired, or likely replaced. The columns are likely realizing some remaining axial capacity due to friction and incidental bond between the corroded steel and the masonry bed joints.
- The condition of the structure, particularly of the partially-exposed, corroded columns presents a complex preservation problem. Should one re-create a building detail that is faulty by design and

ill-suited for a marine-industrial environment, in the interest of authenticity and preservation? Or should a stronger structural column be placed within a new economical curtain wall built of concrete masonry, insulated appropriately, and clad on the interior and exterior with bricks? Could a less thermally-conductive substitute material fill the vertical control joints between the bricks on both faces of the wall to match the appearance of the original column? National Parks Service Preservation Brief 16, *The Use of Substitute Materials on Historic Building Exteriors* addresses some of these concerns. While the repair and conservation of original fabric is of utmost importance in preservation practice, certain building conditions and costs can justify the use of substitute materials.

- Responsible preservation practice also requires design professionals to consider the longevity of any repair or rehabilitation techniques that they specify. Future environmental exposure (marine environment atmosphere, splashback from de-icing salts) maintenance considerations (snow plowing, leaf or sand-blowing) could all undermine a designer's decision to use, for example, galvanized steel columns that replicate the original. One only needs to think about the considerable painting maintenance that all steel-framed parking structures need to undergo to understand the effects of the environment. Re-creating a failed structural detail that provides no true access to maintenance could be considered a failure of preservation to address practicality.
- The double-wide, shallow arch windows illustrate that the north and south walls were not intended to be significant load bearing elements. The side bay trusses bear directly onto plates supported by the tops of the laced angle columns, and the masonry between them was infilled. This construction technique was a major selling point of the steel mill building companies, many of which were major bridge companies. Bridge companies that branched out into steel mill building construction included American Bridge Company and the Pittsburg Bridge Company. The American Bridge company had a sales office in Portland in 1904 (as advertised in Kidder's Handbook), but we have yet to determine if they were present in 1895. In fact, at the time of publication of his *Steel Mill Buildings* text, Milo Ketchum served as the Contracting Manager for American Bridge Company's Kansas City office.
- The beams and trusses must be analyzed for snow load capacity, and the vertically-sawn, wide-board decking above the beams will need to be replaced at deteriorated areas, especially along the eaves. We were not able to measure the sheathing thickness, but its deteriorated appearance and frequent visible instances of failure causes us to believe that it does not provide an adequate diaphragm to transfer lateral loads, and it likely does not have sufficient nailing to resist code-required wind uplift forces. It is possible that all of the roof sheathing in this building may need to be replaced. Salvageable sheathing could be milled into finish trim lumber or reinstalled on shorter spans below the structural diaphragm sheathing above.
- The structure is one of the more consistently framed buildings in the complex, aside from the large concrete block wall that supports Building 5. There are fewer variations in the framing as the uniform steel components were economically mass fabricated.
- Wood frame windows allow significant natural light into the building. The single-pane glazing lacks significant thermal resistance, and would likely need to be replaced with more energy-efficient glazing to keep heat in during the colder months and to keep heat out during the warmer months. Most of the windows are in poor condition and would require extensive rehabilitation or replacement regardless of energy efficiency concerns. As the windows are an important architectural feature of the building, they will need to be rehabilitated to NPS Standards.
- Shallow arch headers over the first floor windows should be spot repaired.
- The brick masonry exterior is in fair to poor condition, in need of widespread repointing and removal at the deteriorated columns. Rising damp is a problem at Building 4, as it is at all structures, especially along the north wall.

- As with the other buildings at the complex there is a problem with site drainage that is affecting the first ten to twelve courses of brick above the foundation.

Adaptive reuse potential:

- It appears that much of the concrete masonry wall and Building 5 extension could be removed if the goal were to preserve Building 4. This would require temporary shoring of Building 4 and rebuilding the south wall to resemble the original south wall (or modified new south wall)
- Ground-level access provides potential to sustain a wide range of occupancies, including large-scale assembly, with minimal egress and accessibility issues.
- Space is relatively straightforward to subdivide, if necessary.
- Like Building 1, an infill floor could be installed independent of or in support of the existing structure to add space or lateral support.
- Open access to the structural components permits relatively simple structural strengthening techniques that will be repetitive in nature. Structural strengthening will require the analysis of many different isolated framing conditions created as the building was modified over time.

Recommended Building Envelope and Structural Rehabilitation Scope:

- As a first step, explore the feasibility of making structural modifications that meet Historic Tax Credit criteria by consulting with the National Park Service.
- Shore and stabilize the structure as required to address south and north wall column deficiencies. Shore and stabilize building as required to replace concrete masonry walls at the east end of the building, and to rebuild the east gable wall to resemble conditions from the period of historic significance.
- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing.
- Strengthen existing roof structure as required, particularly near potential drift areas, and to resist wind uplift.
- Repair or replace existing wood windows with thermally efficient units that meet National Park Service Standards.
- Repair the bearing wall between Building 3 and Building 4, and the curtain walls on the north and south sides of the building.

4.5 Building 6B – Blacksmith Shop, c. 1896-1904

Structure and Building Envelope Description:

- 6,500+/- square foot footprint, single story structure with relatively steep timber-framed roof and trapezoidal wood-framed shed addition at north side. We did not access the north side addition.
- Timber frame structure has nine interior roof bays along the length of the building (Photo #6B7). Building has ten interior bays spaced at regular intervals.
- Main part of structure lacks interior timber columns. All queen-rod trusses bear on masonry piers or upon timber plates on masonry.
- Exterior masonry features brick piers that extend one wythe beyond the primary masonry field, creating a rhythmic façade that illustrates the pattern of the structural roof framing.
- Large, tall windows, fairly low to the ground, provide excellent natural light. Most windows on the south elevation have been boarded over.
- Three-tab brick-colored asphalt shingles clad the roof, and appear to be in good condition.
- Fiberboard eave trim has completely failed.

Observations and Evaluation:

- We concur with the BSE assertion that repairs need to be performed to temporarily support the wall framing at the Building 6 and Building 6B intersection.
- Extensive water infiltration at the top of the wall is resulting in the degradation of the setting mortar and loose bricks. The brick has widespread open and failed mortar joints.
- The treatment of the masonry is tied to correcting defects in the roofing. The mortar in the courses directly below the roof is deteriorated from water infiltration and as a result the upper courses of brick are loose. Resetting the upper courses of brick may be required.
- Trusses appear to be generally in good to fair condition. However, the bearing conditions at the ends are questionable, due to the eave conditions that have caused significant water infiltration onto the upper masonry. Truss ends and bearing points should be assessed individually to confirm that no rot is present.
- Roof rafters and purlins are undersized. Supplemental rafters are required, and purlins should be intermediately supported to shorten their span. If excessive deflection has already occurred in the rafters, it will be more complex, but not insurmountable, to sister the rafters. A longitudinal bracing system, made clearly distinctive from the original structure, could transfer loads from the center of the purlins to the bottom chord of the queen rod trusses, leaving the purlins in place.

Adaptive reuse potential:

- The building is a short, easily accessed structure with a sloped roof that could easily be repaired. The ample windows allow significant natural light, and the long, regular structure could easily be converted into multiple units.
- Ground-level access provides potential to sustain a wide range of occupancies, including large-scale assembly, with minimal egress and accessibility issues.
- Space is relatively straightforward to subdivide, if necessary.
- Open access to the structural components permits relatively simple structural strengthening techniques that will be repetitive in nature. Structural strengthening will require the analysis of many different isolated framing conditions, particularly at the truss eaves.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Make necessary temporary and permanent stabilizations and repairs at the wall between Building 6 and Building 6B.

- Investigate the top of the brick walls to determine extent of mortar deterioration.
- Investigate the end bearing of the trusses and the top plate of the wall to determine if replacement is needed.
- Strengthen roof rafters, as is likely necessary.
- Analyze the original mortar to determine the type of binder and ratio of aggregate used.
- Remove and reset loos sections of brick.
- Repoint 100% of the exterior walls with a mortar that matches the properties and appearance of the original mortar.
- Replace non-matching modern granite sills with sills that match the existing.
- Perform necessary structural upgrades.

4.6 Building 7 – Car Shop, c. 1873, 1904

Structure and Building Envelope Description:

- The building appears to have been originally a long rectangular structure (Photo #7.1 and Photo #7.2), supplemented later on by a shed addition on the south side (Photo #7.5). We did not access the south side addition, which apparently served as a lumber shed.
- The single-story building has perimeter loadbearing masonry walls, and some interior loadbearing masonry partition walls.
- Shallow brick arch lintels top the windows, and granite sills are located at the base of the openings.
- The interior timber frame supports a low-pitched roof. The roof rafters at the center of the structure are rectangular rafters topped with a sloped shim piece (Photo #7.5). The rafters have long spans placing substantial weight on the masonry side walls.
- A combination of membrane and asphalt roofing covers the structure (Photo #7.9).
- Many large openings have been cut into the side bearing walls (Photo #7.1, #7.2, and #7.3).

Observations and Evaluation:

- There appears to have been significant water infiltration from defects in the roof into the brickwork at the top of the wall. The mortar in the upper courses, just below the shallow eaves, is deteriorated as a result of the water infiltration. A similar condition exists at the bottom of the wall where rising damp has deteriorated the mortar in the brick courses just above grade.
- The outer wythes are bowing and detached from the inner wythes at the brick panels between the windows on the south elevation (Photo #7.8, Photo #7.10).
- There are a significant number of cracked and damaged bricks as well as bricks that have been repaired in the past with the same cement rich pointing mortar used to point the bricks.
- There is some corrosion and brick jacking at the steel lintels installed at the newer openings into the building.
- The roof framing is in poor condition and is undersized. In many locations, water infiltration appears to have caused framing rot, and there is likely significant top wall plate rot at the eaves (Photo #7.7). In a few places, we could see daylight through the rotted roof sheathing and failed surfacing.
- The finish grade around the shed addition (Photo #7.4) appears to direct roof runoff back to the base of the south wall.

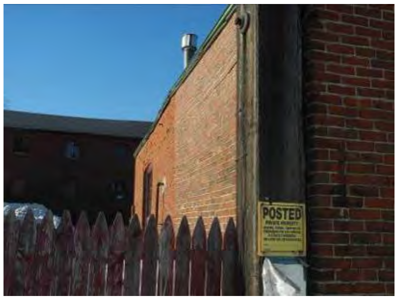
Adaptive Reuse Potential:

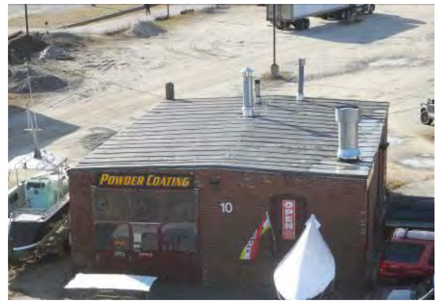
- The building is in poor condition. While its spaces could be rehabilitated and converted to a wide variety of uses, it would likely need to be almost completely rebuilt. The overall condition of the structure would likely dictate that it be placed on new foundations.

Recommended Rehabilitation Scope:

- Comprehensive rebuilding of the existing perimeter loadbearing walls, roof surface and sheathing removal and replacement, significant roof framing strengthening and/or replacement; essentially demolition and reconstruction on the same footprint.

4.7 Building 10 – Paint Shop, 1873





Structure and Building Envelope Description:

- 1,350 square foot footprint, single story (Photo #10.1);
- Unreinforced multi-wythe brick masonry perimeter bearing walls;
- Numerous infilled brick windows and enlarged door openings (Photo #10.3, #10.6, #10.8);
- west masonry wall has been partially rebuilt and is currently structurally unstable (Photo #10.3, #10.9);
- Some wood-framed window glazing on north and west walls;
- Battened membrane roof with numerous patches and ponding (Photo #10.2), indicating that the rafters have sagged significantly or rotted near the eaves.

Observations and Evaluation:

- We were unable to access the building interior.
- Upper roof surfacing consists of battened roof membrane, in fair to poor condition. The roof appears to be insulated, judging from conditions viewed through one of the windows.
- The masonry walls are in poor condition, with the west wall in unstable condition. This wall is in sufficiently unstable condition to warrant vacating the building, as stated in the Becker report.
- Roof framing was not visible but reportedly consists of wood rafters. It is possible that the rafters have tapered wedges placed atop each joist to create the very shallow roof pitch, as was done in Building 7 (see Photo #7.5), built around the same time.

Adaptive Reuse Potential:

- The building has a little adaptive reuse potential, due to its overall poor condition. Rehabilitating the structure would require significant time and effort, which may not be economically feasible when compared to a rebuilt structure on the same footprint.
- If the building were rebuilt, it would have to thoroughly comply with all contemporary code requirements for new construction, including foundation design.
- Reconstructing a new building to match the building during its period of historical significance is possible, depending upon future site use.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Demolish and rebuild existing walls, roof, and foundation.
- Rebuild structure to match period of historic significance, using windows that meet National Park Service Standards and building systems complying with building codes for new construction.

4.8 Building 11 – Pattern Storehouse, 1885

Structure and Building Envelope Description:

- Irregularly shaped, approximately 4,600 square foot footprint, two stories (Photo #11.1)
- Timber-framed interior with reported four-foot deep crawl space below first floor.
- Unreinforced multi-wythe brick masonry perimeter bearing walls on four sides. Building 12 upper wall appears to have been built on top of Building 11 South wall.
- Nearly-flat roof framing, pitched to the south and the north by stacking timber crib pieces beneath roof rafters (Photo #11.7 through #11.10)
- Roof appears to pitch two ways, to the east and to the west, at the intersection with the upper wall of Building 12.
- Relatively little number of wood window openings per square foot of wall.
- Climbing hillside at Fore Street drains runoff to the base of the north wall, several feet above the first floor (Photo #11.3).

Observations and Evaluation:

- We did not access the reported crawl space below the first floor. Given our experience working on structures with significant quantities of runoff pitched toward them, combined with the significant bow in the north wall, we believe that the first floor framing is probably rotting near the north wall, and no longer bracing it.
- The north masonry wall has failed (Photo #11.3, #11.5). Lateral earth pressures and possible first floor framing rot have caused the wall to bulge inward several inches. We believe that this condition creates as significant concern as the wall conditions at Building 10, and that the building should be vacated until this condition is evaluated and repaired.
- We observed evidence of a perimeter drain along the north elevation, but we were unable to confirm if it is operable.
- Roof framing consists of timber framing. The roof framing members are cribbed off of the columns at various heights to create a central ridge and adjacent slopes. This roofing system cannot transfer diaphragm loads from the roof into the timber frames below.
- The west and north unreinforced brick masonry walls are in good to fair condition. Much of the masonry requires repointing, particularly near the west elevation ground level.
- We observed active roof leaking into barrels placed on the second floor (Photo #11.8).
- The bottom masonry on the north side of the building is in poor condition due to raised grade and likely saturation from snow accumulation, rising damp, and poor site drainage.
- There appears to have been some relatively structural reinforcement to a girder tying into the common wall between Building 11 and Building 12 (Photo #11.10).
- The high roof of building 12 presents a significant potential for snow drifting (Photo #11.1, #11.2) Runoff from both roofs drains from the wall at the building junction (Photo #11.2). Previous masonry repointing repairs attempted to solve the problem, but only temporarily eliminated the symptoms.

Adaptive Reuse Potential:

- The building has a relatively short floor-to floor height between the first and second floors. Combined with the lack of windows, the ground floor space feels confining and may not be suitable for occupancies that require substantial daylight. It could become a future tenant storage area if structural concerns are addressed.
- The lack of windows results from the use as a pattern storehouse, to minimize potential draft situations in the event of a fire.
- The second floor space, despite the relative lack of windows, appears to be brighter and amenable to different commercial occupancies, if the egress were improved.

- The structural failure of the north wall presents a significant economic concern that could be an obstacle to building rehabilitation.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Shore building and rebuild north masonry wall. This will likely require excavation along the base of the north wall, and slope stabilization further back toward Fore Street. Additional work will likely be required to confirm condition of first floor framing.
- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking. Provide legitimate connections to transfer forces from upper roof through cribbing to the tops of posts, and to the tops of walls.
- Insulate roof, and resurface with proper edge flashing and counterflashing. Reconsider relationship of roof against Building 12, because splashing and snow drift will likely continue to cause structural problems along this wall.
- Strengthen existing roof structure as required, particularly near potential drift areas.
- Strengthen existing roof structure as required to provide wind uplift resistance and to transfer lateral loads through roof.
- Repair or replace existing wood windows with thermally efficient units that meet National Park Service Standards.

4.9 Building 14—Drafting Room & Storehouse, 1858-64

Structure and Building Envelope Description:

- Undetermined square foot footprint, two story (Photo #14.1)
- A shared end wall with Building 15/16.
- Wood construction at south-facing wall; use of site retaining wall buttresses for lower side walls at east and west ends (Photo #14.3, Photo #14.4).
- The wood-framed façade has more recently been re-sided, and the some windows replaced.
- A bridge leads from Building 14 to the second floor of Building 3 is in poor condition, but not assessed as part of this survey. (Photo #14.1). A bridge between Building 2 or Building 58 connects the second floor "Map Room" to the Building third floor drafting shop (Photo #14.2).

Observations and Evaluation:

- Upper roof surfacing consists of ballasted rolled asphalt, in good to fair condition. The roof is possibly insulated in some areas, but we could not determine the extent.
- Roof framing consists of timber king post trusses, purlins, and rafters. The rafters, purlins, and trusses must be analyzed for snow load capacity, and the decking above the beams will need to be replaced at deteriorated areas.
- We were not able to measure the sheathing thickness, but it likely does not provide an adequate diaphragm to transfer lateral loads, and it likely does not have sufficient nailing to resist code-required wind uplift forces.
- The current tenant reports that warm-weather condensation is prevalent, as the heat in the building rises to the peak at the Fore Street masonry wall. The condition at the top of the Fore Street wall should be assessed to provide appropriate insulation and weather protection.

Adaptive Reuse Potential:

- Ground-level access to second floor (from 58 Fore St.) and from alleyway provides potential to sustain a wide range of business occupancies, including mercantile, office, and artists' studios, with some thought to egress and accessibility issues. This structure, along with that of Building 15/16 presents a configuration almost unique within the City of Portland. While the structures do not engage Fore Street, they create a unique alleyway on the north side of the site. Properly secured and lighted, it could present unique occupancy opportunities.
- Lateral stone walls provide fire separation between individual units if second-floor walls above are outfitted with appropriate fire-rated doors.
- Reconstruction of the south elevation to its original appearance would address identified deficiencies in the wood façade and improve the overall lateral stability of the building.
- Exposed rubble stone walls, if properly repaired, could become a unique architectural feature of the interior spaces.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing. Develop a method to insulate the uppermost wall near Fore Street to protect against water and air infiltration.
- Strengthen existing roof structure as required.
- Strengthen existing roof structure as required to provide wind uplift resistance and to transfer lateral loads through roof.

- Repair/ replace existing wood windows with thermally efficient units that meet National Park Service Standards.
- Rebuild the south first-floor elevation to match period of historic significance and to strengthen lateral capacity of south wall.

4.10 Building 15/16 – Boiler House/Brass Foundry, 1858,1864

Structure and Building Envelope Description:

- Small (unknown area), two-story structure with conventional lumber framing (15) and unreinforced multi-wythe brick masonry bearing wall (16) along the south (alley) elevation. Building 16 also has an infill wooden partition below a steel beam that previously created a large door opening. Refer to photos #16.1 and #16.2.
- Brick vaults reportedly extend from Building #15 beneath the Fore Street sidewalk. We did not observe these vaults.
- Rubble dry-stacked retaining walls exist at north, west and east elevations. At Building 16, it appears that water penetrates the wall or has in the past.
- Back wall (north wall) is large stone masonry retaining wall supporting hillside at Fore Street.
- Mono-pitch wood-framed roof slopes down toward the south (alley-facing) wall.
- Two-wythe brick masonry front wall features a mixture of granite (likely original) brick, and steel or iron headers on the window and door openings.
- The remnants of the Boiler House chimney base remain between Building 15 and Building 16.
- A large standpipe at east end of building.

Observations and Evaluation:

- The wooden and brick masonry walls of both buildings are in poor condition.
- The chimney base bricks should be checked and stabilized in place.
- Timber and lumber roof framing at Building 16 is undersized for contemporary snow loads.

Adaptive Reuse Potential:

- The building's current use is as a blacksmith's forge, a use not dissimilar to its original purpose as a brass foundry. It may be necessary to rebuild most of the Building 15 framing. In that case, Building 15 would likely need to conform to contemporary code requirements for new structures. From a preservation standpoint, the blacksmith occupancy is likely to be considered as the best and highest use of the structure.
- Open access to framing in Building 16 permits relatively simple structural strengthening techniques. We assume that much of the Building 15 structure will need to be rebuilt.
- As discussed in the Building 14 section, this structure provides opportunities for unique occupancies if properly secured and lighted.

Recommended Building Envelope and Structural Rehabilitation Scope:

- Strip existing roofing, repair damaged sheathing, and add a structural diaphragm, consisting either of plywood sheathing or metal decking above the interior exposed roof decking.
- Insulate roof, and resurface with proper edge flashing and counterflashing.
- Strengthen or rebuild existing roof structure as required, particularly near potential drift areas.
- Strengthen existing roof structure as required to provide wind uplift resistance and to transfer lateral loads through roof.
- Repair or replace existing doors and windows with thermally efficient units that meet National Park Service Standards.
- Repair/replace existing steel lintels with properly galvanized, painted or prepared/painted steel.
- Rebuild the south elevation and Building 15 timber or lumber structures as required.
- Rehabilitate brick masonry front wall of Building 16, to match period of historic significance.
- Improve site drainage and grading around the alley and hillside.

5.0 RECOMMENDATIONS AND CONCLUSION

The individual structures within the Portland Company complex that were included in the project scope are in generally poor condition due to deferred maintenance and, in some cases, inherent but correctable lack of stability against lateral forces and snow loads. The severity of deterioration varies from building to building; it also varies within any given building. In some cases, significant deterioration is quite localized; in other cases, the overall structure is in a state of significant disrepair.

Buildings in poor condition do not necessarily warrant demolition. The fact that a number of the buildings within the Portland Company complex continue to be occupied—some by large assemblies for special events and some by business tenants--attests to the fact that most of the buildings are still serviceable and are in salvageable condition.

In our opinion, it is possible to address the identified structural and building envelope conditions in ways that retain each building's historic character and that are feasible from a cost perspective. To do so, however, will require case-by-case assessment, creative design solutions, and the involvement of consultants and contractors experienced in historic building rehabilitation.

We concur with many of the primary findings of the Becker Structural Engineers report as to the current condition of the individual buildings. We believe, however, that the simplified construction techniques that characterize these buildings together with the repetitive nature of many of the required repairs make possible a relatively straightforward rehabilitation project. These attributes also present an opportunity to improve lateral stability of the building within contemporary code requirements while making other repairs. The simple, modular nature of the long buildings allows for replication of the individual structural repair details. The exposed floor and roof structures provide easy access to make repairs. The limited hidden conditions lower the need to include large cost contingency factors for structural upgrades. In summary, most of the building structures are not that complicated when compared to many other historic commercial building rehabilitation projects undertaken in Portland and in Maine during the last quarter century. With proper planning, specification, and construction administration, most of the existing structures can be rehabilitated by contractors trained in preservation work, primarily in masonry rehabilitation and timber framing. Appropriate planning, engineering, and site inspection will need to occur to ensure the proper execution of the repairs.

In our opinion, three structures stand out as buildings presenting the greatest structural and building envelope challenges. The buildings in the worst condition include Building 7 (Car Shop) #10 (Paint Shop), and 11 (Pattern Storehouse). The immediate safety concerns identified by Becker Structural Engineers at the wall between buildings 6A/6B, and of the overall condition of Building 10, are valid concerns and should be addressed as soon as possible. Stabilizing the wall and roof framing between 6A and 6B can be performed as a stand-alone project prior to other rehabilitation of these buildings. Additionally, Building 11 should not be occupied due to lateral pressures exerted by soil and snow against the north wall.

It has been a pleasure to assist you with this project. If you have any further questions about the content of this report, please feel free to contact me at your convenience.

Sincerely,

Alfred H. Hodson III, P.E.
Resurgence Engineering and Preservation, Inc.

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APPENDIX A

RELATIVE STRUCTURAL CONDITION AND
RELATIVE REHABILITATION COSTS
RESURGENCE ENGINEERING AND
BECKER STRUCTURAL ENGINEERS

APPENDIX A
Portland Company Complex – March 2015
Relative Condition and Rehabilitation Cost Comparison

BUILDING NUMBER – NAME DATE	RELATIVE STRUCTURAL CONDITON			RELATIVE REHABILITATION COST	
	BECKER	RESURGENCE /BECKER SCALE	RESURGENCE SCALE	BECKER	RESURGENCE
BUILDING 1 - ERECTING BUILDING 1918	2.0	2.5 (REPETITIVE DTLS)	P2	4.0	3.5 (REPETITIVE DTLS)
BUILDING 2 - MACHINE SHOP 1847	2.5	2.5	P2+	4.5	4.5
BUILDING 3 - MACHINE SHOP 1847	3.0	3.0	P2+	3.0	3.0
BUILDING 4 – FOUNDRY/ACETYLENE HS 1895, 1904-09	1.5	1.5	VP2	4.5	4.0 (REPETITIVE DETAILS, CUSTOM REHABILITATION)
BUILDING 6B - TANK SHOP 1896-1904	3.0	3.0	P2+	3.5	3.5
BUILDING 7 - CAR SHOP 1873,1904	2.0	1.5 (BOWED WALLS)	VP1	5.0	5.0
BUILDING 10 - PAINT SHOP 1873	1.0	1.0	VP1	4.5	4.0 (REBUILD IN KIND)
BUILDING 11 - PATTERN STOREHOUSE 1885	2.5	2.0 (NORTH WALL)	VP2	4.5	4.5
BUILDING 14 – DRAFTING ROOM AND STOREHOUSE 1858,1864	NOT INSPECTED	2.0	VP3	NOT INSPECTED	3.5
BUILDING 15/16 (NO ACCESS TO B15) BOILER HOUSE/BRASS FOUNDRY 1858, 1864	1.5	1.5	VP3	3.0	3.0
Averages of common buildings inspected (excluding Building 14)	2.11	2.06		4.06	3.89

SEE FOLLOWING PAGES FOR EXPLANATION OF BECKER STRUCTURAL ENGINEERS AND RESURGENCE ENGINEERING RATING SYSTEMS

Notes:

1. Coordinate this document with "Portland Company Complex General Building Assessment" prepared by Resurgence Engineering et al, March 2015, and "Evaluation of Existing Buildings at the Portland Company Property" prepared by Becker Structural Engineers, March 28, 2014.
2. Further discussion about relative rehabilitation costs related to these structures, by Resurgence Engineering, follows this page.

APPENDIX A
EXPLANATION OF BECKER AND RESURGENCE RATING SYSTEMS

Becker Structural Engineers' (BSE) Rating System

The **relative structural conditions** rating system used in the Becker Structural Engineers Report is shown below:

1 = Very poor/unsafe/demolition likely
2 = Very poor/salvageable with significant structural rework and investment/questionable economic viability/consider demolition
3 = Poor/requires substantial structural work to elements and systems
4 = Fair/requires nominal structural work to elements
5 = Good condition/minor structural work required

Becker's **relative rehabilitation cost rating system** is based upon structural complexity and size of building, using a scale of 1 to 5 -- 1 being relatively low costs and 5 being relatively high costs. BSE gives no specific definitions of the relative costs, simply a numerical grading system. Such an approach appears to be reasonable, given the preliminary nature of assessment that both firms were instructed to provide.

Resurgence Engineering and Preservation's (REP) Rating System

For ease of comparison, REP used the same **relative structural conditions rating system** as BSE in the summary chart. However, REP believes there is a more accurate and further defined way to classify the buildings in terms of condition. *See chart on following page for REP's proposed rating system as regards condition.*

REP has used the same **relative rehabilitation cost rating system** as BSE. The BSE report provided no specific definition of cost for each rating category.

RESURGENCE ENGINEERING RELATIVE STRUCTURAL CONDITION SCALE OF EXISTING BUILDINGS IN POOR CONDITION

BSE condition #	REP NUMBER	DESCRIPTION OF CONDITION, PRE AND POST MITIGATION	LOCAL/MAINE BUILDING EXAMPLES PRE AND POST MITIGATION
(n/a)	VP1 (very poor, not salvageable)	PRE: Immediate <u>widespread public safety threat and site/occupant safety threat</u> if not barricaded and structurally shored; evacuate nearby buildings, streets, sidewalks, block off parking spaces. Potential for widespread debris field in event of collapse; Building cannot be re-occupied following triggering event. POST: Condemn and demolish building.	Buildings with extensive fire damage
1	VP2 (very poor but salvageable, expensive to rehabilitate, i.e. approx.. BSE cost #4 to #5)	PRE: Immediate <u>widespread public safety threat and site/occupant safety threat</u> if not barricaded and structurally shored; evacuate nearby buildings, streets, sidewalks, block off parking spaces. Potential for widespread debris field in event of collapse; Building cannot be re-occupied following triggering event. POST: Building assessed, barricaded, structurally shored; nearby buildings deemed safe for return; streets, and/or sidewalks and parking spots remain blocked off. Building itself cannot be occupied after stabilization. Unsafe for rescue personnel to enter if trespassers are inside. Shored and secured structure relatively expensive, but feasible, to rehabilitate.	PRE: Norway Opera House, 2007-09 POST: Norway Opera House, 2010+
1	VP3 (very poor but salvageable, moderately expensive to rehab, i.e. BSE cost #3 to 4)	PRE*:* ***Immediate*** <u>site/occupant</u> safety threat and <u>localized public safety threat</u> if not if not barricaded and structurally shored; Block off streets, sidewalks, and parking spaces. Potential for localized debris field in event of collapse; Building can be occupied following the triggering event. POST: Building assessed, barricaded, structurally shored; nearby buildings deemed safe for return; streets, and/or sidewalks and parking spots can remain blocked off or reopened following mitigation. Building itself can be occupied.	PRE: Buildings with widespread loose façade components. i.e. Masonic Temple Localized structural failures i.e. Portland Company Complex Building 4 POST: Stabilized structures, removing loose components or installing covered sidewalk and blocked off parking spaces.
2	P1 (very poor but salvageable, less expensive to rehab; i.e. BSE cost #2)	PRE: ***Likely*** <u>site/occupant</u> safety threat and <u>localized public safety threat</u> if not if not barricaded and structurally shored; Block off streets, sidewalks, and parking spaces. Potential for localized debris field in event of element failure; Building can be occupied following the triggering event. POST: Building assessed, barricaded, structurally shored; nearby buildings deemed safe for return; streets, and/or sidewalks and parking spots can remain blocked off or reopened following mitigation. Building itself can be resume occupancy.	PRE: Buildings with a few loose façade components that can easily be removed or snow and ice buildup that can easily and quickly be removed, POST: Stabilized structures, removing loose components or installing covered sidewalk and blocked off parking spaces.
3	P2	PRE: ***Possible*** <u>site/occupant</u> safety threat and <u>localized public safety threat</u> if not if not barricaded and structurally shored; No triggering event causing distress; possible change of use makes economics questionable. POST: Rehabilitation Feasibility Study considering economics for specific buildings and structures.	PRE: Portland Company Building Complex Building #1

Most of REP's condition and cost ratings align with those of BSE. Using our own rating system, however, REP's conclusions are slightly different, especially in regards to the potential for rehabilitating buildings in distress (i.e. Buildings with a "1" to "2" condition ranking). We would not have necessarily characterized these buildings as unsalvageable, as Becker suggests. Our justification for this would be to consider the cost benefits that could be realized using historic preservation tax credit incentives, along with the added flexibility afforded historic structures under the IEBC. Tax credit incentives could offset the costs of more custom-designed engineering and building envelope rehabilitation solutions. They would also offset the cost of higher-quality, longer lasting building materials necessary for the marine climate.

Our primary departures from BSE exist in Building 1, Building 4, Building 7, Building 10, and Building 11. We downgraded the relative structural condition of Building 7 and Building 11, while we upgraded the relative structural condition of Building 1. We lowered the relative rehabilitation costs of Building 1, Building 4, and Building 10. The paragraphs that follow explain the reason for our departure at each building.

For Building 1 we believe that the more recent construction date (1918), combined with the repetitive nature of the building elements, can allow for a slightly less expensive rehabilitation than indicated in the BSE report.

Building 4 could yield a relatively less expensive rehabilitation if a customized approach to reframing the edge columns and rebuilding the masonry could be achieved economically. Such an approach would have to be understood and approved in advance by the National Park Service if tax credits were desired on this building project. If historic preservation tax credits can be used on this project using a different approach to reframing the edge columns and rebuilding the masonry, while strengthening the existing structure, we disagree that this building is a likely candidate for demolition.

In our opinion, the condition of Building 7 is slightly worse than considered in the BSE report, because of the poor condition of the loadbearing masonry at the north elevation. We concur with the relative rehabilitation costs for the building.

We depart from the BSE cost condition assessment of Building 10, only in the sense that it may make the most economic sense to demolish the existing structure.

The compromised north wall at Building 11 necessitates downgrading its condition from 2.5 to 2.0 in comparison to the BSE report. We recommend that the building remain unoccupied until the north wall is stabilized. Demolition of this structure may be warranted pending further understanding of the roof framing and first floor framing conditions.

As stated in the BSE report, immediate safety concerns need to be addressed, whether as isolated repairs (Building 6A/6B common wall and truss) or comprehensive measures (vacancy of Building 11).

Basis for Cost Opinion Conclusions for Each Building

Building 1 - Erecting Building, c.1918

Relative rehabilitation costs for this structure and building envelope are based primarily upon the fact that the structure is repetitive in construction technique, offset by the likely reconstruction of the front masonry (west) wall. The staging and access cost required to perform clerestory rehabilitation from interior and exterior will be an increasing cost factor in building rehabilitation. A significant amount of steel-framed window glazing would require repair or replacement. Since this is the most recent building in the study, existing steel materials may be of higher quality and some understanding of snow loading requirements was incorporated into the design.

Building 2 – Machine Shop, c.1847

This building, the most structurally complicated and tallest within the buildings studied, would likely cost the most to rehabilitate, but could present the greatest risk/reward. The structure itself will likely take the most time to thoroughly assess from a structural and building envelope standpoint, given the number of changes that occurred over the years and the addition of the third floor. The large wooden windows on the first and second floors would be very labor intensive to rehabilitate, given the large number of individual panes. Third floor windows might not be as expensive to rehabilitate or replace, because they may have been 2:2 light sash, which were common in the early 20th century. A well thought-out temporary shoring plan is necessary to tie the cantilevered third-floor framing further back into the existing building. Third floor cladding, though high up, could be replaced relatively simply. At approximately 45 feet high and three stories, this building will be subjected to the greatest wind and seismic forces of all the buildings studied.

Building 3 – Machine Shop, c.1847

Building 3 is the second most structurally complicated building within the complex, but is not as relatively expensive to rehabilitate as Building 2. The additional floor support structure is less complicated than Building 2, lacking the cantilever framing existing at that neighboring building. The second floor also provides interior access to the much smaller clerestory, facilitating any structural work required there. The smaller overall footprint and lower percentage of glazing helps contain rehabilitation costs.

Building 4 – Foundry, c.1895

The Foundry rehabilitation work likely involves wholesale rethinking of the structure and building envelope along the exterior walls. Structural upgrades and replacement of an existing structural system that was improper for its marine, cold-weather climate may actually simplify the rehabilitation by permitting a complete column removal and replacement with contemporary steel columns, not exposed to the exterior elements. However, this more significant structural change may require the longest lead time to confirm whether the structure and building envelope modifications would be eligible to receive historic tax credits.

Building 6B – Tank Shop, c.1896-1904

Tank Shop rehabilitation is simplified because of its relatively short height, simple gable roof, and relatively small windows. Added longitudinal roof bracing can support the intermediate roof purlins between trusses and stiffen the roof against wind and seismic forces. The low roof height will likely keep the building from experiencing significant wind load increases due to height. Each one of the trusses will require further inspection, nondestructive testing and/or invasive inspection to confirm that end bearing conditions are structurally sound.

Building 7 – Car Shop, c. 1873, 1904

Although the Car Shop is a single-story structure, rehabilitation becomes complicated and more costly due to the overall poor condition and insufficient depth of the roof framing and because of the poor condition of the existing exterior masonry. The existing roof framing has such a low slope that it likely has permanent deflection "set", which will complicate efforts to strengthen the framing by sistering. Significant roof leaks in the structure have likely rotted sheathing and possibly framing, in more areas than are visible due to penetrating sunlight. The windows are not large or great in area relative to the total façade area, which would diminish the rehabilitation costs somewhat. However, the existing loadbearing masonry would likely require complete rebuilding because it is in such poor condition.

Building 10 – Paint Shop, c. 1873

Originally isolated by the remaining structures for safety purposes, the paint shop stands alone as the most significantly altered structure in the worst overall condition. Building rehabilitation is hard to justify, given the small size and poor condition. Rebuilding the structure to resemble the original during the site's period of significance, in conformance with contemporary codes, would be a more straightforward option, despite the likely required foundation upgrades.

Building 11 – Pattern Storehouse, c. 1885

The Pattern Storehouse carries with it the greatest uncertainty about rehabilitation costs. It is the only building studied that has a wood-framed first floor situated over an earthen crawl space, and it is the only structure that had the majority of its roof framing concealed by ceilings. The low-slope roof, pitching partially toward Building 12, creates drift conditions and roof runoff that are detrimental to both buildings.

Building 14 – Drafting Room and Storehouse, c. 1858-64

Tucked in between buttresses of the Fore Street retaining wall, Building 14, like the Boiler House and Brass Foundry to the immediate north, contains relatively limited floor space in a structure that is practically unique. The existing timber frame purlin and rafter system needs to be carefully assessed near the peak, as that area is vulnerable to condensation and leakage due to snow buildup and insufficient insulation.

Building 15/16 – Boiler House and Brass Foundry c.1858, 1864

We did not enter Building 15, but the visible condition of the second floor framing means the structure would likely need to be rebuilt. Building 16, the Brass Foundry, requires several of the same structural assessments and likely upgrades that Building 14 requires, as well as the rehabilitation of the small south façade.

APPENDIX B

PHOTOGRAPHS

APPENDIX C

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PHOTO #1.1 A 2 95.jpg	Building 1: View from west. Large, tall bay door has replaced original smaller overhead door and symmetrical high windows. Increased roof pitch at right side of photo appears to have been in place since late 1930s.

PHOTO #1.2 R 07.jpg	Building 1: View along south elevation looking toward Building 2, showing five bays of steel-framed windows and a small bay near Building 2. Note large crack at left, near joint with west wall.

PHOTO #1.3 A 30 86.jpg	Building 1: View from west end of upper roof, showing felt and gravel surface. Lower side roof levels, not visible, consist of rubber membrane on south side and possibly felt on the north side. Building 2 gable roof visible in background.

PHOTO #1.4 R 17.jpg	Building 1: Interior view of upper roof framing, showing flat Warren trusses, I-beam purlins, and edge and center-bead roof decking. Note rotted decking areas (arrow) and steel-framed clerestory windows.

PHOTO #1.5
R 37.jpg

Building 1: Existing rail crane is supported by girders spanning the length of the building. Rail cranes in mill buildings require offset framing at columns in order to support low roofs and upper roof framing. Note horizontal angle bracing at high roof.

PHOTO #1.6
R 32.jpg

Building 1: Rising damp at perimeter wall base, failed concrete sills, and significantly damaged steel-framed windows.

PHOTO #1.7 R 06.jpg	Building 1: Brick masonry crack, northwest corner of building. Rebuilding the west wall of the building and performing other masonry repairs can improve lateral stability of the building. .

PHOTO #1.8 maine memory ntwk	Building 1: 1938 aerial photo shows smaller-scale door opening and symmetrical windows. Rebuilding west wall to a similar configuration could strengthen wall and return elevation to its period of significance.

PHOTO #2.1 R 26.jpg	Building 2: View from southeast. Note third floor (added in 1905) cantilevered over original building cornice. Walkway to Building 6 was not assessed as part of this study.

PHOTO #2.2 A P 5.jpg	Building 2: View from southwest showing continuous third-floor shed dormer cantilevered over original roof cornice.

PHOTO #2.3
A 29 14.jpg

Building 2: View of southeast corner of building, looking up at cantilevered dormer. Note relief in brick cornice above window. A downspout likely descended from that location before the addition was built.

PHOTO #2.4
A 29 107.jpg

Building 2: Walkway from third-floor drafting room to plan vault. Walkway was not assessed as part of this project.

PHOTO #2.5 ah 1 x 0.jpg	Building 2: Metal-clad walkway extending from Building 24 (vault storage) to drafting office allowed quick access to drawings in progress and drawings from archives, without exposing drawings or draftsmen to weather conditions.

PHOTO #2.6 A 30 86.jpg	Building 2: West gable viewed from West end of Building 1. Third floor dormers extending from each side of gable require strengthening to ensure integrity of cantilevered structure. Note different dormer cladding materials.

PHOTO #2.7 R 179.jpg	Building 2: Gable end rake viewed from Building 1 roof. With proper safety precautions, much of the rake and gable peak can be repointed without extensive scaffolding.

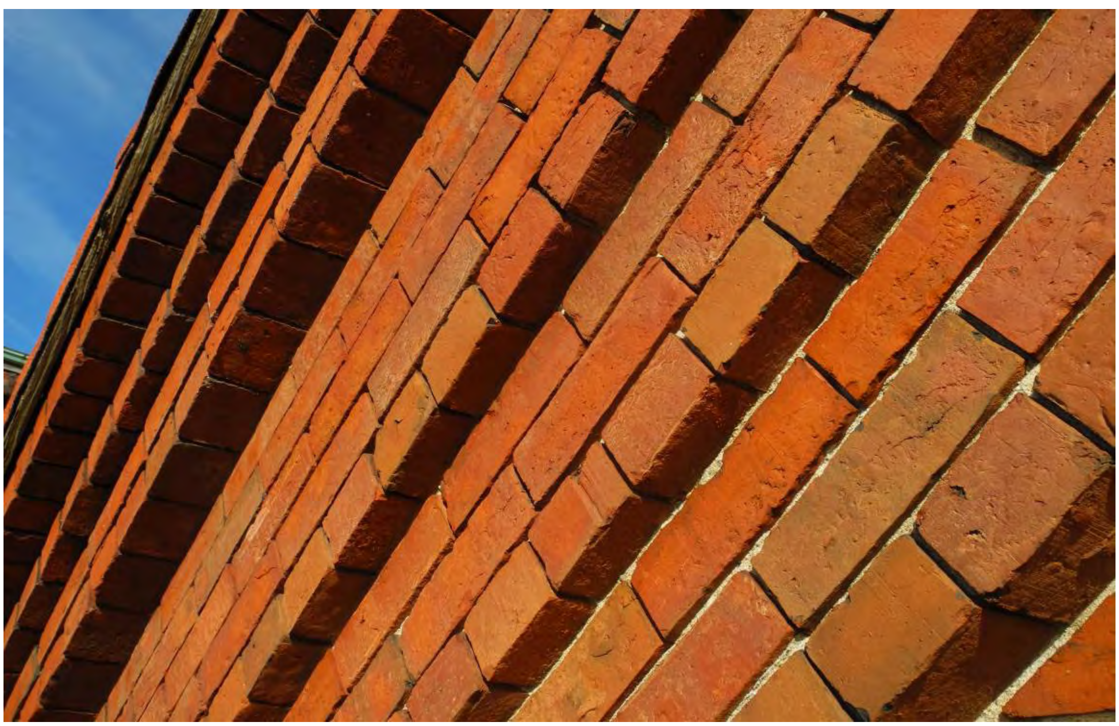

PHOTO #2.8 A 30 68.jpg	Building 2: West Gable end rake (detail) comprised of 15 courses of brick masonry corbelling out over one foot beyond outside face of primary gable end wall. Repointing required, but otherwise in good condition.

PHOTO #2.9 A 30 95.jpg	Building 2: West end of north-facing third-floor dormer. Note corroded metal siding and missing siding. 6/6 window sash is likely original.

PHOTO #2.10 R 169.jpg	Building 2: View from east end of third floor. Plastic sheeting has been used throughout to prevent roof leaks from reaching the assembly space below.

PHOTO #2.11 A 30 100.jpg	<u>Building 2</u>: 3rd floor drafting office viewed from west wall. Queen rod trusses support roof structure, and lower half of roof extends out as low-slope shed dormers, not visible in this photo.

PHOTO #2.12 A 30 55.jpg	Building 2 upper roof: Note skylights previously located along roof.

PHOTO #2.13 A 29 58.jpg	Second floor assembly area, supported below by additional cast iron and timber posts. Iron rods were used to suspend the floor from the roof trusses. Dormer cantilever floor framing has very little backspan (arrow).

PHOTO #2.14 A P 1.jpg	Second floor assembly area: In use as assembly facility, December 2014.

PHOTO #2.15
A 3 23.jpg

Building 2 (right side of wall) and Building 3 (left side of wall) share a common partition that consists primarily of 12-inch (3 wythe) brick masonry. Arrow indicates point of view from stair landing shown in Photo 2.24 below.

PHOTO #2.16
A 3 37.jpg

Building 2: Common wall with Building 3: Extensive masonry crack near second floor south door.

PHOTO #3.1
A 2 78.jpg

Building 3: View from southeast. Second floor added sometime around 1895. Unlike level added at Building 2 (at left) second floor wall consists of loadbearing brick masonry in alignment with the first-floor masonry wall.

PHOTO #3.2
A 2 73.jpg

Building 3: View from northeast showing original monitor roof extending above clerestory roof now covered in snow. Note drifting patterns developing around various roof intersections.

PHOTO #3.3 A 2 107.jpg	Building 3: View of northwest corner of building, looking up at cantilevered dormer of Building 2 (right) and clerestory of Building 3 (left).

PHOTO #3.4 A 2 63.jpg	Building 3: Walkway from second--floor space to stair landing leading to Fore Street. Walkway was not assessed as part of this project.

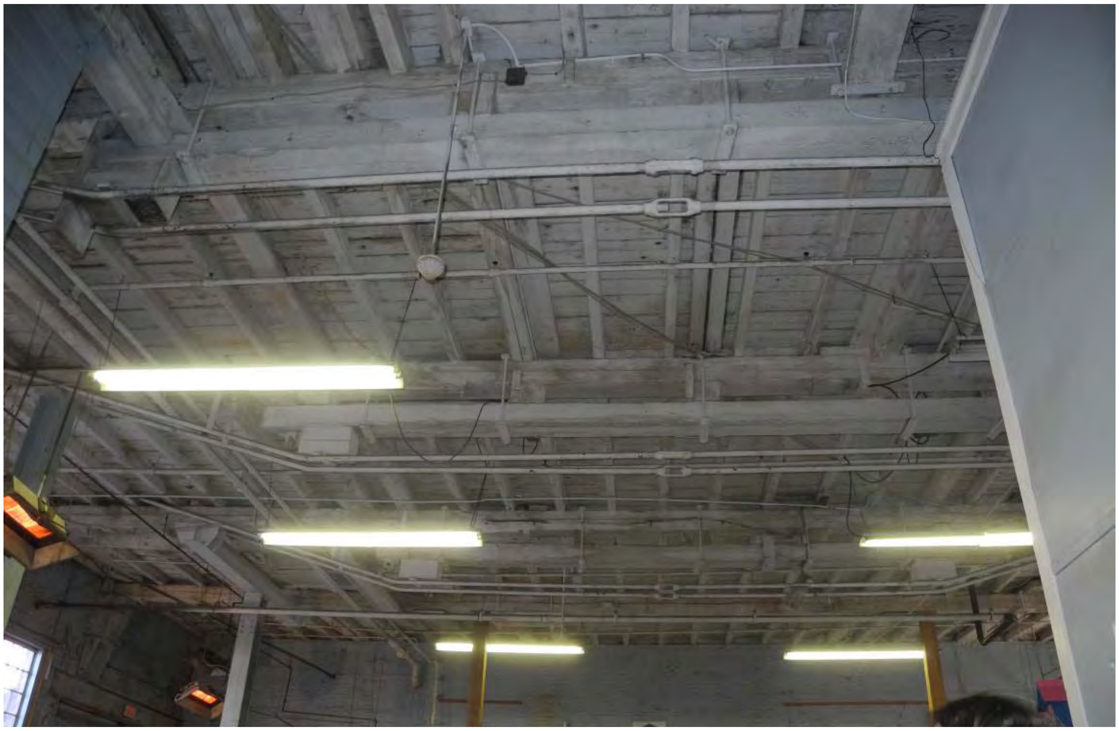

PHOTO #3.5 A 3 20.jpg	Building 3: Second floor framing viewed from east. Added rods and turnbuckles create double-strut trussed beams that also serve as the bottom chord of the roof trusses.

PHOTO #3.6 A 3 21.jpg	Building 3: Detail looking up at reinforced bottom chord of underhung queen rod truss/trussed girder. Further inspection is necessary to better understand the load path of this framing system.

PHOTO #3.7 A 3 29.jpg	<u>Building 3:</u> Original roof truss modified to create third-floor dormer. View taken looking toward south facing wall.

PHOTO #3.8 A 3 31.jpg	<u>Building 3:</u> Potentially rotted sheathing at south eave. Closely examine ends of sheathing and eave plates for rot. Additional sheathing may be needed to create sufficient diaphragm action between roof edges and wall.

PHOTO #4.1 R 61.jpg	Building 4: View from northwest, looking along north elevation. Hill descending from left drains substantial water toward the Building 4 foundation, and plant growth limits available sunlight in summer months.

PHOTO #4.2 R 65.jpg	Building 4: View looking east shows 30-light clerestory windows. As a foundry building, snow loads likely never accumulated on the roof while the foundry was operational. Since closing, snow loads can accumulate on roof.

PHOTO #4.3 R 79.jpg	Building 4: View looking north. Construction date of taller two-story structure at right is unknown but reportedly dates to original construction.

PHOTO #4.4 R 89.jpg	Building 4: View toward east, where new roof structure of Building 5 spans across the building width with contemporary steel roof joists.

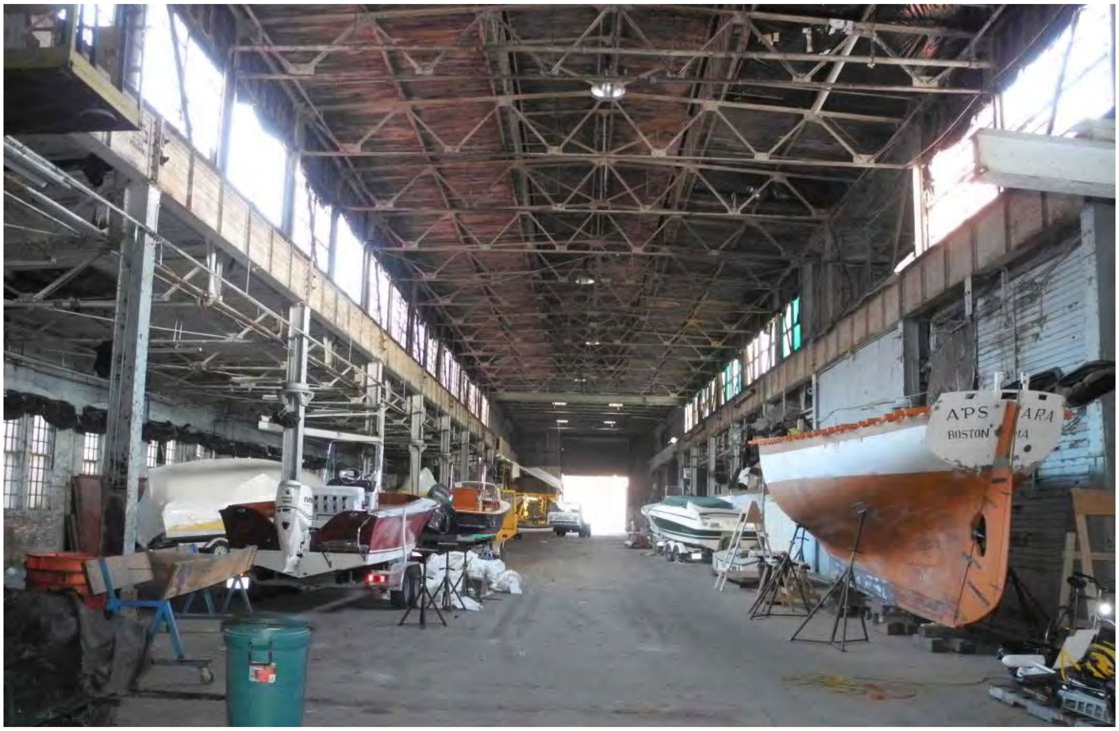

PHOTO #4.5
A 29 63.jpg

Building 4: Expansive open space and high ceiling provides natural light, unless monitor windows are covered. East end of Building 4 ties into surrounding Building 5, eliminating the pattern of structure and light.

PHOTO #4.6
A 29 64.jpg

Building 4: Monitor roof at center of photo supported by small steel truss framed onto clerestory truss.

PHOTO #4.7
A 29 68.jpg

Building 4: Ornate column cap and diagonal bracing visible at the bottom of the crane rail.

PHOTO #4.8
A 30 109.jpg

Building 4: South-facing upper wall and clerestory roof, with significant wood staining and possible rot. Continuous crane rail is visible in the foreground.

PHOTO #4.9 A 3 38.jpg	Building 4: Detail view of upper and lower columns joining and overlapping to provide clearance for continuous crane rail (arrow)

PHOTO #4.10 A 3 40.jpg	Building 4: North bay roof decking: Local roof sheathing rot supported by multiple 2x framing members spanning between trusses.

PHOTO #4.11
A 29 49.jpg

Building 4: Significantly deteriorated built-up angle column. Constant exposure to a shoreline environment, along with inherent construction flaw, caused failure of these columns for several feet above the base.

PHOTO #4.12
A 29 79.jpg

Building 4: Built-up column consists of four steel angles attached with riveted lacing bars. Columns are intended to support the side bay trusses.

PHOTO #4.13
A 2 81.jpg

Building 4: South elevation, with more recent steel structure attached. A concrete masonry bearing wall picks up the primary load from the new roof, and new steel columns support the upper south wall and roof.

PHOTO #4.14
A 2 70.jpg

Building 4, looking Southwest along upper roofs. Note tall clerestory roof and smaller upper monitor roof at clerestory roof ridge.

PHOTO #4.15 A 2 69.jpg	East end of Building 4, surrounded by slightly lower roof at Building 5, at left and toward water. View taken from Fore Street shows high drift at east end of lower roof.

PHOTO #4.16 R 82.jpg	Building 4: North side low bay truss framing. Small Warren-type trusses bear on plate and angle column at exterior wall, and tie into upper wall column at interior post.

PHOTO #6B.1
A 2 35.jpg

Building 6B: View from southwest. Building 6A is at far left of photo. Building has relatively steep pitched roof in comparison with most buildings on site.

PHOTO #6B.2
A 2 75.jpg

Building 6B: South elevation and east (gable) elevations viewed from southeast. Building contains ten window bays and nine interior truss bays.

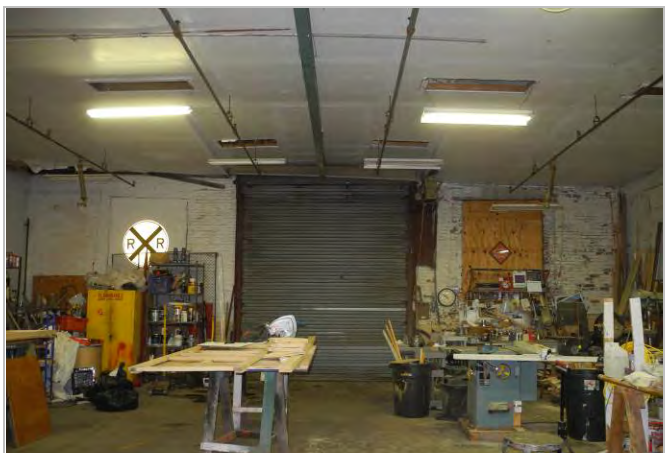

PHOTO #6B.3
A 30 06.jpg

Building #6B: East wall interior elevation. Attic space above ceiling served as storage.

PHOTO #6B.4
A 30 03.jpg

Building #6B: Roof truss framing showing flush-framed rafters, purlins, and diagonal knee bracing.

PHOTO #6B.5
A 30 02.jpg

Building #6B west end roof truss: Deteriorated south end of roof truss. Building #6A second floor visible at right. Provide temporary shoring beneath truss.

PHOTO #6B.6
A 30 13.jpg

Typical framing bay: Rafters extend from center purlin up to ridge. Knee braces serve to provide lateral stability in the longitudinal direction of roof.

PHOTO #6B.7 A P 11.jpg	Building #6B, looking toward east gable wall: Interior view showing expanse of roof framing and storage area shown in Photo #6B.3.

PHOTO #7.1
R 101.jpg

Building 7: View from northwest showing large overhead door openings cut into masonry bearing wall.

PHOTO #7.2
R 102jpg

Building 7: North elevation, looking west. Many changes have been made to the building facades, weakening existing walls and diminishing original fabric.

PHOTO #7.3
R 100.jjpg

Building 7: East elevation wall showing large overhead door cut into south end of wall. Also note bow of adjacent north wall at right of photo.

PHOTO #7.4
R 108.jpg

Building 7: Back shed addition, in very poor condition. Site pitches back toward the building immediately beneath eaves.

PHOTO #7.5
A 30 15 .jpg

East end unit: Conventional flat rafters with tapered shim on top provide roof pitch in this area. Rafters appear to be significantly undersized for span length.

PHOTO #7.6
A 30 20.jpg

North wall overhead door opening: Roof leaking near eaves is possibly causing wall top plate rot and infiltration into masonry above steel header.

PHOTO #7.7
A 30 21.jpg

Roof framing: Deteriorated rafters and sheathing at location of previous fire. North bearing wall is visible at right of photo.

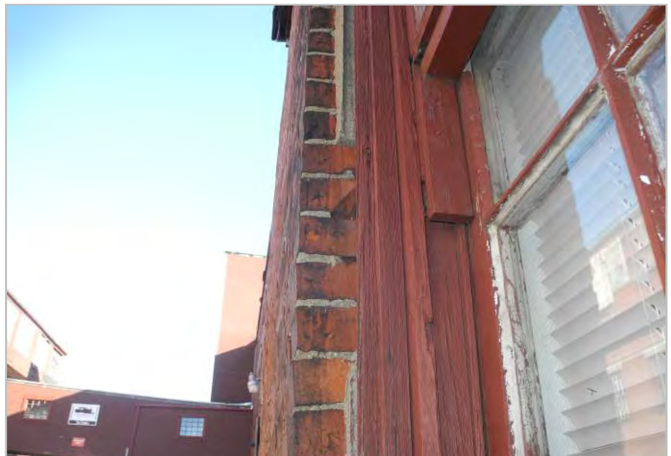

PHOTO #7.8
A 30 23.jpg

North wall: Masonry suffers from significant bowing throughout and will likely need to be rebuilt, as opposed to stabilized.

PHOTO #7.9
A 30 89.jpg

Roof surfacing: Built-up asphalt roof exhibits many repairs. Open areas of the roof were visible toward the west end of the building.

PHOTO #7.10
A 30 42.jpg

North wall: Visible wall bowing along the length of the structure. Necessary stabilization efforts will be significant. Walls will likely need to be rebuilt.

PHOTO #10.1
A30 87.jpg

Building 10: View from Building 1 Roof showing Building 10 roof and East elevation. Note very low slope roof with surface partially covered by battens.

PHOTO #10.2
a 30 88.jpg

Building 10: Close up of low slope roof. Note numerous patches in roofing system and ponding at right. Roofing system has far exceeded anticipated life.

PHOTO #10.3
A 2 93.jjpg

Building 10: West elevation wall showing unstable rebuilt south half (right) and deteriorated north section (left). Original window remains at south half.

PHOTO #10.4
A 2 92.jpg

Building 10: Loose mortar and deteriorated masonry on South elevation near infilled window. Building likely retains few of its original windows.

PHOTO #10.5
A 29 114.jpg

West elevation window: Significant bow in masonry wall and failed brick. Potential exists for significant water infiltration from driven rain.

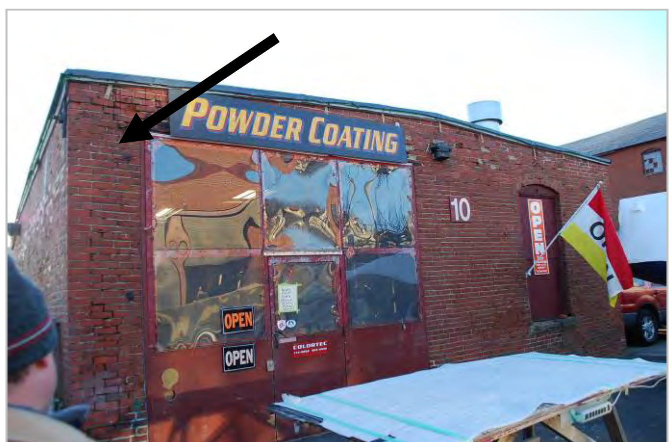

PHOTO #10.6
R 129.jpg

East elevation (detail): Contemporary door infill. Note badly deteriorated mortar visible at left side of door and along upper roof (arrow).

PHOTO #10.7
R 128.jpg

Building 10 south wall: Note infilled windows with granite sills and arched headers.

PHOTO #10.8
R 124.jpg

Building 10 north wall: Infilled wood windows (one opening remaining) and recently-added door.

PHOTO #10.9
A 3 5.jpg

West elevation, viewed from south: Significantly bowed masonry at south half of wall is unstable. Upper masonry at north half of wall is in poor condition (see Photo #10.5) We concur with the BSE report that the building should not be occupied.

PHOTO #11.1
A 29 103.jpg

Building 11: West and north elevations viewed from northwest on Fore Street. Note roof taper back toward Building 12, and relative lack of windows.

PHOTO #11.2
A 29 99.jpg

Building 11: Southeast corner at junction with Building 12. Temporary cricket has been set up to help divert water away from second floor windows and wall @ Bldg 12.

PHOTO #11.3
A 3 81.jpg

Building 11: North elevation along driveway. Snow and water accumultions lead to infiltration, mortar erosion, lateral pressures and wall failure.

PHOTO #11.4
A 3 2.jpg

Building 11: Ice and water runoff at west wall junction between Building 11 and Building 12. Masonry repointing cured symptoms of damage, but not cause.

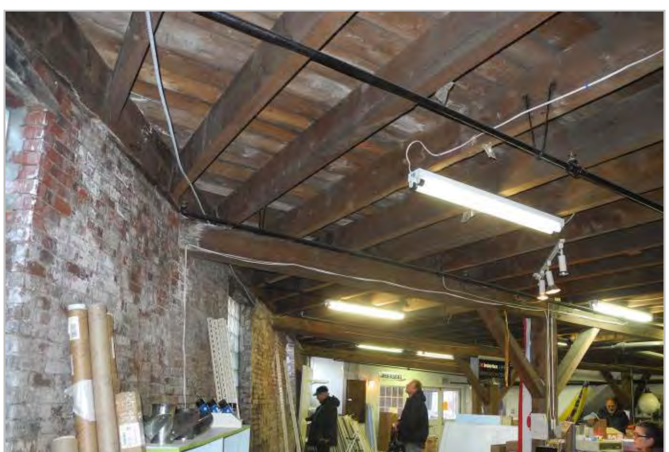

PHOTO #11.5
A 30 30.jpg

Ground floor north wall: Significant bow in masonry wall caused by lateral earth pressure and potential local rot beneath floor.

PHOTO #11.6
A 30 32.jpg

Ground floor north wall (detail): Significant bow in unstable masonry wall, caused by lateral earth pressure. Wall is bowed several inches out of plumb over four feet.

PHOTO #11.7
A 30 34.jpg

Second floor assembly space: Open area features visible timber framing and exposed masonry walls. Space has low ceilings and relatively few windows.

PHOTO #11.8
A 30 45.jpg

Second floor assembly space, east end: Barrels beneath multiple active roof leaks.

PHOTO #11.9
A 30 40.jpg

Roof framing: Built-up stub support for sloped roof girder. Roof appears to have two-way slope on its irregular floor plan.

PHOTO #11.10
A 30 42.jpg

Roof framing: Apparent attempt to strengthen roof girder below drift area at Building 12 intersection. Ceiling conceals most framing, leaving condition unknown.

PHOTO #14.1
A 2 35.jpg

Building 14: View from walkway into Building 2 second floor. Fore Street runs roughly parallel to the Building 14 roofline.

PHOTO #14.2
A 3 62.jpg

Building 14: East side of walkway to Building 2 third floor. Bridge connected drafting room to map room. Note rotted framing and water damage at base.

PHOTO #14.3
A 3 57.jpg

Building 14: First floor wall at west side of Building 14 serves as a buttress for the larger retaining wall at right.

PHOTO #14.4
A 3 59.jpg

Building #14: East side of Building 14 wall buttress.

PHOTO #14.5
A 3 52.jpg

Building #14, second floor: Kingpost timber truss supporting pitched roof central purlin. Ceiling prohibited view of roof rafters and purlins in this room.

PHOTO #14.6
A 3 51.jpg

North wall at second floor bindery space: Ceiling at top of wall is higher than adjacent Fore Street sidewalk, creating condensation in warm months.

PHOTO #14.7 A 3 54.jpg	Roof framing center section of Building 14: North wall visible at left. Note rafters running on top of purlins that span between trusses.

PHOTO #14.8 A 3 53.jpg	Map room, looking east: Mold growth on wall resulting from water infiltration requred tenant to leave in late 2014.

PHOTO #16.1
R 57.jpg

Building 16: View from southeast from alleyway. Note masonry wall return cracks on east elevation (arrow).

PHOTO #16.2
R 56.jpg

Building 15: View from southeast from alleyway. Building did not appear to be safe to enter, and we did not enter first floor.

PHOTO #16.3
a f 93.jjpg

Building 16: Enlarged opening in south elevation wall. Entire south wall requires repointing, repair, and anchoring into east wall.

PHOTO #16.4
P 23.jpg

Building 15/16: Remnants of boiler house chimney stack between Buildings 15 and 16.

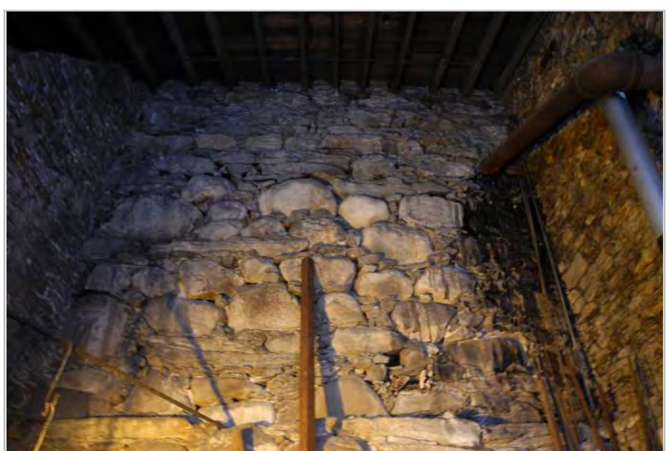

PHOTO #16.5
P 25.jpg

Building 16: North wall doubles as Fore Street retaining wall. Sloped roof rafters bear onto top of wall. Need to check condition of top plate above this wall.

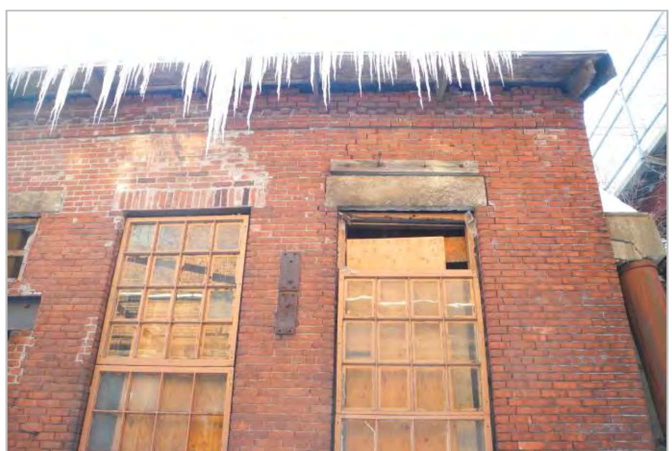

PHOTO #16.6
A 29 35.jpg

Building 16 south wall (detail): Masonry has simple details and small cornice at the top. Window header at left has been replaced with brick soldier course and steel lintel.

PHOTO #16.7
A 29 36.jpg

Building 16 roof framing, south wall: Roof previously had skylights or vents on south side of roof. Note center line of bearing at braced column. Framing likely undersized.

PHOTO #16.8
A 29 37.jpg

North and east walls: Barrels beneath multiple active roof leaks.

PHOTO #16.9
A 29 42.jpg

Catch basin grate, east of Building 16: Grate covered by leaves and debris, and basin itself appears to be clogged.

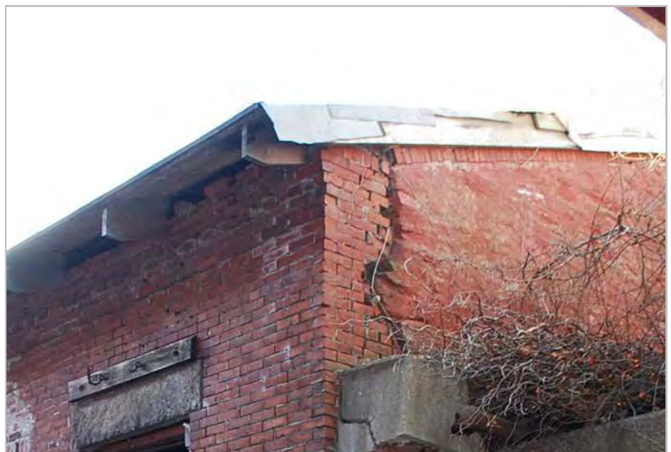

PHOTO #16.10
A 30 42.jpg

Building 15 southeast wall corner: Masonry repair is required to create weatherproof and structurally sound transition from brick to stone wall.