Renner | Woodworth

Fort Williams Projects Final Report

Main Entrance Gate
Interpretive Signs at Battery Knoll
Bleachers
Batteries
Goddard Mansion

March 26, 2009

Renner|Woodworth

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Architecture
Environmental Design
Exhibit Design
Graphic Design

To: Fort Williams Advisory Commission

From: Richard Renner, Renner|Woodworth

Date: March 26, 2009

Re: Fort Williams Projects – Final Report

In early 2008, Renner|Woodworth, with its consultants Becker Structural Engineers and Stantec, were selected by the Town of Cape Elizabeth to assist the Fort Williams Advisory Commission with the following projects:

- Design and coordinate improvements to the main entrance; including new gates, fencing and stonewall reconstruction
- Design new interpretive/orientation signage to replace an existing panoramic display on Battery Knoll
- Assess the condition of the bleachers and develop options, and the associated costs for repair, replacement, and/or redevelopment
- Assess the condition of Goddard Mansion, develop options, and the associated costs for repair, restoration, and additional development
- Assess the condition of the batteries south of the access drive to Portland Head Light and develop options and the associated costs for repair, restoration, development, and interpretation

The new entrance gate has been completed, and the new interpretive signs will be installed this spring, not at Battery Knoll, but at a higher location known as Kitty's Point. This report focuses on the studies of the bleachers, Goddard Mansion, and the batteries. (Late in 2008, the team was also asked to assess the condition of Battery Keyes and to recommend measures to stabilize the structure and make it safer. That work is summarized in a copy of the Becker's report included in the appendix at the end of this report.)

Goddard Mansion

We completed a structural analysis of the Mansion, building on and updating the report completed by Oest Associates in September, 2004. Using maps, site reconnaissance, and 3D computer models, we developed options for historic interpretation and complementary uses. Finally, we developed the following cost estimates for a refined set of options:

1. Do nothing to stabilize or preserve. Buy fencing and surround building to protect the public.
Estimated cost - $10,000

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2. Demolish the entire ruin, salvaging masonry elements for re-sale.
Estimated cost - $65,000

3. Install fence at the Main House and the Connector to protect the public. Repair critical areas at Carriage House, which will allow the public to approach but not enter. This leaves open the possibility of continuing preservation efforts in the future.
Estimated cost - $25,000

4. Complete emergency repairs to stabilize the most dangerous areas, which will allow public to approach the building but not to enter it. Existing fencing within windows and doors would be retained. This leaves open the possibility of continuing preservation efforts in the future.
Estimated cost - $65,000

5. Complete full repairs to the Carriage House and Tower to preserve these elements for the long-term. Demolish the balance of the building down to within 24" to 30" of the ground. Retain the door frame at the Main House. Public will be able to enter the Carriage House.
Estimated cost - $280,500

5A. Selective demolition and removal of stone, salvaging some elements for re-sale.
Selective re-build of remaining 24"-30" tall wall. Repairing and stabilizing stone at doorway.
Will include minor foundation work and steel support frame.
Estimated cost - $170,000

6. Same as #5 above, but add interpretive signage and construct a picnic shelter in the Carriage House.
Estimated cost - $411,034

By way of comparison, the estimated cost of a full structural repair of Goddard Mansion is $631,000. This does not include any interpretation or the construction of a picnic shelter. Note that the above numbers do not include an annual maintenance budget; for Items 4, 5, and 6, we estimate that annual maintenance will be $5,000.

Bleachers

Based on site inspections, exploratory excavations, an examination of scale drawings, and a review of historic information, we assessed the current condition of the bleachers. We reviewed the state of the bleachers with the State Historic Preservation Office. We developed alternate scenarios for redevelopment to enhance the functionality and increase seating. Finally, we developed the following cost estimates for a refined set of options:

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1. Do nothing to stabilize or preserve.
Estimated cost - $0

2. Demolish all bleachers and regrade.
Estimated cost - $75,000

3. Demolish existing bleachers, rebuild in concrete the bleachers immediately behind and around home plate, regrade and retain balance of demolished bleacher area, provide new backstop and directional signage.
Estimated cost - $434,845

Battery Blair

After a brief review of all the batteries, it was decided that Battery Blair was the most promising battery for development, restoration and repair, and interpretation. This was primarily because of its proximity to Portland Head Light, other heavily used areas in the Fort, and the extensive adjacent parking. The team assembled historic information about the battery and, using a backhoe, investigated the condition of the upper concrete deck and buried portions of the structure.

Initially, there had been some discussion of locating storage, bathroom, and/or visitors center functions inside the battery. We determined, however, that because of dimensional constraints and the cost of creating dry, climate controlled space inside the batteries, it would be better to locate these functions elsewhere.

A full assessment of the condition of the horizontal concrete surfaces will require core-drilling for samples and subsequent analysis. The buried features that were revealed in the test excavation were in good condition. On a preliminary basis, we determined that it would be possible to excavate the entire battery, restore the original grades, and provide adequate surface drainage.

On the basis of this preliminary information, we estimated that the cost of full excavation, regarding, repair and restoration, and interpretation would be $771,000.

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Appendix

Goddard Mansion
Bleachers
Battery Blair
Battery Keyes
Kitty's Point

November 11, 2008 Draft
Bob Malley
Town of Cape Elizabeth
Cape Elizabeth, Maine

FORT WILLIAMS – GODDARD MANSION STRUCTURAL INVESTIGATION UPDATE
CAPE ELIZABETH, MAINE

Dear Bob,

Based on our proposal and your verbal authorization, we have begun our evaluation of the existing structure at Goddard Mansion. Initial field work was performed on October 27, 2008 by Nathan Merrill, E.I. and then again on November 13, 2008 with Paul Becker, P.E. Scope of work is to provide an updated structural evaluation, updated repair scope and updated repair cost estimate for the mansion structure based on a previously completed investigation performed by OEST Associates, Inc. in 2004. The end goal of the updated evaluation is to prepare preliminary estimates for stabilizing the structure and/or allowing controlled access and limited use. The attached photos accompanied by a diagrammatic floor plan and building elevations will serve to document our findings and identify areas that we believe require remedial action. Please see the assessment by OEST Associates, Inc. for information referenced herein.

Observations
Fencing was observed to be present at all openings in the perimeter walls of the ruin to prohibit access to the interior of the structure. Therefore our observations were limited to areas visible from outside the building. This was not present at the time of the previously performed assessment. The majority of the stone masonry appears to have seen very little change in state since the 2004 evaluation. The masonry mortar still appears to range in condition from poor to satisfactory. Headers, sills and jambs at window and door openings also appear to have generally seen very little change in condition. However, localized changes in condition were observed, either due to repair or further degradation, and these locations are noted on the attached drawings.

An observation made that is not consistent with the aforementioned assessment is the condition of mortar parging on portion of the east facing exterior wall (refer to attached Exterior Elevation G drawing). Several locations of wall previously noted as possessing mortar parging were observed to be spawled with the debris found on the ground below (see attached photo). The exposed stone masonry at the spawled locations was observed to be moist. Other locations on this wall were found to have cracks in the parging with evidence of moisture present at the crack locations.

Findings
Masonry stone was found to be generally in satisfactory condition. As in the aforementioned assessment, there are locations where existing stones are cracked. It was also stated in the previous assessment that areas were backfilled using materials collected by street sweeping operations. We agree that such materials are not suitable for this application. Where the cracks propagate through the thickness of the wall and extend the majority of the wall height, we believe the cracking may be due to differential movement across the length of the wall and wedging action of water freezing within the wall cavity. This differential movement may initially be caused by heaving of this unsuitable soil due to freeze/thaw cycles. Once cracks exist, the severity of wall cracks is increased by water directly entering the joint and expanding with every freeze/thaw cycle. The associated cracks are identified on the attached drawings and photos.

The masonry mortar joints range in condition from satisfactory to poor. These areas are identified on the attached drawings and are classified in the same manner as the previous assessment. The majority of the area in poor condition exists at the top of walls in which the stone appears to have not been intended for such exposure. In many of these locations, directly below the concrete cap, masonry stones were observed to be completely loose and free of restraint creating a safety concern in our opinion. While the fencing at the perimeter of the ruin does restrict access to the interior of the ruin, we believe significant safety concerns exist for observers outside of the ruin.

Parging on the east wall was found to be in poor condition with areas of spawling observed. These areas are identified on the attached drawings. This finding varies significantly from the previous report issued in 2004 which states the parging was in good condition. We believe the spawling is caused by moisture infiltration in the stone masonry behind the parged surface. Water moves down the wall face and enters the wall interior, migration to and being trapped by the parging. Through freeze/thaw action, the parging is pushed off the stone surface creating cracks and eventually resulting in spawling of the parge coat. Prior to failure and loss of the parging the trapped moisture deteriorates the mortar causing loss of strength and voids. The mortar joints, once weathered, are further deteriorated by subsequent freeze/thaw action. We believe safety concerns are present for observers outside of the ruin due to falling mortar at spawling locations. Tree growth was observed in very close proximity to the exterior of the ruin in this area. This is a detriment to masonry not only due to poor air flow and ventilation of the masonry, but roots may also penetrate and undermine the structure resulting in significant structural damage.

There are a number of locations where new cracks in the granite headers, sills and jambs are present. We believe these are due to weathering of the stone in the time since the last assessment. Radial spawling of the granite was observed in many locations however the spawling has seen little change since 2004. We agree that this spawling is the result of the controlled burn as the previous report mentions. The condition of the wood headers appears to be unchanged from the time of the last assessment.

Structural Rehabilitation Recommendations

We concur with the previous estimate of cracked stone to be less than 5% of the surface area of the walls. However, we believe these stones may be left in place with no detriment to the overall structural performance of the wall.
At locations where cracks propagate through a majority of the wall height and thickness we recommend the following action be taken.

• A drainage system comprised of perimeter underdrains be installed. This shall include replacement of fine material excavated during installation with clean fill possessing free draining characteristics. The replacement of the soil along with a drainage system will effectively transport moisture away from the wall base, arresting further heaving concerns.

• Once the drainage system is installed and operable for a full seasonal cycle, repair of the cracks shall take place. This acclimation period should allow the wall bases to stabilize prior to initiating masonry rehabilitation work. Repair of cracks shall include raking out, reinforcing and repointing of horizontal mortar joints which cross the crack. See attached drawings for locations and additional information.

The attached drawings indicate the locations of the various mortar joint conditions. We are of the opinion that masonry mortar joints in poor condition should be immediately addressed with focus on the band of loose stone at the top of most of the walls which present potential of falling onto observers. We believe this safety concern should be addressed as follows.

• Immediately erect a temporary fence or barrier around the perimeter of the ruin such that observers are kept a safe distance from potential falling stones.

• Once fencing is erected, point the loose stone masonry at top of walls with mortar.

Repointing mortar joints described as unsatisfactory and satisfactory in condition should follow. If we were confident that the walls were to be moisture tight, application of a sealer would then be a prudent measure. However, due to the many locations and means to which moisture can infiltrate the masonry walls, we feel it would be harmful to apply a sealer once repairs are completed. We believe the sealer would hinder moisture from escaping the wall and result in further damage to mortar joints. Due to the historic nature of the building we believe masonry mortar should be a type in coordination with the *Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings* prepared by The Secretary of the Interior's Standards for the Treatment of Historic Properties.

Where parged areas of the east wall are spawling, we believe the parging should be completely removed over the entire extent of the wall. This will not only alleviate safety concerns associated with falling parge coat but also discontinue the weathering of the stone masonry mortar joints caused by trapped moisture. The masonry will be allowed to breath and moisture will no longer be captured between the two surfaces. Once parging is removed, mortar joints shall be raked and repointed. In an effort to aid air circulation on the east wall, we recommend tree growth be removed within a 25 foot proximity of the wall.

Where cracked granite lintels exist without any supplemental shoring, we recommend these lintels be shored utilizing pressure treated lumber headers and jambs at the inside of the existing opening similar to other existing shored locations. See attached drawings for locations.

Related Recommendations

Additional observations were noted and listed below are related suggestions to better improve the structure and site. These suggestions were previously stated in the assessment performed by OEST Associates.

• Bird/Animal Nests: We recommend that when renovation work is complete no holes large enough for animals to enter shall exist. This includes chimneys, walls, window areas or basement areas.

• Guy Wire: We recommend the guy wire on the east face of the building be removed along with associated poles.

• Metal Embeds: We recommend all metal embeds in granite headers, jambs, sills and stone masonry be removed to reduce the risk of further spawling due to corrosion of the metal.

• Existing Piping: We recommend all locations of metal piping be removed and holes filled with like stones and mortar.

• Chimney Repair: We recommend removal of bricks which extend beyond the face of the surrounding wall, leaving only the back course. This would leave the outline of the chimneys for viewing purposes and address falling concerns of loose brick. Remaining brick should be raked and repointed.

Maintenance Recommendations

In addition to the previously stated rehabilitation and related recommendations, annual inspection of the ruins should be performed in order to maintain repairs.

• Mortar joints in both brick and stone masonry should be observed annually for damage that may have occurred due to freeze/thaw action through the winter season. Due to the harsh environment the sealant will be exposed to, we recommend that the joints be sealed once every 5 years.

• All masonry and granite headers, sills and jambs should be inspected for cracks which may be an indication of differential movement. Timber headers and jambs should also be inspected for rot and deterioration on a yearly basis.

Conclusions

Based on our observations and findings we have concerns over visitor safety that should be addressed as soon as possible at the Goddard Mansion ruin site. We recommend temporarily restricting access to observers within 10 feet of the perimeter of the ruin until certain rehabilitation work is completed. Portions of the mansion could be rehabilitated to allow safe passage of visitors at a future time. In addition to masonry rehabilitation, other work may be done at the ruin to benefit the structural longevity, overall aesthetics and visitor interaction.

We trust this letter and attachments address your concerns at this time. We are available to discuss this information if you have any questions.

Sincerely,

BECKER STRUCTURAL ENGINEERS, Inc.

Nathan Merrill, E.I.
Paul Becker, P.E.

Attachment

Location of spawled parging on East Wall.

Debris from spawled parging on East Wall.

Front elevation of Goddard Mansion at Fort Williams

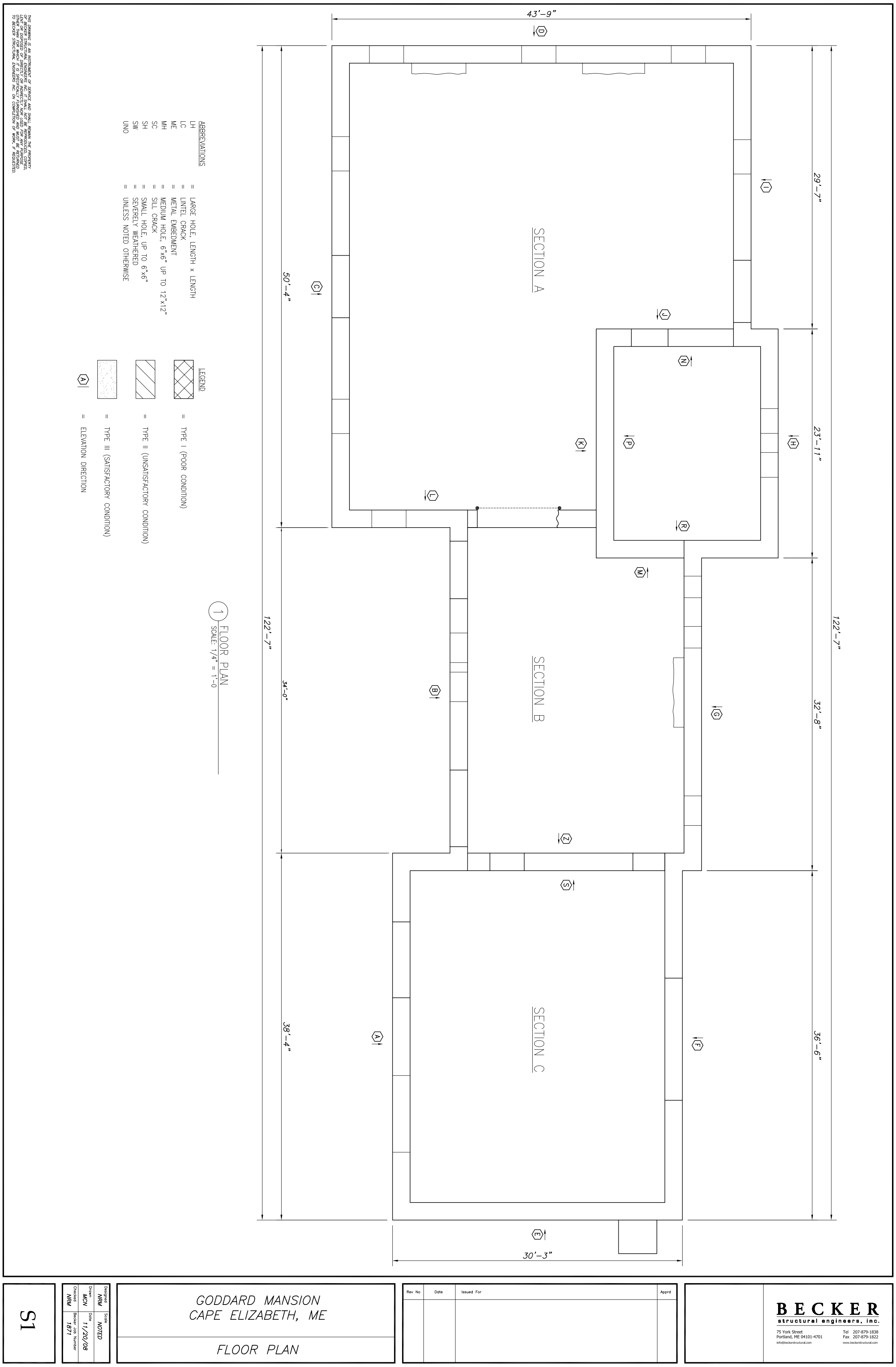
Stone rubble with concrete cap typical around majority of building perimeter

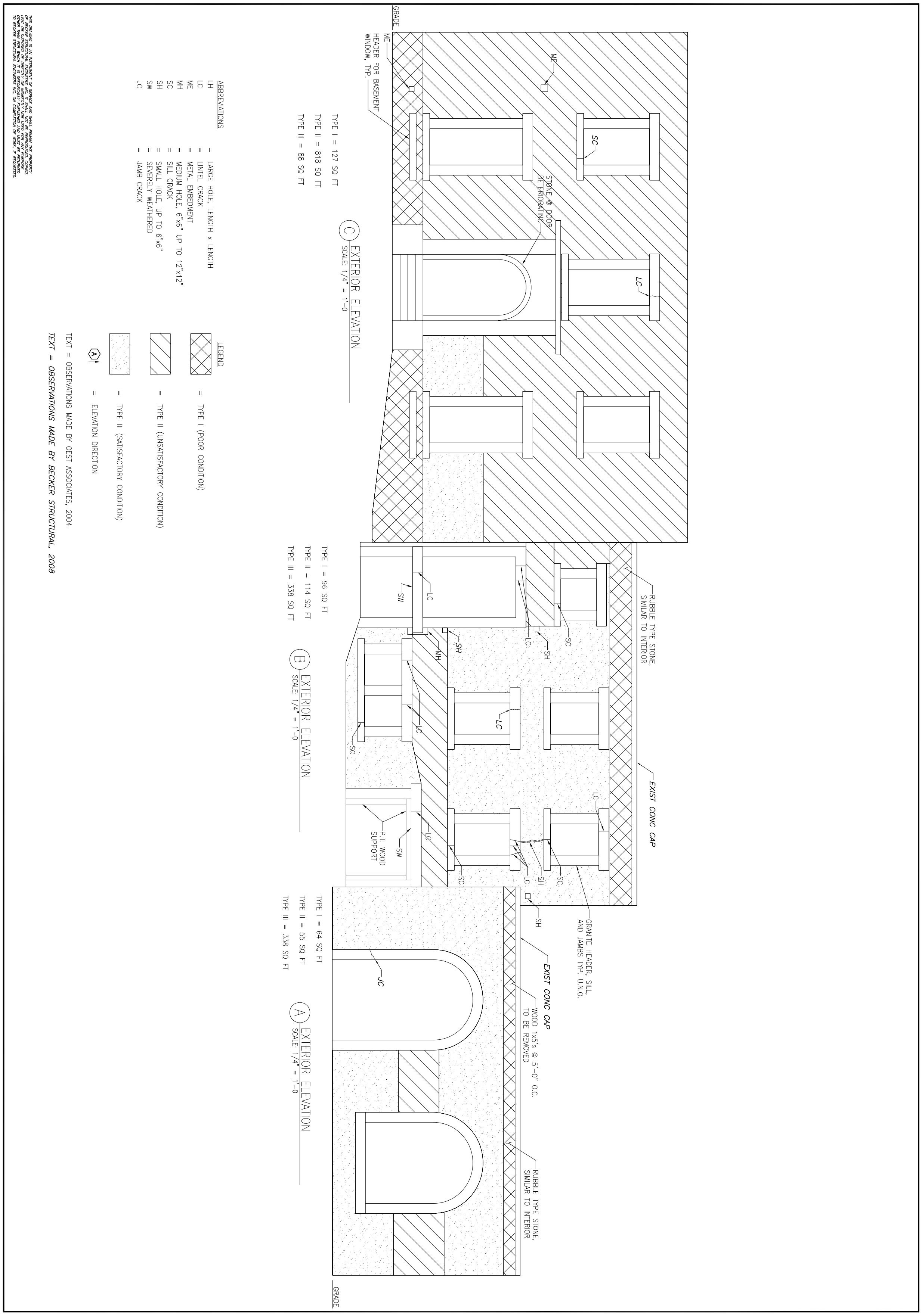
Crack through granite header and sill

Crack through granite sill above, stone masonry and granite header below

Loose brick at East Wall chimney

Loose brick at North Wall chimneys


43'-9"
30'-3"
122'-7"
50'-4"
34'-0"
38'-4"
29'-7"
23'-11"
32'-8"
36'-6"
SECTION A
SECTION B
SECTION C
ABBREVIATIONS
LH = LARGE HOLE, LENGTH x LENGTH
LC = LINTEL CRACK
ME = METAL EMBEDMENT
MH = MEDIUM HOLE, 6"x6" UP TO 12"x12"
SC = SILL CRACK
SH = SMALL HOLE, UP TO 6"x6"
SW = SEVERELY WEATHERED
UNO = UNLESS NOTED OTHERWISE
LEGEND
= TYPE I (POOR CONDITION)
= TYPE II (UNSATISFACTORY CONDITION)
= TYPE III (SATISFACTORY CONDITION)
= ELEVATION DIRECTION
1 FLOOR PLAN
SCALE: 1/4" = 1'-0
S1
Designed NRM
Scale NOTED
Drawn MCN
Date 11/20/08
Checked NRM
Becker Job Number 1871
GODDARD MANSION
CAPE ELIZABETH, ME
FLOOR PLAN
Rev No
Date
Issued For
Apprd
BECKER
structural engineers, inc.
75 York Street
Portland, ME 04101-4701
Tel 207-879-1838
Fax 207-879-1822



S2	Designed NRM / Drawn MCN / Checked NRM / Scale NOTED / Date 11/20/08 / Becker Job Number 1871	GODDARD MANSION CAPE ELIZABETH, ME ELEVATIONS	Rev. No / Date / Issued For / Apprd

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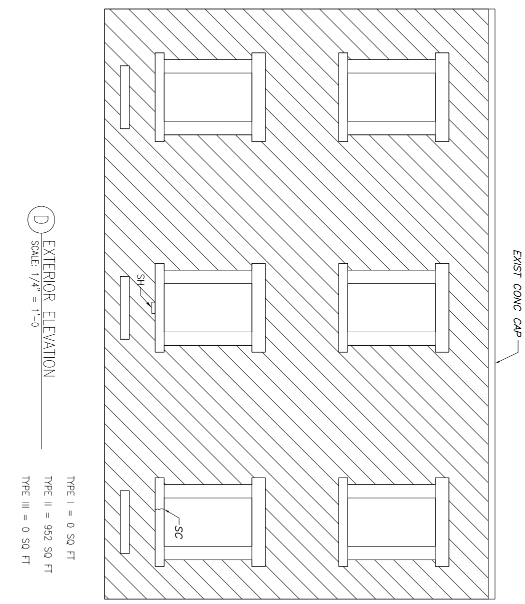

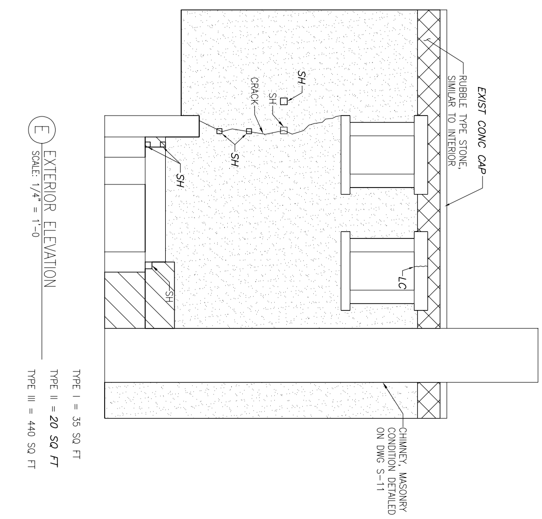

S3	Designed NRM	Drawn MCN	Checked NRM
	Scale NOTED	Date 11/20/08	Becker Job Number 1871

GODDARD MANSION
CAPE ELIZABETH, ME

ELEVATIONS

Rev No	Date	Issued For	Appd

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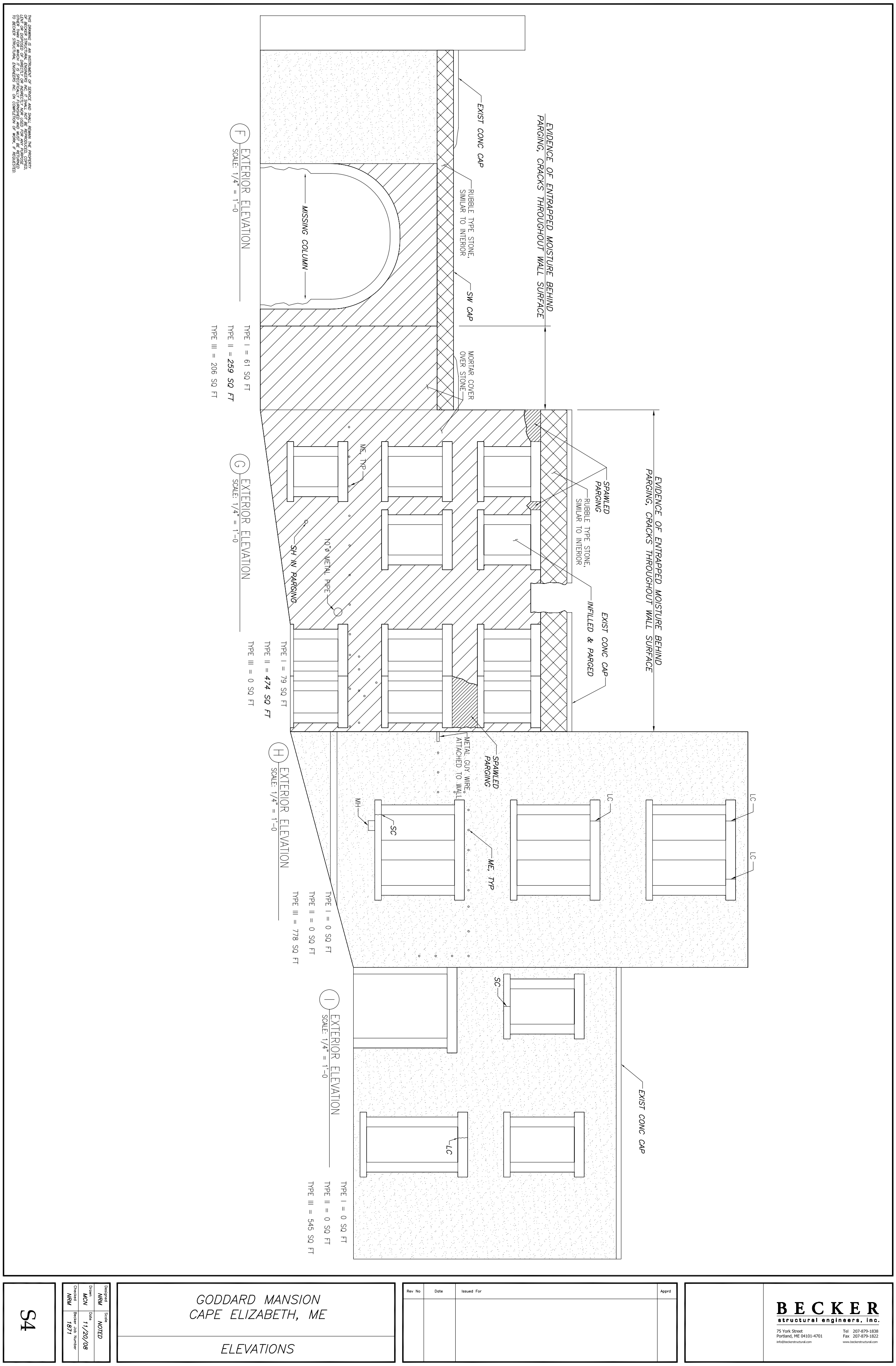
EVIDENCE OF ENTRAPPED MOISTURE BEHIND PARGING, CRACKS THROUGHOUT WALL SURFACE
EXIST CONC CAP
RUBBLE TYPE STONE, SIMILAR TO INTERIOR
SW CAP
MORTAR COVER OVER STONE
MISSING COLUMN
F EXTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 61 SQ FT
TYPE II = 259 SQ FT
TYPE III = 206 SQ FT
SPAWLED PARGING
RUBBLE TYPE STONE, SIMILAR TO INTERIOR
EXIST CONC CAP
INFILLED & PARGED
ME, TYP
10" METAL PIPE
SH IN PARGING
G EXTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 79 SQ FT
TYPE II = 474 SQ FT
TYPE III = 0 SQ FT
SPAWLED PARGING
METAL GUY WIRE ATTACHED TO WALL
LC
LC
LC
MH
SC
ME, TYP
H EXTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 0 SQ FT
TYPE II = 0 SQ FT
TYPE III = 778 SQ FT
SC
EXIST CONC CAP
LC
I EXTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 0 SQ FT
TYPE II = 0 SQ FT
TYPE III = 545 SQ FT
S4
Designed NRM
Drawn MCN
Checked NRM
Scale NOTED
Date 11/20/08
Becker Job Number 1871
GODDARD MANSION
CAPE ELIZABETH, ME
ELEVATIONS
Rev. No
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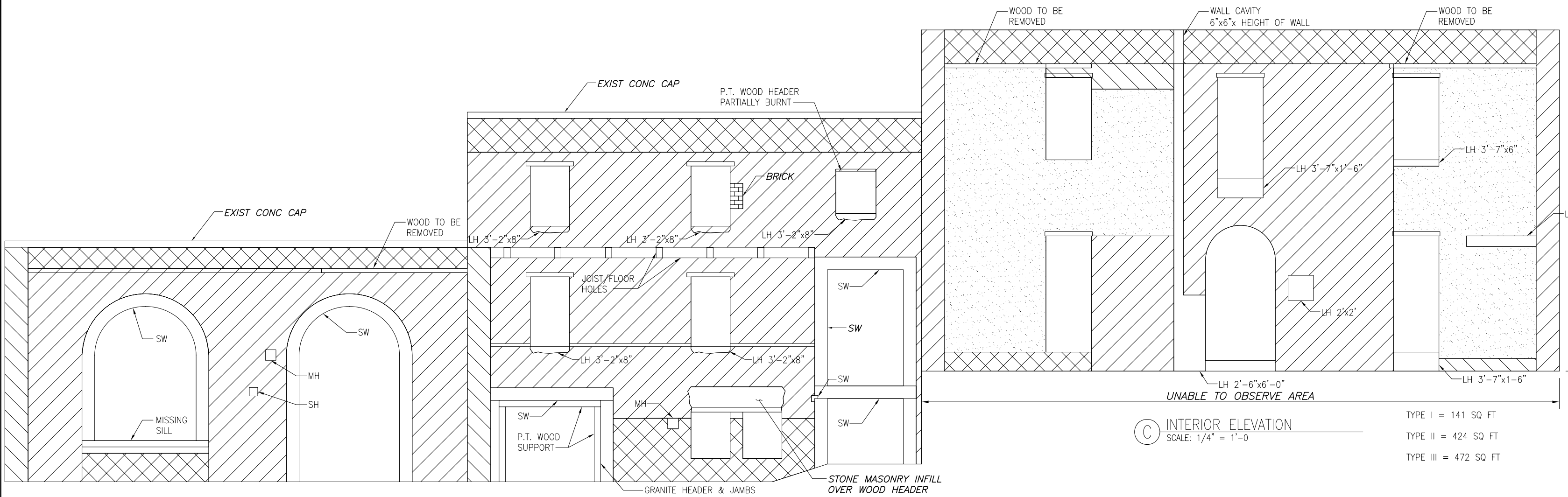

A INTERIOR ELEVATION
SCALE: 1/4" = 1'-0

TYPE I = 80 SQ FT
TYPE II = 305 SQ FT
TYPE III = 0 SQ FT

B INTERIOR ELEVATION
SCALE: 1/4" = 1'-0

TYPE I = 153 SQ FT
TYPE II = 503 SQ FT
TYPE III = 0 SQ FT

C INTERIOR ELEVATION
SCALE: 1/4" = 1'-0

TYPE I = 141 SQ FT
TYPE II = 424 SQ FT
TYPE III = 472 SQ FT

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CAPE ELIZABETH, ME

ELEVATIONS

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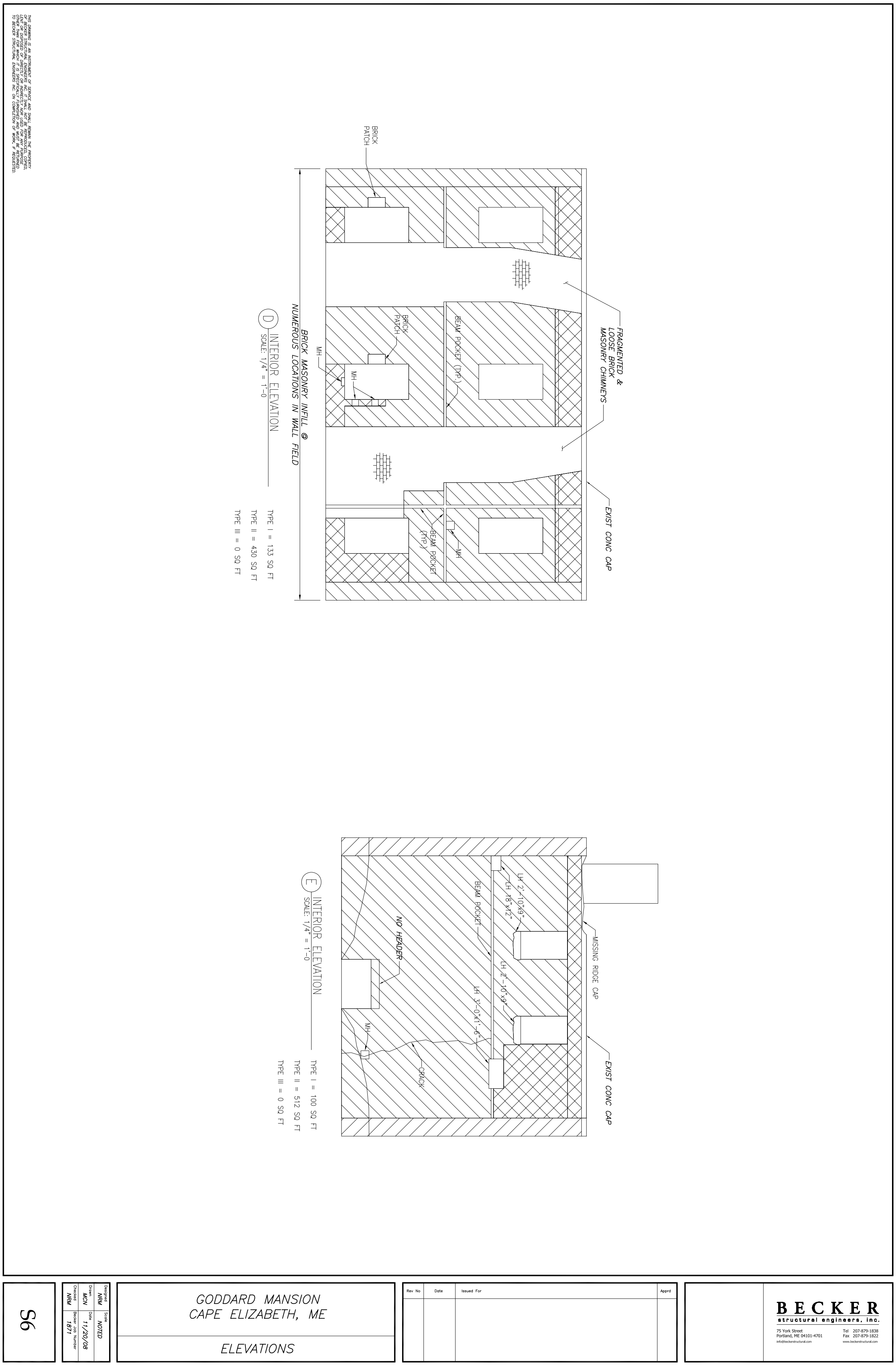
Drawn MCN	Date 11/20/08
Checked NRM	Becker Job Number 1871

S5


BRICK PATCH
FRAGMENTED & LOOSE BRICK MASONRY CHIMNEYS
BEAM POCKET (TYP.)
BRICK PATCH
MH
EXIST CONC CAP
BEAM POCKET (TYP.)
BRICK MASONRY INFILL @ NUMEROUS LOCATIONS IN WALL FIELD
D INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 133 SQ FT
TYPE II = 430 SQ FT
TYPE III = 0 SQ FT
BEAM POCKET
MISSING RIDGE CAP
NO HEADER
MH
CRACK
EXIST CONC CAP
E INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 100 SQ FT
TYPE II = 512 SQ FT
TYPE III = 0 SQ FT
S6
Designed NRM
Drawn MCN
Checked NRM
Scale NOTED
Date 11/20/08
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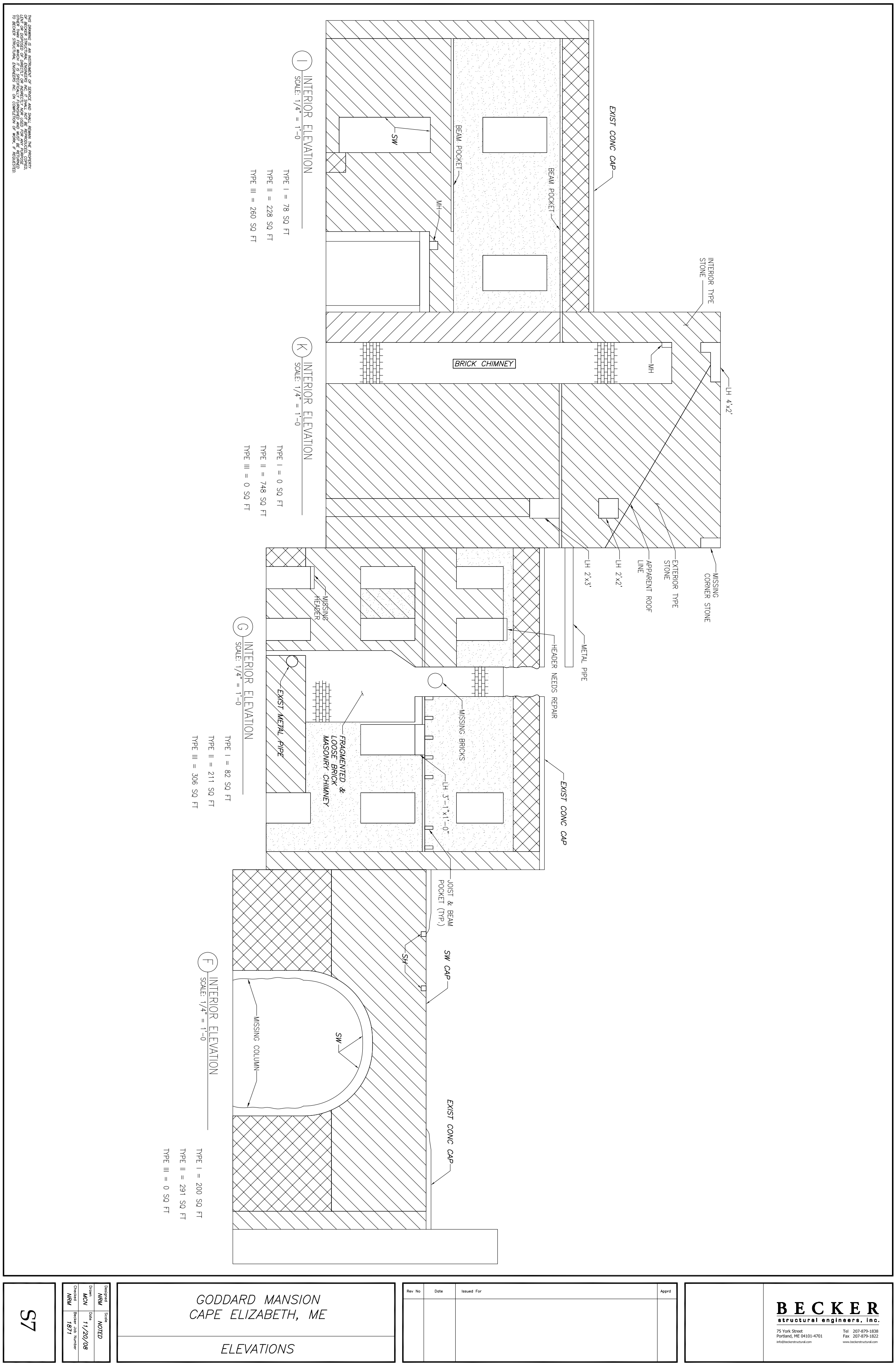

EXIST CONC CAP
BEAM POCKET
SW
MH
INTERIOR TYPE STONE
BRICK CHIMNEY
LH 4"x2"
MISSING CORNER STONE
EXTERIOR TYPE STONE
APPARENT ROOF LINE
LH 2"x2"
LH 2"x3"
METAL PIPE
HEADER NEEDS REPAIR
MISSING HEADER
MISSING BRICKS
FRAGMENTED & LOOSE BRICK MASONRY CHIMNEY
EXIST METAL PIPE
LH 3"-1"x1'-0"
JOIST & BEAM POCKET (TYP.)
SW CAP
SH
MISSING COLUMN
I INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 78 SQ FT
TYPE II = 228 SQ FT
TYPE III = 260 SQ FT
K INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 0 SQ FT
TYPE II = 748 SQ FT
TYPE III = 0 SQ FT
G INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 82 SQ FT
TYPE II = 211 SQ FT
TYPE III = 306 SQ FT
F INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 200 SQ FT
TYPE II = 291 SQ FT
TYPE III = 0 SQ FT
S7
Designed NRM
Scale NOTED
Drawn MCN
Date 11/20/08
Checked NRM
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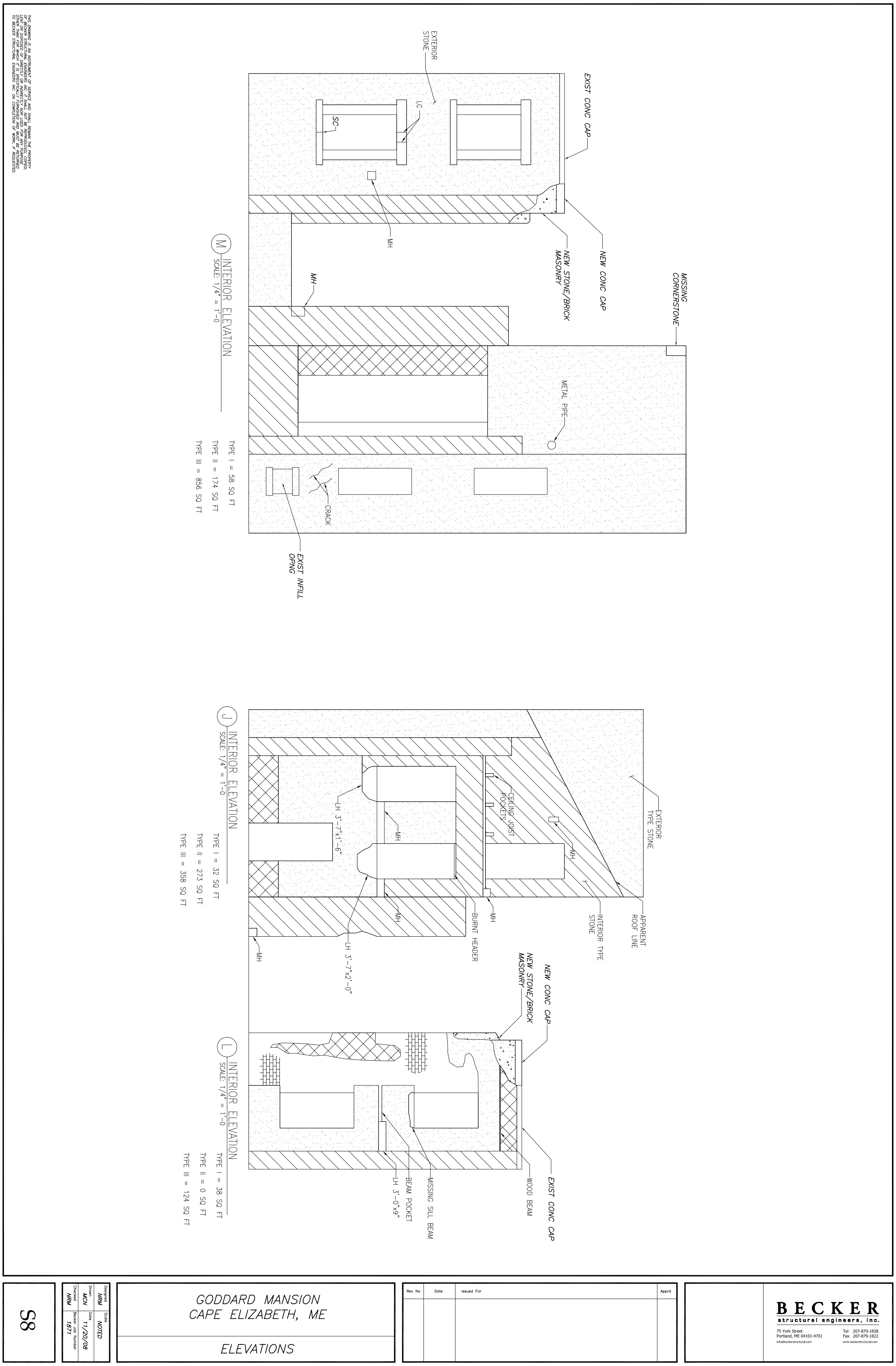
EXIST CONC CAP
EXTERIOR STONE
LC
SC
MH
NEW CONC CAP
NEW STONE/BRICK MASONRY
MISSING CORNERSTONE
METAL PIPE
CRACK
EXIST INFILL OPNG
M INTERIOR ELEVATION
SCALE: 1/4" = 1'-0"
TYPE I = 58 SQ FT
TYPE II = 174 SQ FT
TYPE III = 856 SQ FT
CEILING JOIST POCKETS
EXTERIOR TYPE STONE
APPARENT ROOF LINE
INTERIOR TYPE STONE
BURNT HEADER
LH 3'-7"x1'-6"
LH 3'-7"x2'-0"
J INTERIOR ELEVATION
SCALE: 1/4" = 1'-0"
TYPE I = 32 SQ FT
TYPE II = 273 SQ FT
TYPE III = 358 SQ FT
WOOD BEAM
MISSING SILL BEAM
BEAM POCKET
LH 3'-0"x9"
L INTERIOR ELEVATION
SCALE: 1/4" = 1'-0"
TYPE I = 38 SQ FT
TYPE II = 0 SQ FT
TYPE III = 124 SQ FT
S8
Designed NRM
Scale NOTED
Drawn MCN
Date 11/20/08
Checked NRM
Becker Job Number 1871
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CAPE ELIZABETH, ME
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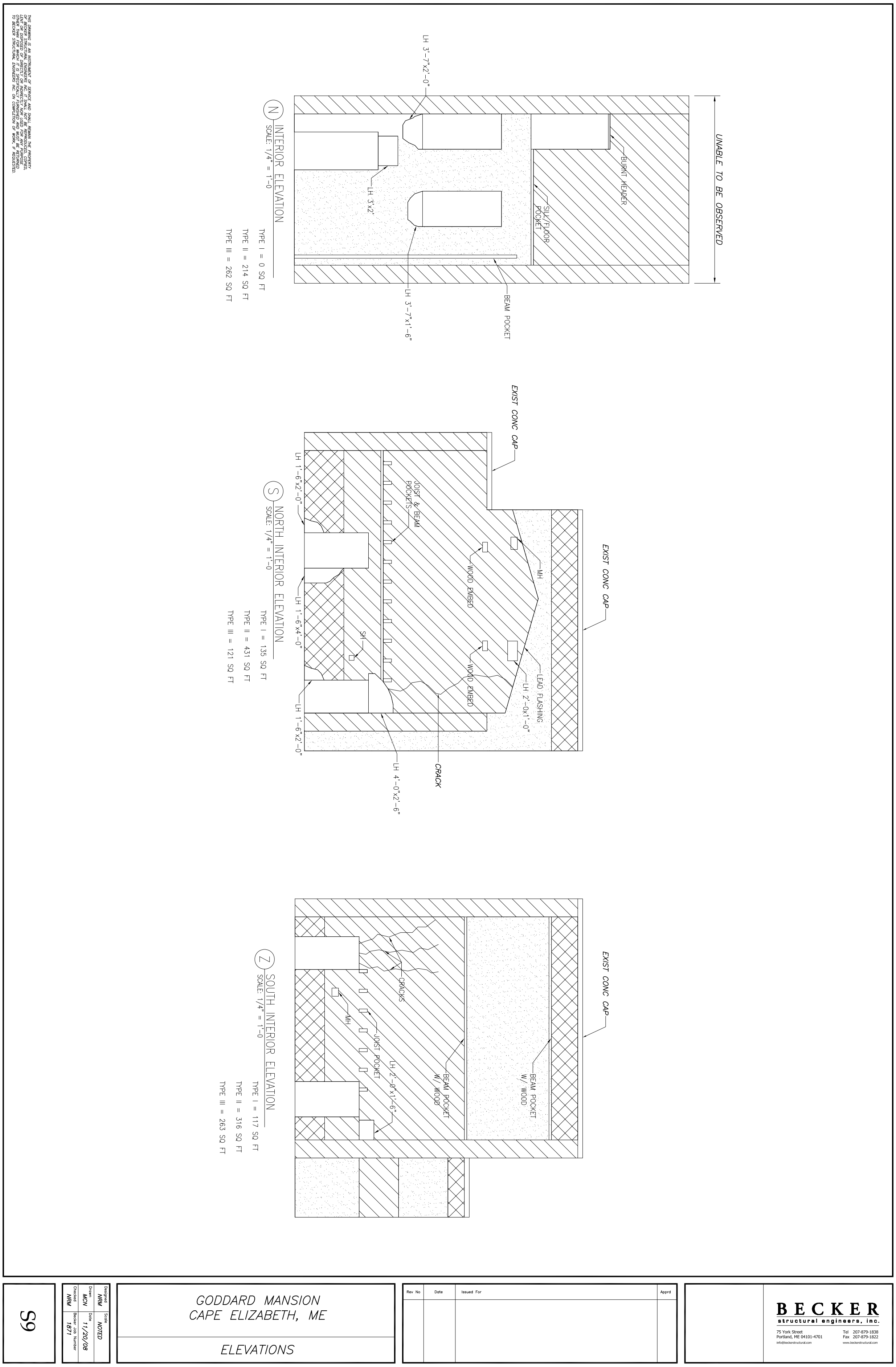
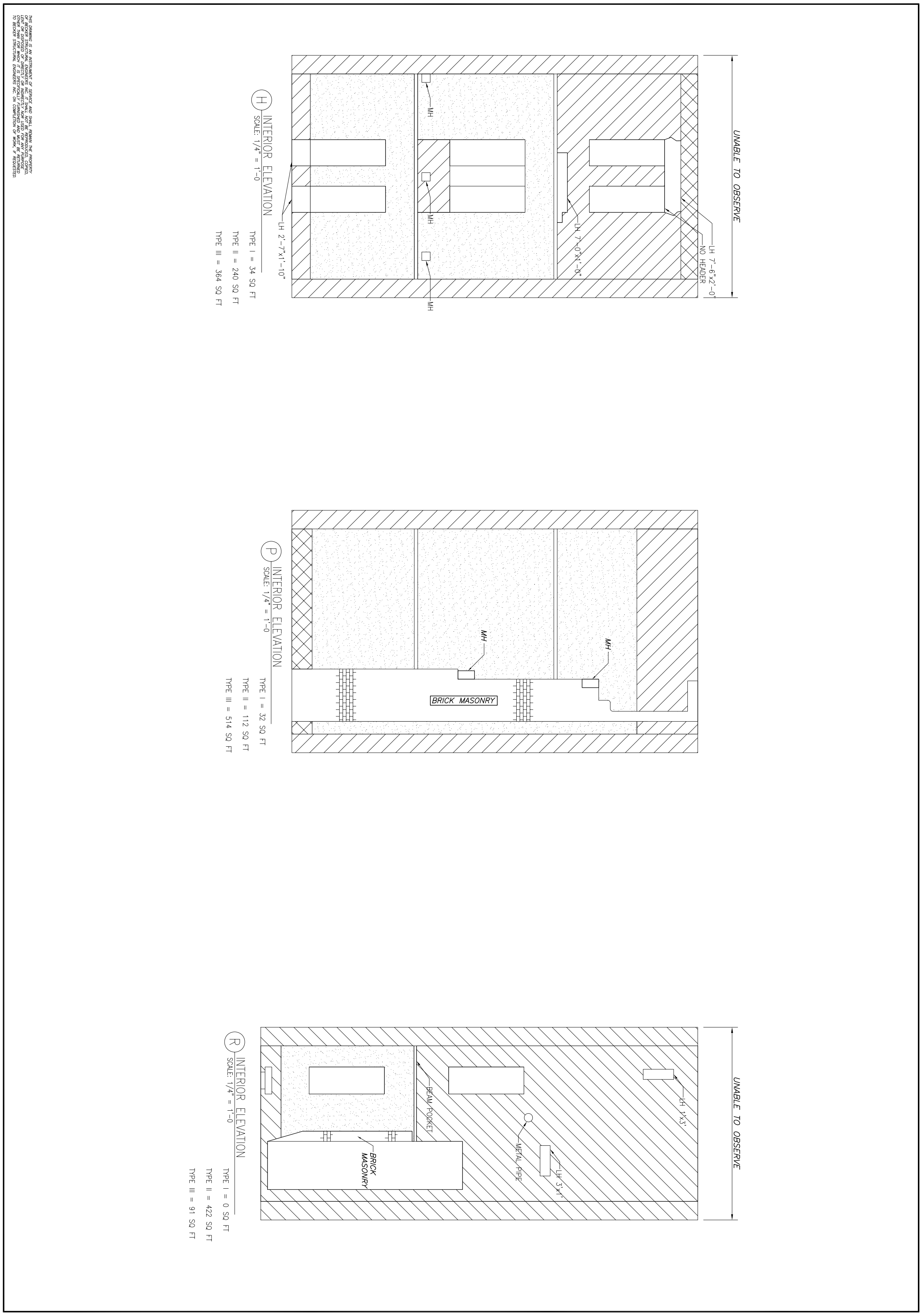

UNABLE TO BE OBSERVED
BURNT HEADER
SILL/FLOOR POCKET
BEAM POCKET
LH 3'-7"x2'-0"
LH 3'x2'
LH 3'-7"x1'-6"
N INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 0 SQ FT
TYPE II = 214 SQ FT
TYPE III = 262 SQ FT
EXIST CONC CAP
EXIST CONC CAP
JOIST & BEAM POCKETS
WOOD EMBED
WOOD EMBED
MH
SH
LEAD FLASHING
LH 2'-0x1'-0"
LH 1'-6"x2'-0"
LH 1'-6"x4'-0"
LH 1'-6"x2'-0"
LH 4'-0"x2'-6"
CRACK
S NORTH INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 135 SQ FT
TYPE II = 431 SQ FT
TYPE III = 121 SQ FT
EXIST CONC CAP
CRACKS
MH
JOIST POCKET
LH 2'-0"x1'-6"
BEAM POCKET W/ WOOD
BEAM POCKET W/ WOOD
Z SOUTH INTERIOR ELEVATION
SCALE: 1/4" = 1'-0
TYPE I = 117 SQ FT
TYPE II = 316 SQ FT
TYPE III = 263 SQ FT
S9
Designed NRM
Drawn MCN
Checked NRM
Scale NOTED
Date 11/20/08
Becker Job Number 1871
GODDARD MANSION
CAPE ELIZABETH, ME
ELEVATIONS
Rev No
Date
Issued For
Apprd
BECKER
structural engineers, inc.
75 York Street
Portland, ME 04101-4701
Tel 207-879-1838
Fax 207-879-1822



S10

Designed NRM | Scale NOTED
Drawn MCN | Date 11/20/08
Checked NRM | Becker Job Number 1871

GODDARD MANSION
CAPE ELIZABETH, ME

ELEVATIONS

Rev. No	Date	Issued For	Apprd

BECKER
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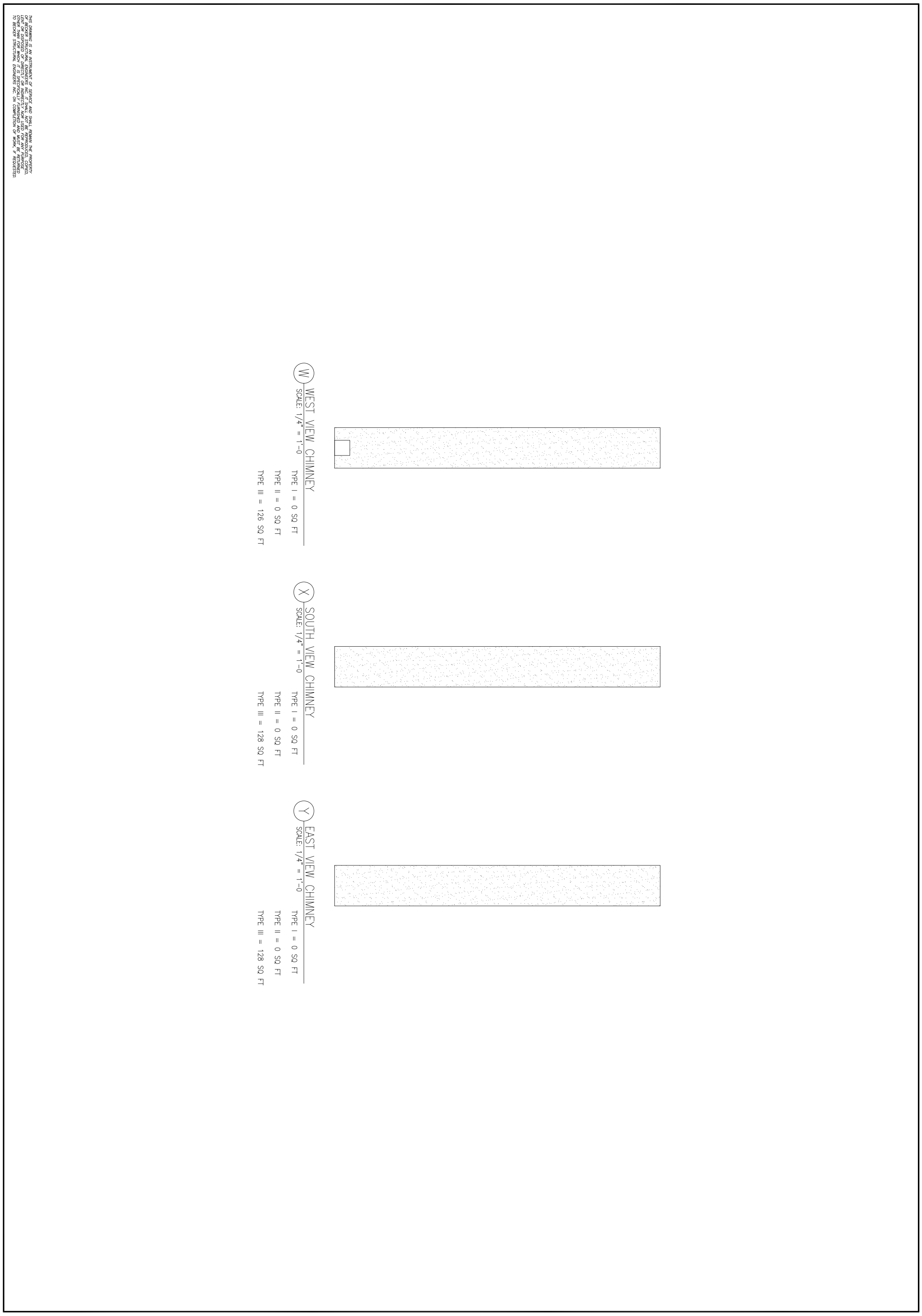

S11

Designed NRM | Scale NOTED
Drawn MCN | Date 11/20/08
Checked NRM | Becker Job Number 1871

GODDARD MANSION
CAPE ELIZABETH, ME

ELEVATIONS

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FORT WILLIAMS BLEACHER INVESTIGATION
9/17/2008

We have concluded our field evaluation of the existing concrete bleachers at the site of the former parade grounds. The former parade grounds have been converted to a Little League baseball field. Our evaluation was directed at determining the practical and economical viability of repairing the existing concrete elements to provide a safer and more enduring feature.

Our field investigation included visual observations of the concrete section, probing of the cementitious coating applied approximately 10 years prior, and consulations with concrete repair contractors with whom we have collaborated on other projects, specifically the repair of concrete parking structures. Open parking structures are subjected to continuous exposure to the elements, thermal gradients and high levels of de-icing salts; some of the most severe long-term conditions a structure may face and this experience flavors our perspective regarding the bleacher evaluation. In addition to our observations and discussions we removed three concrete cores from the riser portion of the bleachers. One core was broken in the lab to evaluate the strength of the concrete. Another core was sent to a laboratory in Ohio for petrographic analysis. The core is sliced wafer thin and analyzed under a high powered microscope to evaluate the properties of the existing concrete.

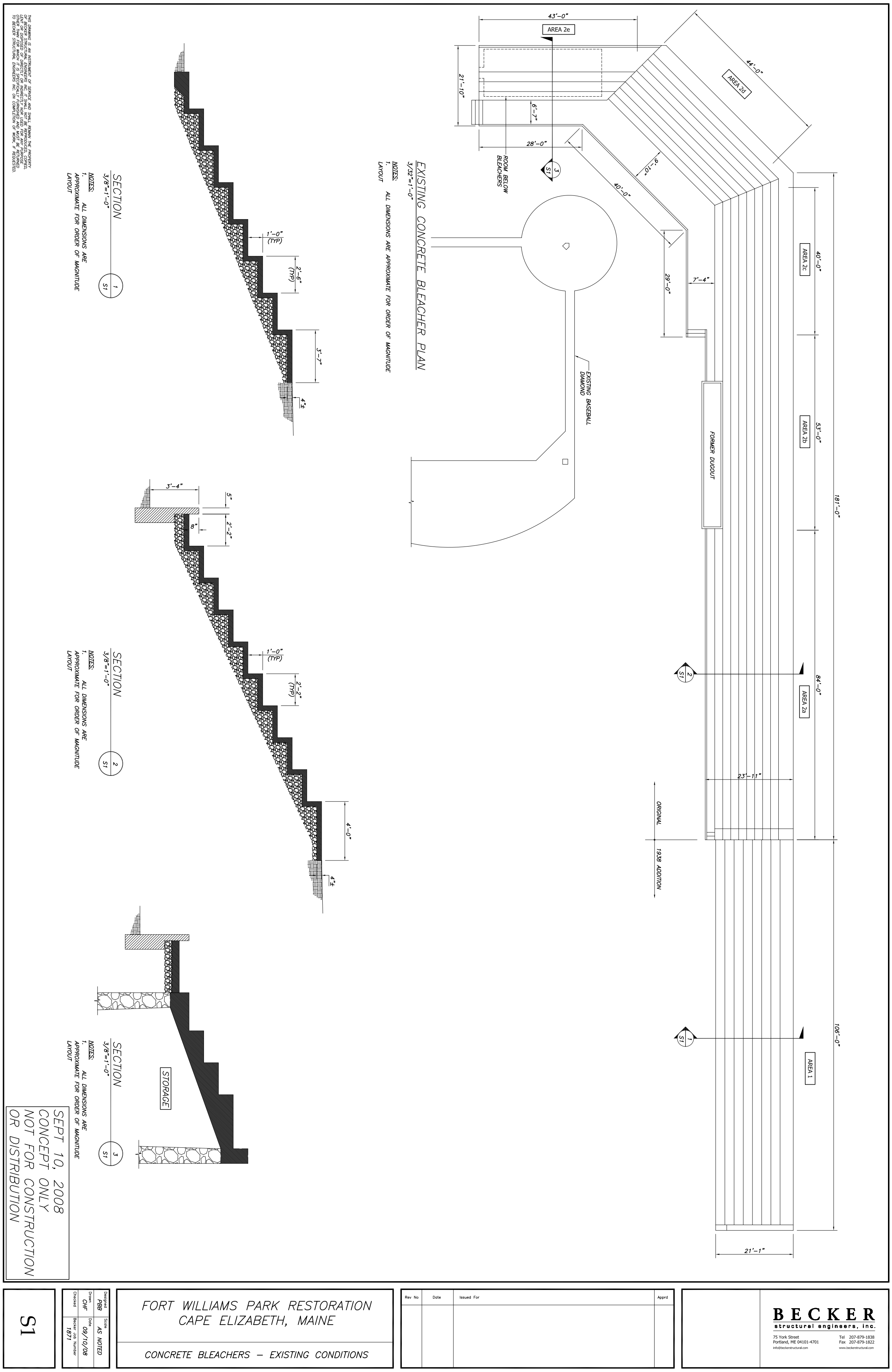
Our core sample determined that the existing concrete strength is over 5,500 psi and this represents an appropriate strength for exterior exposure. The petrographic analysis indicated that the concrete contained approximately 9 bags of cement per yard which is consistent with high strength concrete. However, the concrete was poorly consolidated, contained smaller aggregates and it was not air entrained. The poor consolidation and fine aggregates result in a thin cement rich layer at the top of the concrete surface with a leaner (lower cement content) at the underlying layers. The sample also showed evidence of freeze-thaw damage. Lack of air entrainment makes concrete prone to freeze-thaw damage. Air entrainment is incorporated into modern concrete to provide resistance to freeze-thaw damage. The report cites “The high cement factor would have allowed placement of the concrete at a low water cement ratio. The low water to cement ratio of the layer would reduce permeability and improve freeze-thaw durability within it. However, once cracks form and water can enter into the underlying less durable body of the concrete, the mortar would act to trap water in the underlying concrete body and freeze-thaw damage to the protective mortar layer would occur.”

We considered two options; repair or replacement. There is also a third, “do nothing” option. With regard to repair, the cost of repair would be significant and a repair will only address the cracks and damage which is visible at the time of the repair. The material properties and data suggest that the existing concrete lacks the composition to provide durability and will be subject to continued deterioration. Money invested today for repairs will need to be followed by a continuing fund to repair new areas of damage which develops.

Considering the size of the bleachers and the limited use of the facility, this does not seem to be a wise investment of monetary resources.

In considering the removal and replacement option, the extent of replacement is also in play. It seems the existing bleacher can be demolished and a new smaller bleacher constructed in its place. The extent of the new bleacher would include the area surrounding the ball field backstop and include replacement of the underground storage room. The balance of the old bleacher, extending to the water can be left as a graded and grass covered slope which could serve as an on ground seating area for amphitheatre type events.

Based on our initial cost evaluation, it will be less costly or perhaps the same cost to pursue the removal and replacement option which will provide an enduring, relatively maintenance free seating option which can incorporate ADA accessibility and improved safety and access.


EXISTING CONCRETE BLEACHER PLAN
3/32"=1'-0"
NOTES:
1. ALL DIMENSIONS ARE APPROXIMATE FOR ORDER OF MAGNITUDE LAYOUT
SECTION
3/8"=1'-0"
NOTES:
1. ALL DIMENSIONS ARE APPROXIMATE FOR ORDER OF MAGNITUDE LAYOUT
STORAGE
AREA 1
AREA 2a
AREA 2b
AREA 2c
AREA 2d
AREA 2e
FORMER DUGOUT
EXISTING BASEBALL DIAMOND
ROOM BELOW BLEACHERS
ORIGINAL
1938 ADDITION
181'-0"
106'-0"
84'-0"
53'-0"
40'-0"
44'-0"
43'-0"
28'-0"
29'-0"
23'-11"
21'-1"
21'-10"
SEPT 10, 2008
CONCEPT ONLY
NOT FOR CONSTRUCTION
OR DISTRIBUTION
S1
FORT WILLIAMS PARK RESTORATION
CAPE ELIZABETH, MAINE
CONCRETE BLEACHERS — EXISTING CONDITIONS
Scale AS NOTED
Date 09/10/08
Rev No
Date
Issued For
Apprd
BECKER
structural engineers, inc.
75 York Street
Portland, ME 04101-4701
Tel 207-879-1838
Fax 207-879-1822

Introduction

At the request of Mr. Paul Becker, P.E. of Becker Structural Engineers, Inc., petrographic studies of a concrete core that had been extracted from the Bleachers at Fort Williams Park, Cape Elizabeth, ME were conducted. The concrete represented by the core has been in service for about 90 years. About 15 to 20 years ago, the exposed surfaces of the bleachers were coated with a repair mortar. The current studies were requested to characterize the concrete.

Sample

One 2.6-inch diameter concrete core was submitted for the studies. The core was not marked. The asreceived appearance of the core is shown in Figures 1 through 3. The core was 2.2 inches long and was reported to represent concrete from a "good" location in the bleachers. Two 1/2 inch thick slabs were cut lengthwise from the center of the core using a water-cooled continuous-rim diamond saw blade. The plane surfaces were lapped using progressively finer silicon carbide abrasives. The lapped surfaces and the remainders of the cores were then examined using methods outlined in ASTM C856 Standard Practice for Petrographic Examination of Hardened Concrete and ASTM C457 Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.

Studies

The exposed surface of the core had been coated with a gray polymeric layer that had largely deteriorated (Figure 4). The coating was partially covered with dormant plant life. A highly air-entrained mortar layer that was approximately 0.04 inch thick adhered to the base concrete (Figure 5). The mortar was firm, but it could be disrupted with a steel probe. It contained fine siliceous sand aggregate. Both fly ash and portland cement were detected in the mortar layer.

The air-entrained mortar had been applied to the eroded surface of the base concrete (Figure 5). The matrix of the base concrete just beneath the interface with the air-entrained mortar was tan-colored. This tan colored region of the matrix was fully carbonated, but the underlying body of the cementitious matrix was not carbonated.

The coarse aggregate was a natural pea gravel composed of various felsic to mafic igneous rock types as well as metamorphic rock types. The maximum nominal size of the aggregate was 3/8 to 1/2 inch (Figure 6). Fine grained igneous rocks included granite as well as fine grained volcanic rock. Fine grained metamorphic rocks that included phyllite, schist and gneiss were also present. A number of the coarse aggregate particles exhibited clarified rims, which can be indicative of a reaction with the surrounding cementitious matrix (Figure 6 and 7). Since the coarse aggregate is a natural gravel, it is possible that the clarified rims formed due to weathering before the particles were incorporated into the concrete. In one case, a coarse aggregate particle located near the surface of the core had a partial darkened rim. Theportion of the particle that did not have the darkened rim was adjacent to a crack (Figure 8). The cementitious matrix adjacent to the crack was carbonated. This condition suggested that the partial rim on the particle formed after it was incorporated into the concrete. No evidence of deleterious expansion of aggregate particles with clarified rims was detected. However, a single entrapped air void located near the base of the core was seen to be filled with a white secondary deposit (Figure 9). When viewed at higher magnification using the petrographic microscope, the portion of the secondary deposit located adjacent to the void surface was seen to contain isotropic material that had a low refractive index (Figure 10). This is characteristic of silica gel. The remaining material in the center of the void had high birefringence which is typical of carbonated silica gel.

The body of the cementitious matrix was medium to dark gray (Figure 6). Dark gray regions were typically deficient in aggregate (Figure 11). This is indicative of incomplete initial mixing. The dark gray regions contained concentrations of coarsely ground residual portland cement (Figure 12) and had a very low water to cement ratio. The coarsely ground nature of the residual portland cement particles is consistent with the reported age of the concrete.

The cementitious matrix was not air entrained. Air was present in irregularly-shaped voids that are characteristic of entrapped air. The volumes of the coarse and fine aggregates, cementitious matrix and air were determined using the modified point count method outlined in ASTM C457 and the results are given in the Table. As expected for non-air-entrained concrete, the parameters of the air void system were well outside the range normally expected for modern air-entrained concrete. The measured paste volume is unusually high and is consistent with a cement content of more than 9 bags of cement per cubic yard of concrete.

Two microfractures that were oriented parallel to the exposed surface were detected near the base of the core (Figure 13). The orientation of these cracks is consistent with freeze-thaw distress. However, no similar cracks were detected in the upper two inches of the core.

Summary and Discussion

The body of the concrete represented by the core was in remarkably good condition. Textural features detected in the concrete indicated that a reaction between some of the fine grained siliceous aggregate particles and the surrounding matrix may have occurred (that is, the alkali silica reaction or ASR). However, no evidence of deleterious expansion was detected.

Textural features also indicate that the concrete was very poorly mixed. The high estimated cement factor of 9 bags per cubic yard of concrete may simply indicate that the sample was extracted from a cement rich region of poorly mixed concrete. However, the relatively fine size (pea gravel) of the aggregate, in combination with its generally good dispersion suggests that the concrete may represent a thin cementrich layer of material that was installed over a much leaner (that is, lower cement factor) concrete mix that may make up the bulk of the bleachers. Cement-rich mortar layers were commonly used before about 1940 to improve durability of concrete prior to widespread use of air entrainment. The high cement factor would have allowed placement of the concrete at a low water to cement ratio. The low water to cement ratio of the layer would reduce permeability and improve freeze-thaw durability within it. However, once cracks form and water can enter into the underlying less durable body of the concrete, the mortar would act to trap water in the underlying concrete body and freeze-thaw damage to the protective mortar layer would occur. The presence of fractures that may be indicative of freeze-thaw distress near the base of the core are consistent with this interpretation. Examination of concrete below the level represented by the submitted core would be needed to confirm this interpretation.

Storage: Thirty days after completion of our studies, samples will be discarded unless the client submits a written request for their return. Shipping and handling fees will be assessed for any samples returned to the client. Any hazardous materials that may have been submitted for study will be returned to the client and shipping and handling fees will apply. The client may request that WJE retain samples in storage in our warehouse. In that case, a yearly storage fee will apply.

Table. Air Void System Parameters for a Concrete Core from the Bleachers Located at the Fort Williams Park Parade Ground, Cape Elizabeth, ME

	Observed Parameters	Usual Requirements
Sample Identification	Fort Williams Park Bleachers	--
Air Content (%)	1.8	5 to 8
Paste Content (%)	39.3	--
Sand Content (%)	23.8	--
Coarse Aggregate (%)	35.1	--
Number of Voids/inch	1.07	Greater than the percent of entrained air
Average Chord Intercept (inch)	0.0017	--
Specific Surface (in^2/in^3)	232	Greater than 600
Spacing Factor (inch)	0.0380	Less than 0.008

Figure 1. The as-received appearance of the top of the core sample is pictured.

Figure 2. The as-received appearance of the bottom of the core sample is pictured.

Figure 3. The as-received appearance of the side of the core sample is pictured.

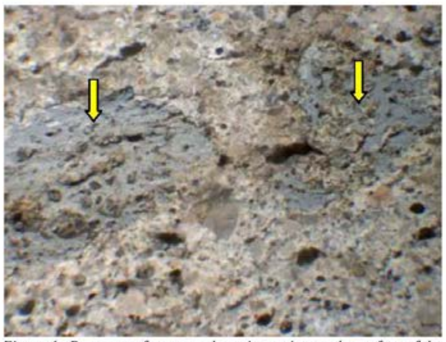


Figure 4. Remnants of a gray polymeric coating on the surface of the core are marked with arrows. The small depressions in the coating contain dormant plant life. The width of the field of view is 0.25 inch.

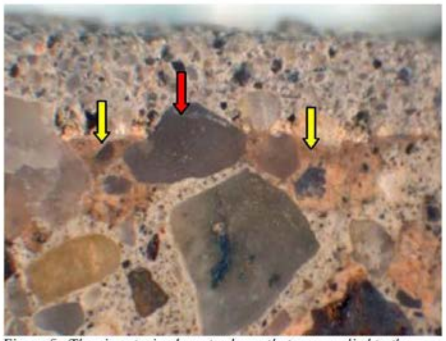


Figure 5. The air entrained mortar layer that was applied to the surface of the core is visible along the top of the photo. The red arrow marks a sand particle that was exposed on the eroded surface of the base concrete at the time the mortar layer was applied. The yellow arrows mark the tan-colored fully carbonated portion of the cementitious matrix of the base concrete. The width of the field of view is 0.5 inch.

Figure 6. One of the lapped surfaces used for the studies is pictured. The yellow arrow marks a dark gray concentration of incompletely dispersed portland cement. Note the small size of the coarse aggregate particles (pea gravel 3/8 to 1/2 inch maximum nominal dimension). Many of the aggregate particles can be seen to exhibit darkened (clarified) rims which may be indicative of a reaction with the surrounding cementitious matrix. The width of the sample is 2.5 inches.

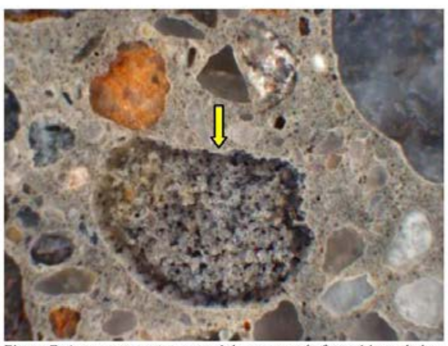


Figure 7. A coarse aggregate particle composed of granitic rock that has a clarified rim is marked with a arrow. No evidence of deleterious expansion is present. The width of the field of view is 0.5 inch.

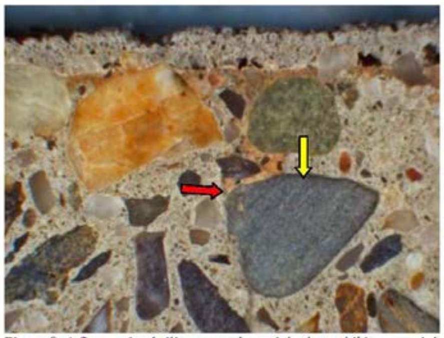


Figure 8. A fine grained siliceous rock particle that exhibits a partial darkened rim is marked with a yellow arrow. Note that the particle does not have a darkened rim along the left side of the particle where it is in contact with a crack and carbonated cementitious matrix (marked with a red arrow). The width of the field of view is 0.5 inch.

Figure 9. An air void located near the base of the core that is filled with a white secondary deposit is marked with an arrow. Note the darkened bands around the perimeters of the particles marked with red arrows. The width of the field of view is 0.25 inch.

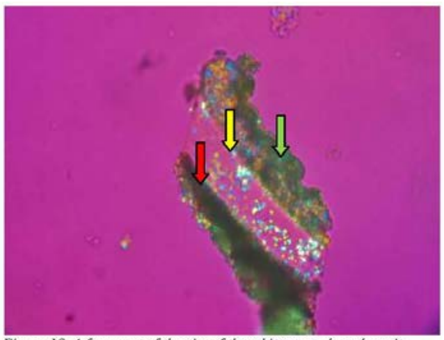


Figure 10. A fragment of the rim of the white secondary deposit contained in the void pictured in Figure 9 as viewed using polarized transmitted light is pictured. (The gypsum plate is in the light path.) The yellow arrow marks the optically isotropic region. The red arrow marks the fragment of cementitious matrix of the concrete that is adjacent to the perimeter of the void. The green arrow marks the highly birefringent dull white material that fills the bulk of the void. The width of the field of view is 0.015 inch.

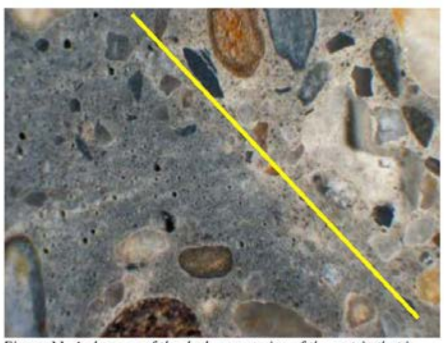


Figure 11. A close-up of the dark gray region of the matrix that is deficient in aggregate content is visible to the left of the yellow line. Note the small spherical voids contained in the dark gray zone. Similar voids were not detected in the body of the matrix.

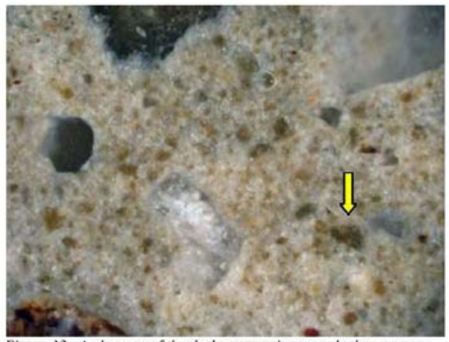
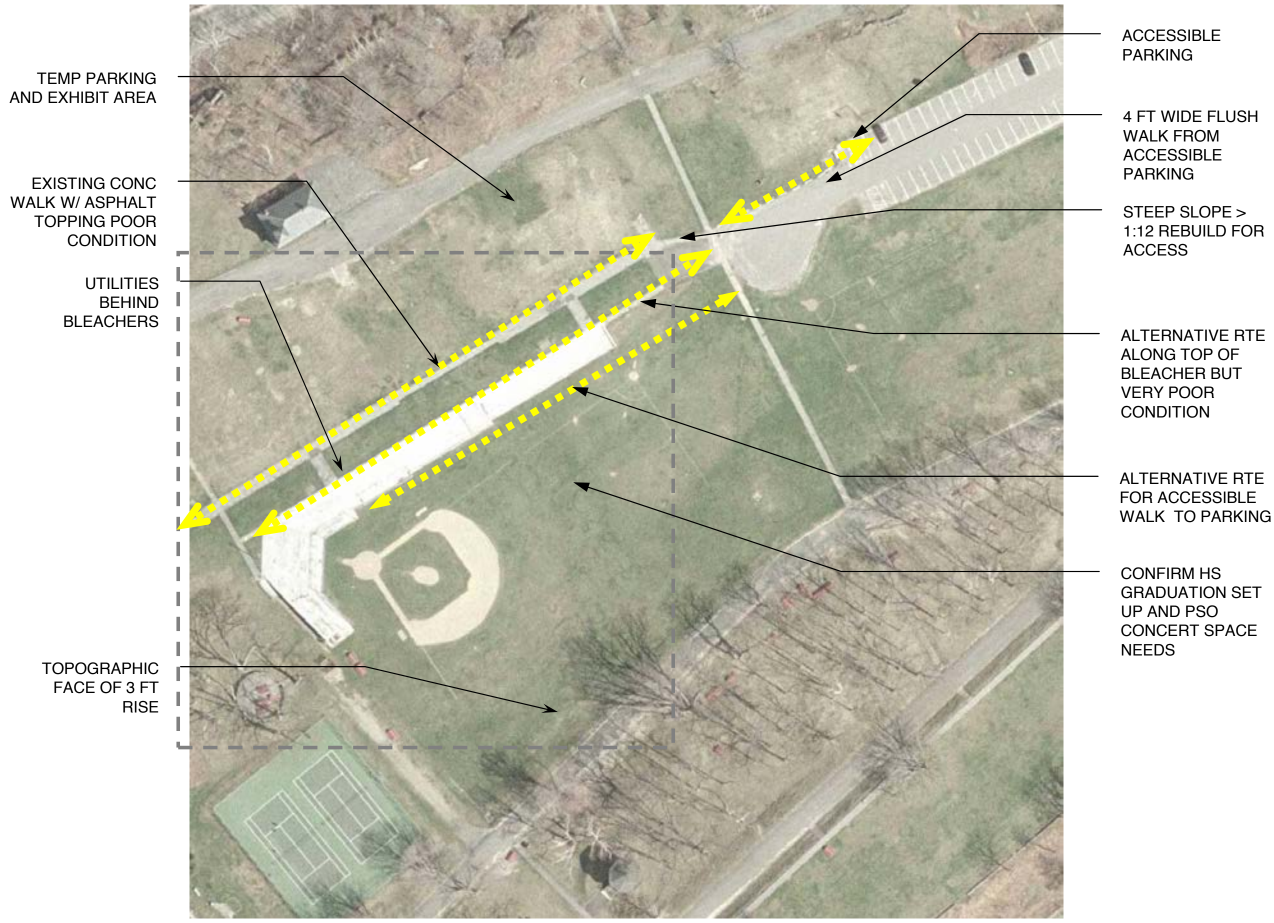
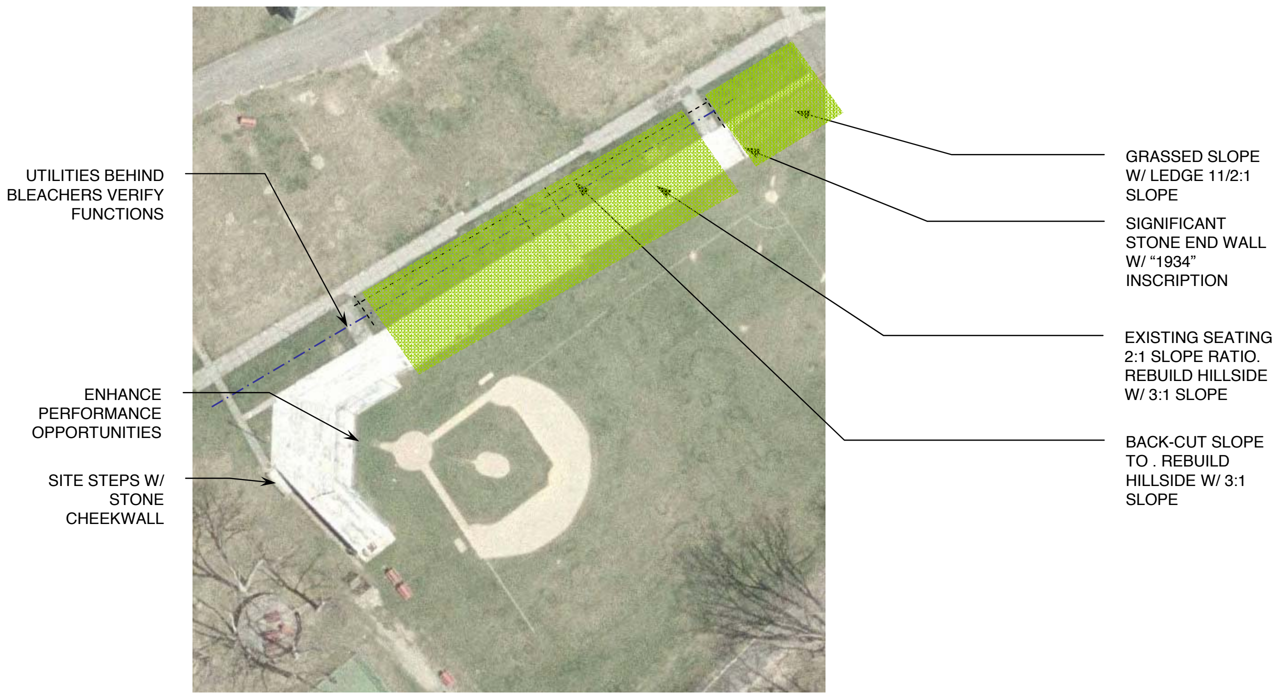


Figure 12. A close-up of the dark gray region reveals the presence of very closely spaced coarsely ground residual cement particles. The yellow arrow marks a portland cement particle that has a length of 0.007 inch (and would be retained on a 80 mesh screen). The width of the field of view is 0.11 inch.

Figure 13. Two cracks that may be indicative of freeze-thaw distress and that are located near the base of the core are marked with arrows. The width of the field of view is 0.25 inch.



Parade Grounds Environs



Bleacher/ Ball field Site

L 2.1	**Site Improvements Concept Plan** Drawn by / Scale NTS / Date 11.20.08 File Bleachers / Project No 210800298 / Revised	Fort Williams Bleachers Shore Rd. Cape Elizabeth, Maine	**Consultants** Becker Engineering STANTEC	**Renner | Woodworth** 25 Pleasant Street Portland, Maine 04101 207.773.9699 207.773.9599 fax


11/18/2008


11/18/2008

FORT WILLIAMS BATTERY BLAIR INVESTIGATION
9/17/2008

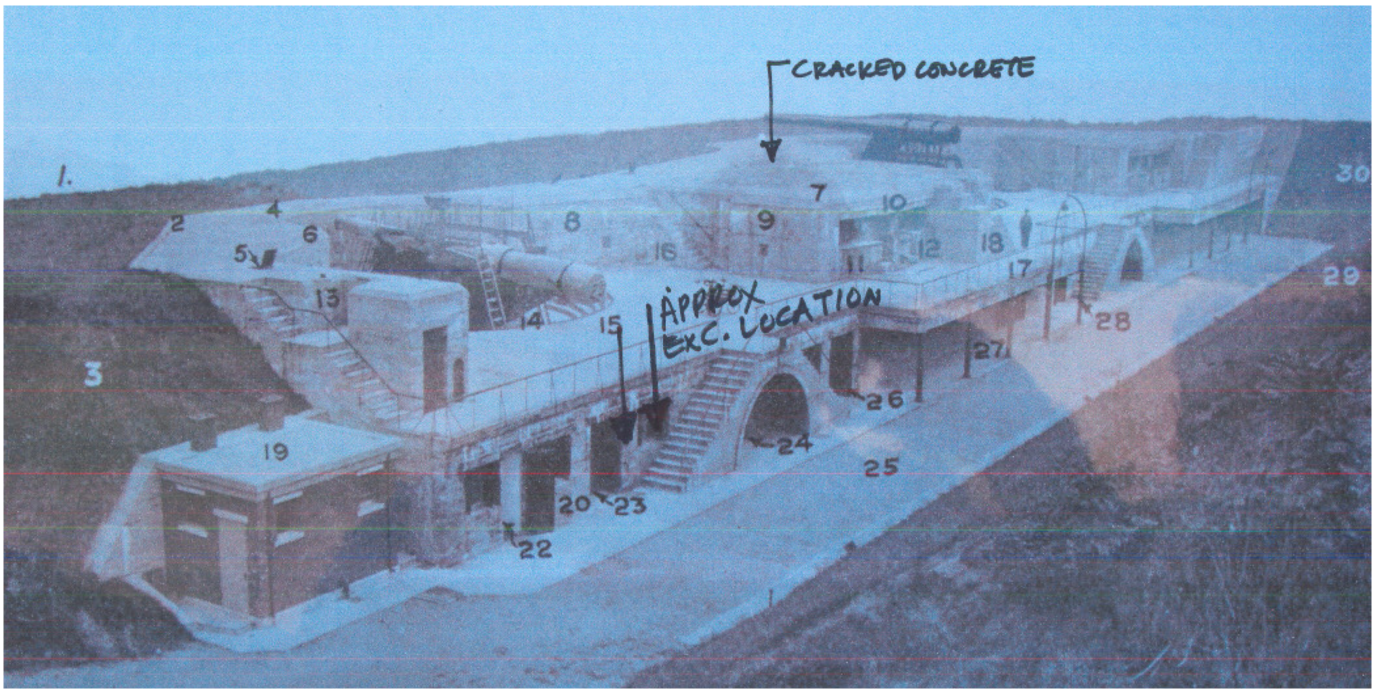
On Wednesday September 03, 2008 we visited the site with Rick Renner, Tom Emory for the purpose of conducting an exploratory excavation at the buried face of Battery Blair. Bob Malley from the Town of Cape Elizabeth attended and provided a backhoe and backhoe operator. The presumed face of the gun platform was paced off from the display wall and over from the edge of the battery.

The excavation went down about 4 ft until an existing door or window opening was revealed. A large boulder blocking the opening was moved and the interior of the chamber was visible. It seems prior to backfilling each door or window opening was blocked by a boulder to avoid filling the chambers. The chamber interior was relatively dry and free of backfill material. There were some stalactites at the ceiling indicating salt laden water is migrating through the structure from the top surface. The exterior concrete condition at the excavation appeared good with evidence of cracking caused by chloride infiltration and corrosion of reinforcing steel. Based on the limited observations I view this cracking to be of a minor nature.

We moved the backhoe to try removing a loose section of the battery roof. The roof surface is scored and it appears that there may have been a concrete topping placed over the structural concrete. The removal of cracked concrete indicated that the crack extended deep into the roof surface and that the roof is likely monolithic.

We recommend the roof surface in the vicinity of this preliminary investigation be core drilled to establish the thickness and scanned with an R meter to determine the location of rebar. Local chipping of the concrete will establish the bar size and condition.

The exposed surface of the Battery has been coated with a cementitious parge coating. The coating is severely cracked and “bubbled”. It is clearly trapping moisture and is detrimental to the long term condition of the concrete. It is our recommendation that any renovation or remedial work include removal of all parge coatings.



December 20, 2008

Robert C. Malley
Director of Public Works
Town of Cape Elizabeth
10 Cooper Drive
Cape Elizabeth, ME 04107

FORT WILLIAMS – BATTERY KEYES STRUCTURAL INVESTIGATION
CAPE ELIZABETH, MAINE

Dear Bob,

Based on our proposal and your verbal authorization, we have begun our evaluation of the existing structure at Battery Keyes. Field work was performed on October 27, 2008 by Nathan Merrill, E.I. and again on November 13, 2008 with Paul Becker, P.E. Scope of work is to provide a structural evaluation along with recommendations for stabilizing the battery and improving visitor safety. The attached photos accompanied by a diagrammatic floor plan and building elevations will serve to document our findings and identify areas that we believe will require remedial action.

Background

Battery Keyes, located at Fort Williams Park, was originally completed in 1906 outfitted with two-3" Rapid-Fire Guns on pedestal mounts. A Mine Observation Station was built atop the battery between the years of 1906 and 1917. The observation station is a rare surviving example of stucco-type construction. In 1921 an additional building was set alongside the battery and housed a newly developed Coincidence Range Finder (CRF) Station. Battery Keyes remained an active Battery through World War II but was inactivated by 1946. In 1964 the town of Cape Elizabeth purchased Fort Williams from the GSA and since then the battery has seen little maintenance.

Observations

The structural elements of the Battery, Mine Observation Station and CRF Station were visually inspected to identify their condition and photographs were taken for record. Please see the attached photos and drawings for documented observations.

Coincidence Range Finder Station

Observation began to the right (when viewed from roadway) of the Battery complex at the CRF Station building. The roof of the building was found to be a sloped monolithic steel reinforced concrete slab supported by steel beams on 3 sides and concrete bearing wall on 1 side. The drip edge of the slab was observed to be spawled and extremely weathered with exposed reinforcing steel. A crack in the slab was observed to extend the entire width and thickness of the slab. The crack was located where the bearing transitions from steel beam to concrete bearing wall.

Steel I-beams supporting the roof slab were found to be extremely corroded. Severe scaling of the flanges and webs was observed over the majority of the beam spans with numerous locations of holes present in the beam web. Gaps were observed between the beams and the roof slab around a majority of building. Steel beams were found to be supported by small diameter steel pipes at two locations and concrete bearing walls at two locations. Steel pipes were observed to be skewed from plumb and extremely corroded at the top and bottom with the field of the pipe showing no significant signs of corrosion. Beams appeared to be mitered at corners supported by pipes with the connection between beams exhibiting severe corrosion.

Exterior bearing walls and site walls were found to be constructed of cast-in-place steel reinforced concrete. Cracks were found throughout the walls along with areas where concrete was spawled. Previously performed repairs of spawled locations were observed at numerous locations. In some cases the repairs were found to be spawling as well.

Stairs leading to the entry of the structure that were 30 inches above grade or more were found to lack a railing creating a safety concern. Also, at the retaining wall to the side of the station building, intermediate balusters to restrict a 4 inch diameter sphere from passing per applicable codes were observed absent. The entry itself was found to possess spawling concrete in the threshold and cracks were observed at the lintel over the entry. The steel casing at the entry was found to be completely corroded in locations such that no casing remained at all.

Mine Observation Station

The Mine Observation Station was observed atop the original Battery. The observation station is comprised of two unique structures; the station building and a deck that wraps around the building to provide access.

The station building roof structure was not able to be observed at the time of the visit. The roof appeared to be supported by walls on 3 sides and a beam of unknown size or material that spans over an opening on the Oceanside. A post at one end and center of the opening were observed with the post at the other end observed to be missing with nothing supporting the roof corner. Below the opening on the Oceanside wall of the building appeared to be a cast-in-place concrete retaining wall from which the two posts are supported. The balance of the buildings' walls appears to be constructed of wood studs with a cementitious finish on metal lathe both interior and exterior. Access to the wood studs was limited, however the studs observed were found to be weathered and exhibited possible signs of deterioration. The cementitious finish was found to be cracked over a majority of the wall surface.

The cast-in-place reinforced concrete deck slab appeared to possess numerous cracks running between supporting members. Supporting members consist of five equally spaced reinforced concrete beams. The bottoms of the beams are severely spawled with corroded reinforcing steel exposed at four beams and the deck reinforcing is exposed and corroded at many locations. The concrete beams are supported on one end by the battery wall and by reinforced concrete girders on the other. Corroded reinforcing steel is exposed at both girders due to severe spawling as well. Girders span between reinforced concrete columns that are presumably founded on ledge. Columns appeared to be sound with no significant damage.

An addition to the original deck was observed at one end. The addition is comprised of pressure treated lumber decking supported by steel channels and angles fastened to the original concrete structure. Mildew is present on the lumber decking and the angles exhibit surface rusting and pitting, however the connections between angles were unable to be observed at the time of the visit. The perimeter of the deck is enclosed by a steel pipe handrail of varying condition. Also, intermediate balusters to restrict a 4 inch diameter sphere from passing per applicable codes were observed absent. One railing stanchion location was missing fasteners to the support structure. The balance of the railing posts and anchors appeared stable, but were severely weathered.

Battery

The Battery appears to be constructed of cast-in-place concrete. It is unclear whether the concrete is reinforced because a majority of the concrete visible shows little signs of weathering or deterioration. However, isolated areas of cracking and spawling do exist. The interior ceiling and wall finishes of the rooms within the Battery were comprised of cementitious plaster over lath and wood. They were found to be crumbling with clusters of debris found on the floor slab. The concrete structure behind the finishes appears to be in good conditions with no cracks or damage present.

The Battery is flanked each side by a gun platform. Each platform was observed to consist of cast-in-place concrete tiers. On one side of the platform, a cast-in-place concrete wall retains soil where the tiers are lower than surrounding grade. Retaining walls were observed to be cracked and spawled over a majority of their surface. Directly against each retaining wall is a small shell room. The shell room consists of cast-in-place concrete walls and roof. Shell room walls and roofs were observed to be severely cracked and spawled at many locations. The other side of the platform is the side wall of the assumed Tool Room. Tiers and infill cast-in-place concrete steps were found to be cracked and spawled at numerous locations.

Findings

The following summarizes the findings for the various elements of the Battery Keyes.

Coincidence Range Finder Station

Condition of the CRF Station was found to be very poor for the majority of the structure posing a potential safety hazard. Corrosion of the steel I-beams is severe and it appears they may not be capable of supporting the load they were originally intended for as evident in the gaps between the roof slab and beam top flanges. Failure of the steel beams to further support the slab and associated loads may result in the slab spanning a different orientation and a longer length than originally designed, causing a collapse. The large crack in the roof slab is indicative of the slab being overstressed most likely due to these factors. We believe the skewed pipe posts are the result of settlement and movement due to such a failure.

Spawling and cracking of concrete wall is likely the result of two factors; weathering due to freeze/thaw cycles and infiltration of chlorides from constant salt spray. When chlorides are absorbed into concrete they quickly breakdown the protective bond that is formed around the reinforcing steel. Once the bond is broken down, the heightened pH level of the concrete due to the chlorides causes corrosion of the reinforcing. The increase in the steel volume due to the corrosion induces a stress on the concrete resulting in spawling and cracking.

By current applicable codes, guards are required at all locations where landings are located more than 30 inches above grade below. This is to provide safety to pedestrians as they access the CRF station.

Mine Observation Station

The condition of the Mine Observation Station building is mostly unknown due to limited access to view the existing structure. Access should be made in order to observe the roof structure and member over the opening in the ocean side wall in order to review orientation and condition. Cracks in the cementitious wall finish may be caused by movement of the roof structure due to the absence of one corner post. However, it would not take much movement to cause cracking due to the brittle characteristics of most masonry materials. Access should be made in order to observe wall framing condition.

The cast-in-place reinforced concrete deck slab and supporting members were found to be in very poor condition. The damage seen on a majority of the beams is most likely the cause of chloride infiltration as seen at the CRF Station. Corrosion of the steel reinforcing has caused spawling of the surrounding concrete. At many locations, two bars of reinforcing are visible which greatly reduces the beams bending capacity. This reduction in bending capacity may result in movement causing cracks in the deck slab as observed.

The addition to the deck was found to be in unsatisfactory condition. The chemicals in lumber preservatives are often highly corrosive to carbon steel. These preservatives coupled with salt spray result in the corrosion of the steel channels and angles. Access to the connections should be provided in order to review the condition; this includes connections of the railing to the support structure. Corrosion of these areas is especially concerning since failure of the connection could lead to sudden collapse of the addition or railing. By current applicable codes, guards shall have balusters such that a 4-inch diameter sphere cannot pass through any opening up to a height of 34 inches above adjacent walking surfaces. This is to provide safety to pedestrians as they access the observation station.

Battery

The majority of the Battery structure appears to be in good condition with little damage or deterioration visible. However, ceiling and wall finishes at the rooms within the Battery were found to be in poor condition mostly likely due to vandalism. Falling debris from the ceilings and walls pose a safety hazard to visitors. Site walls, stepped tiers and shell rooms accompanying the gun platforms were found to be in poor condition as well. This is the result of weathering due to freeze/thaw action and chloride infiltration over many years of exposure. Most of the damage appears to be non-structural in nature with the exception of cracks and spawling at the shell rooms.

Rehabilitation/Renovation Recommendations

The following summarizes our recommendations for rehabilitation work at Battery Keyes.

Coincidence Range Finder Station

Due to the very poor condition and immediate safety concerns of the roof structure at the CRF Station we recommend the following action be taken as soon as possible to address safety concerns.

• Restrict further access to interior of building and shore the existing roof structure such that roof slab, beams and posts are stabilized. Access to building may resume upon completion. Another option is to demolish the roof slab, beams, and posts leaving the building open.

• Chip away loose concrete from existing walls, slabs and steps, down to sound substrate.

• Install railing at stair entrance and retaining wall for visitor safety and convenience. Handrail design should comply with current applicable building code or seek a waiver for a more minimalistic style due to the historic nature of the structures.

If funds are available for additional repairs, we suggest the following additional items be considered.

• All exposed steel should be treated to resist corrosion in the form of hot-dipped galvanizing or paint coating system.

• Loose areas of existing concrete walls, slabs and steps should be chipped away to sound substrate. Any exposed steel reinforcing should be cleaned free of visible corrosion, coated and the area should be recast. Small cracks in walls should be pressure injected with epoxy.

• Concrete surfaces should be cleaned and sprayed with a concrete sealer. The sealer should help minimize infiltration of water and chlorides that contribute to weathering and degradation and increase the lifespan of the concrete structure.

Mine Observation Station

Access should be made to allow engineer to observe the roof structure and framing over the opening in the ocean side wall in order to review orientation and condition of framing. Also, access should be provided to observe the cementitious wall finish back-up framing. Rehabilitation work to Mine Observation Station may include, but should not be limited to, the following.

• Replace missing post at building corner

• Repair exterior finish system and roof envelope to make water tight.

• Place protective “boot” at exposed roof drip edge which is at eye level and may injure visitors.

Due to the very poor condition and immediate safety concerns of the deck structure at the Mine Observation Station we recommend the following action be taken to address safety concerns.

• Restrict further access to deck such that visitors are kept a safe distance from the deck. Shore the existing structure such that slab, beams, columns and addition are stabilized.

• Loose areas of existing concrete slab, beams and columns should be chipped away to sound substrate.

If funds are available for additional repairs, we suggest the following additional items be considered.

• Demolish deck structure including slab, concrete beams, columns and steel angle addition and rebuild in kind. Railing should be inspected for condition and anchorage with repairs as necessary. Railing upgrades to comply with current codes may be required. Access to the deck may resume upon completion.

• All exposed steel should be treated to resist corrosion in the form of hot-dipped galvanizing or paint coating system.

• Any exposed steel reinforcing should be cleaned free of visible corrosion, coated and the area should be recast. Small cracks in walls should be pressure injected with epoxy.

• Concrete surfaces should be cleaned and sprayed with a concrete sealer. The sealer should help minimize infiltration of water and chlorides that contribute to weathering and degradation and increase the lifespan of the concrete structure.

Battery

Due to the poor condition of the Battery rooms we recommend restricting further access to rooms within the Battery until loose ceiling and wall debris is completely removed or repaired. Loose concrete at site walls, stepped tiers and shell rooms accompanying the gun platforms should be removed. Exposed rebar should be removed or surface cleaned and areas of removed concrete should be recast if aesthetically desired. Cracks should be cleaned free of debris and pressure injected with epoxy. All stairs at the gun platforms should be chipped of loose concrete and repairs cast in place such that stair is returned to "original" condition. All concrete surfaces should be cleaned and sprayed with a concrete sealer. The sealer should help minimize infiltration of water and chlorides that contribute to weathering and degradation and increase the lifespan of the concrete structure.

Maintenance Recommendations

In addition to the previously stated rehabilitation recommendations, annual inspection of the Battery complex should be performed in order to maintain repairs. Structure should be inspected annually for damage that may have occurred due to chloride attack or freeze/thaw action through the winter season. Due to the harsh environment, we recommend that the exposed surfaces be re-sealed once every 5 years.

Conclusions

Based on our observations and findings we have concerns over visitor safety that should be addressed as soon as possible at the Battery Keyes site. We recommend temporarily restricting access to observers within 10 feet of the perimeter of the CRF Station and the Mine Observation Station (building and deck structures) until certain stabilization work is completed. We also recommend temporarily restricting access to the rooms within the Battery until additional stabilization work is completed. In addition to structural stabilization, other work may be done at the site to benefit the longevity of the structures, overall aesthetics and visitor convenience.

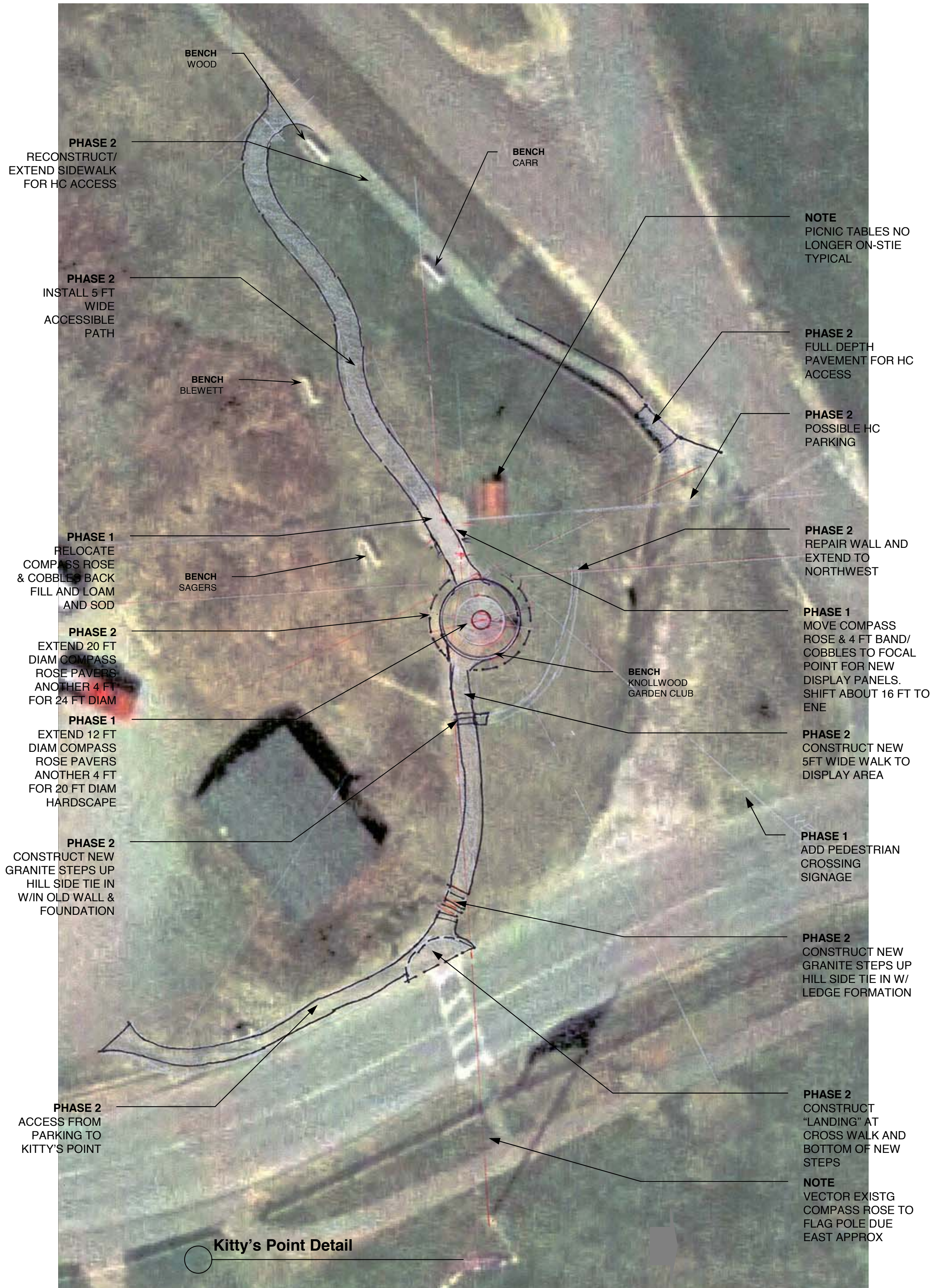
We trust this letter and attachments address your concerns at this time. We are available to discuss this information if you have any questions.

Sincerely,

BECKER STRUCTURAL ENGINEERS, Inc.

Nathan Merrill, E.I.
Paul Becker, P.E.
Attachment

BATTERY KEYES



L 1.1	**Site Improvements Concept Plan** **Drawn by** / **Scale NTS** / **Date 12.03.08** **Goddard Mansion** / **Project No 210800298** / **Revised**	Fort Williams Goddard Mansion Site Shore Rd. Cape Elizabeth, Maine	**Consultants** Becker Engineering STANTEC	**Renner | Woodworth** **25 Pleasant Street** **Portland, Maine 04101** **207.773.9699** **207.773.9599 fax**

LOOKING NORTH

Portland, Maine

Population:
65,000

Surrounding Population:
250,000

Number of Languages Spoken in the Portland Public Schools:
40

Visitors Per Year:
3,750,000

Average Summer Temperature, F:
82°

Miles from Boston:
100

Amount of office space in downtown, in millions of sq ft:
4,000

Arts events each year:
2,000 (over 50% are free)

The motto of Portland, Maine's largest city, is "Resurgam" ("I will rise again"), reflecting the city's resilience after four catastrophic fires from 1690 to1886. The last destroyed 2,000 buildings and left 75% of the population homeless. Portland is considered the state's cultural, social, and economic hub.

Theater and Casino

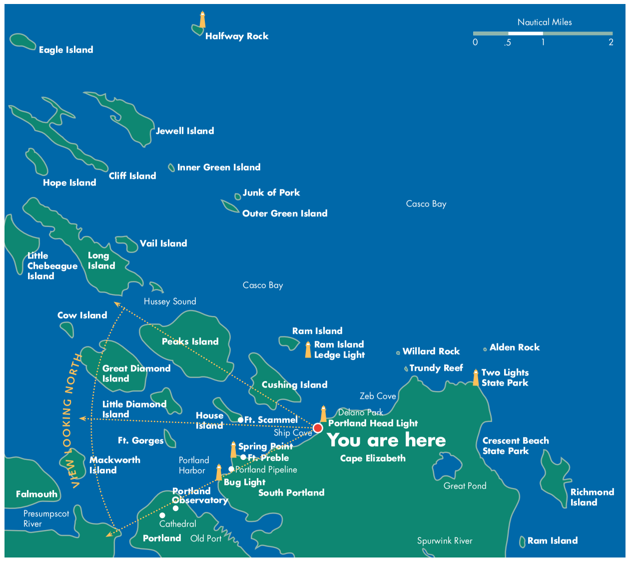
Cape Cottage Theater and Casino stood at Shore and Surf Roads. In the late 1800s a round-trip trolley from Portland was twenty cents, including admission to the summer theater. Near the end of every performance, the audience could hear the squealing of the wheels on the tracks as the trolley cars lined up in front of the theater to take patrons back to Portland.

Courtesy of Cape Elizabeth Historical Society

Colonel John Goddard

At the time of the Civil War, Colonel John Goddard was the wealthiest man in Cape Elizabeth. Goddard was responsible for organizing the First Maine Cavalry. His former residence is located in Fort Williams Park, near Ship Cove.

Courtesy of Cape Elizabeth Historical Society

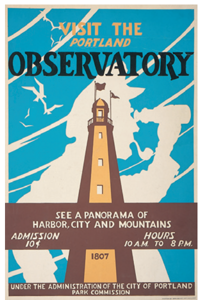


The Portland Observatory

The Portland Observatory is the only extant maritime signal station in the United States. The Observatory became a National Historic Landmark in 2006.

Sea captain-turned-entrepreneur Lemuel Moody (1768-1846) ordered construction of this octagonal, 86' high tower to serve as a communication station for Portland's bustling harbor. With his powerful telescope, Moody identified incoming vessels and then used coded signal flags to alert merchants, allowing them ample time to reserve a berth on the wharves and to hire a crew of stevedores before a vessel docked.

From the time it opened in 1807 (when it included dance halls and a bowling alley), the Portland Observatory was a tourist attraction.



North Atlantic Fleet

During World War II, Portland served as the home base for the North Atlantic Fleet of the U.S. Navy from 1940-1945.

Courtesy of Renner|Woodworth

Liberty Ship Memorial

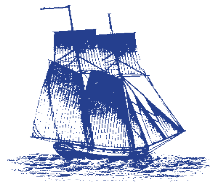
Located on the site of the former shipyards, the Liberty Ship Memorial stands in tribute to the New England Shipbuilding Corporation and the thousands of men and women who built and sailed on Liberty cargo ships during WWII.

The Liberty Ship Memorial is located in Bug Light Park, South Portland. Two hundred sixty-six Liberty Ships were built in South Portland from 1941 to 1945.

Portland Marine Society

In 1796, the stated purposes of Portland's new society were two-fold: first, "the promotion of the knowledge of navigation and seamanship," and second, "the relief of decayed and disabled seamen, and the poor widows and orphans of deceased seamen."

The Portland Marine Society is still active today and is located on Commercial Street in Portland.



Fort Scammel and Fort Gorges, Maine by Seth Eastman (1808 - 1875), Oil on canvas, 1872
Courtesy of U.S. Senate Collection

Coastal Fortifications

Following the War of 1812, the Army Corps of Engineers proposed that a fort be built on Hog Island Ledge in Casco Bay, at the entrance to Portland Harbor. Named for the colonial proprietor of Maine, Sir Ferdinando Gorges, it was designed to support existing forts, including Fort Scammel, built on nearby House Island in 1808.

Congress, however, did not fund construction of Fort Gorges until 1857. Fort Preble, on the campus of Southern Maine Community College in South Portland, was built in 1808 and named in honor of Commodore Edward Preble.

This painting hangs in the U.S. Capitol in Washington, D.C.

1,100

It is said that
Portland has more restaurants per capita than any other U.S.city except San Francisco.

Courtesy of Portland Montreal Pipeline

Portland Montreal Pipeline

Since it first opened in the autumn of 1941, Portland Montreal Pipeline has delivered over four billion barrels of crude oil to Canada.

PMPL owns and operates a tanker unloading facility, two tank farms (South Portland, Maine, and Montreal, Quebec) and a system of pump stations and crude oil pipelines that traverse 236 miles along a common right-of-way from Maine to Quebec.

Early Portland

Portland was called "Machigonne" by the native people who lived in the area. The first European settler was Christopher Levett, an English sea captain, who, in 1623, was granted 6000 acres by the King to establish a settlement in Casco Bay. Captain Levett suggested the name "York." He was unable to drum up support for the settlement, and the next permanent settlement was not until 1632, also by the English. The town was renamed "Casco," and then "Falmouth" in 1658. A monument on the Eastern Promenade commemorates the four historical names.

Courtesy of Bowdoin College, George Mitchell Department of Special Collection & Archives

Fishing Industry

Portland has a large fleet of deep-sea fishing vessels, which offload their catch including, cod, haddock, scallops, and shrimp, primarily at the Portland Fish Exchange.

Numerous towns and islands also serve as ports for lobster boats. Maine has more than 7,000 miles of coastline; however, only 25 of them are used as "working waterfronts."

LOOKING EAST

Casco Bay

Portland Harbor: Ice-free; 25' deep at low tide
Export/Import: Paper, Electronics, Forestry Products, Seafood, Oil & Gas

Winds: Southerly in Summer, Northerly in Winter
Commercial Fishing Fleet: 150

Peaks Island: Most populated island in Casco Bay, located 3 miles from Portland
Ragged Island: Poet Edna St. Vincent Millay purchased the island in 1933.

Halfway Rock: The Halfway Rock Lighthouse is located in Casco Bay, midway between Cape Elizabeth and Small Point.

The name of the Casco Bay "Calendar Islands" is derived from the eighteenth-century myth that there were "as many islands as there are days in the year." According to the *United States Coast Pilot*, there are 136 islands; other sources place the count at slightly over 200.

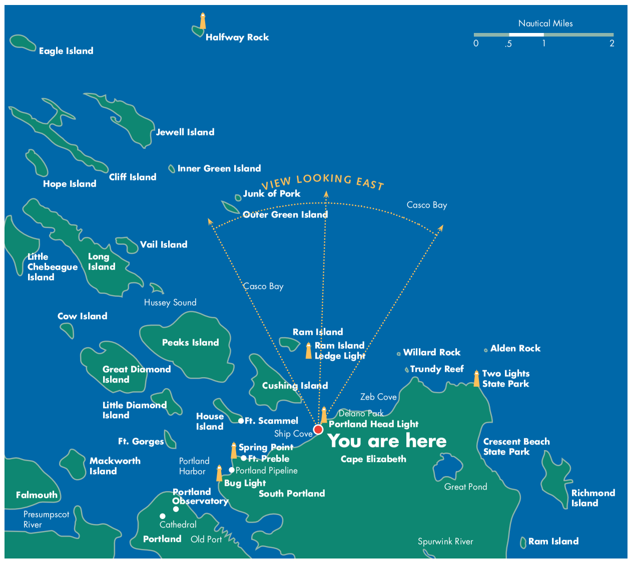
Ram Island Ledge Light

Ram Island Ledge Light (shown at right) is a 72-foot granite tower built in 1905 on a narrow ledge of rocks that threatens the entrance to Portland Harbor. It is nearly a twin of the Graves Light in Boston Harbor, which was built around the same time. Ram Island Ledge can be easily seen from this location.


Ram Island Ledge Light

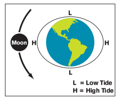
Casco Bay is Home to Six Lighthouses

Bug Light
Halfway Rock Light
Portland Head Light
Ram Island Ledge Light
Spring Point Ledge Light
Two Lights

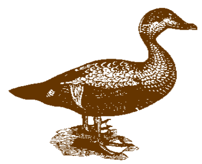


Tides

Daily tides are one of the most reliable phenomena in the world. Tides are the rise and fall of water throughout the Earth's oceans created by the Moon's (and, to a lesser extent, the Sun's) gravitational pull. In most places, there are two high tides and two low tides each day, with 6 hours and 12.5 minutes between each high and low. High tides happen on the opposite sides of the Earth at the same time.



Tidal height changes dramatically along the Gulf of Maine, which stretches from Cape Cod to the tip of Nova Scotia. At the southern end, tides seldom range over 4 feet (little more than 1 meter), but they increase constantly as they go eastward. Immediately to the north of the Cape there is a tidal range of 7 to 10 feet (2-3 meters); near Passamaquoddy Bay they reach 28 feet (8.5 meters); and tides reach as high as 50 feet (15 meters) in the Bay of Fundy – the highest recorded tides in the world.


Eider Duck, Courtesy of Bowdoin College, George Mitchell Department of Special Collection & Archives

Sea Ducks

The Common Eider is characterized by its bulky shape and large, wedge-shaped bill. The male is unmistakable, with its black and white plumage and green nape. The female is brown, but can still be readily distinguished from all ducks, except other eider-species, on the basis of size and head shape. The Common Eider's call is a pleasant "ah-ooo."

Early Casco Bay

There are two theories on the origin of the name "Casco Bay." One is based on the name given the bay by Portuguese explorer Esteban Gómez, who explored the Maine coast in 1525. He called it "Bahia de Cascos" (Bay of Helmets, based on the bay's shape). The second theory is based on "Aucocisco," the Abenaki name for the bay, which means "place of herons" (sometimes translated as 'muddy').

The bay is home to abandoned military fortifications dating from the War of 1812 through World War II; during World War II, Casco Bay served as an anchorage for US Navy ships.

Eagle Island, now a State Historic Site, was the summer home of Arctic explorer Robert Peary.

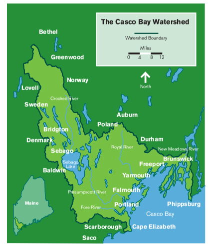
Portland Pilots

The ice-free Portland Harbor offers secure anchorage to deep-draft vessels in all weather. Portland Pilots assist vessels in safely entering the harbor. In addition to utilizing the latest navigation technology, the Pilots typically use "dead reckoning" in good visibility. They take a sighting off of the Cathedral on Congress Street in Portland. This bearing takes them directly into the harbor from just outside of Portland Head Light.

Pilotage is compulsory for all foreign vessels and US vessels under register in the foreign trade drawing over nine feet.

Recreational Boating

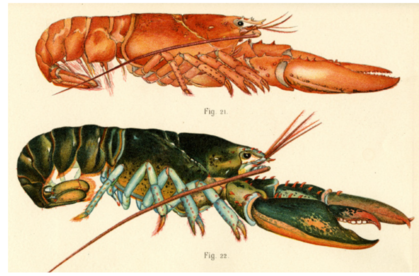
Boating is a popular summer activity. Many boaters "island hop," while others fish and others just enjoy the sights. Recreational boats may also be chartered for fishing. Casco Bay is home to many marinas, stretching from Portland to Phippsburg (Sebasco). Most marinas offer food, fuel, and dockage.



Casco Bay Watershed

Located in southern Maine, the Casco Bay watershed encompasses 985 square miles from the western mountains near Bethel to the coastal waters of Phippsburg and Cape Elizabeth. The watershed includes 41 of the state's fastest growing communities and approximately 25% of its population, including the largest metropolitan area – Portland, on only 3% of the land area. In addition, the watershed boasts 758 islands, islets, and exposed ledges, and more than 1,356 miles of rivers and streams.

Five sub-watersheds comprise the Casco Bay watershed, including the Sebago Lake, Presumpscot River, Royal River, Fore River, and Coastal watersheds. Twelve significant lake and river systems feed the Bay – including Sebago Lake, Greater Portland's drinking water source– and three major freshwater tributaries: the Fore, Presumpscot, and Royal Rivers.
(from The Casco Bay Estuary Partnership)



Engraving of cooked (top) and live lobster
Courtesy of Bowdoin College, George Mitchell Department of Special Collection & Archives

The Maine Lobster

A record catch of over 57 million pounds of this delicacy was landed from Maine lobster traps in 2000.

A lobster sheds its shell in order to grow. A one-pound lobster may be from five to seven years old, having shed about 25 times. Lobsters grow throughout their lives, and it is not unusual for a lobster to live for more than one hundred years.


Photograph © Brian Vanden Brink

Portland Head Light

Built during the presidency of George Washington, Portland Head Light is the oldest of Maine's 66 lighthouses, and is said to be the most photographed lighthouse in America.

For nearly two hundred years the responsibility for maintaining and monitoring Portland Head Light fell to the lighthouse keeper. In 1991, a Museum and gift shop were created in the keeper's former home.


Henry Wadsworth Longfellow
Bowdoin College Student
Silhouette, 1825?
Courtesy of Bowdoin College, George Mitchell Department of Special Collection & Archives

Longfellow and Portland Head

Poet Henry Wadsworth Longfellow, who was born in Portland and graduated from Bowdoin College in 1825, was a frequent visitor to Portland Head Light in his younger years. Longfellow's poem "The Lighthouse" was probably inspired by his many hours here.

"The Lighthouse"

The rocky ledge runs far out into the sea
And on its outer point, some miles away,
The lighthouse lifts its massive masonry,
A pillar of fire by night, of cloud by day.

Henry Wadsworth Longfellow

LOOKING SOUTH

Cape Elizabeth

Hannaford Bros. Co.:
The supermarket chain was founded in 1883 to sell the vegetables and fruits grown on a farm in Cape Elizabeth.

Farming:
Cape Elizabeth-grown cabbage was considered the best in the state, bringing $10 a ton in the late 1880s.

Notable Former Residents:
Bette Davis, actress
John Ford, film director
Dorothy Bush Koch, daughter of President George H. W. Bush
Gary Merrill, actor

Beckett Castle:
Formerly owned by Colonel Walter Singles, who, when he was a professor at West Point, taught chemistry to cadets Dwight D. Eisenhower and Omar S. Bradley.

Settled in 1632, Cape Elizabeth is a residential community of 10,000 people, situated on the southern shore of Casco Bay just south of Portland. In addition to Fort Williams Park, Cape Elizabeth is home to two state parks: Crescent Beach State Park and Two Lights State Park.

Guardians of the Sea: The Lightship Service

From 1820, lightships — floating lighthouses — were placed off the coast as additional protection for ships. A light beacon high above water level operated from dusk to dawn. Lightships were built to withstand 70' seas and 100+ mph winds. Maine's only lightship was stationed off Portland Head Light from 1903 to 1975.

The *Cape Elizabeth* Lightship (74) was built with a wooden hull and was 130 feet long.
Courtesy of Cape Elizabeth Historical Society

Total Average Snowfall

Ranges between 60 and 90 inches a year.


Edward Hopper (American, 1882–1967)
The Lighthouse at Two Lights, 1929 Oil on canvas; H. 29-1/2, W. 43-1/4 in. (74.9 x 109.9 cm)
Hugo Kastor Fund, 1962 (62.95) Collection of the Metropolitan Museum of Art

Edward Hopper

Edward Hopper (1882 – 1967), considered one of America's greatest artists, is well known for both his paintings that captured the loneliness of American cities and those that conveyed the beauty of the American landscape. Beginning in 1914, Hopper regularly spent summers in New England, often visiting and painting at Portland Head Light. This picture is one of three oils and several watercolors that he did of this site during the summer of 1929. The website of the Metropolitan Museum of Art notes, "To Hopper, the lighthouse at Two Lights symbolized the solitary individual stoically facing the onslaught of change in an industrial society."

Joan Benoit Samuelson

Born in Cape Elizabeth, Benoit took to long-distance running to help recover from a broken leg suffered while skiing during her senior year of high school. She went on to excel in running at Bowdoin College, graduating in 1979. At the 1984 Summer Olympics she won the first Olympic women's marathon in a time of 2:24.52, more than a minute ahead of her rivals.


Courtesy of Bowdoin College

Early Cape Elizabeth

As early as 1529 Cape Elizabeth appears as a nameless headland mapped by a Spanish cartographer. Seventy-five years later, Samuel de Champlain charted the promontory, but it was not until 1604, following exploration by John Smith, that the land was given its name, in honor of Princess Elizabeth, sister of Charles I of England.

Events of the years that followed make an intriguing story: the 1632 establishment of Richmond Island as a fishing and trading post; the struggles of settlers in small isolated groups as they began fishing and farming; conflicts between settlers and the region's Native Americans; occasional pirating from the seas; the Revolutionary War.

Beach to Beacon

In 1997, Joan Benoit Samuelson-founded a 10-K road race that starts at Crescent Beach State Park and ends at Portland Head Light. It attracts over 5,000 runners and 10,000 spectators.

Local Shipwrecks

The *Annie C. Maguire* was headed for Portland Harbor from Buenos Aires, Argentina, when it hit the rocks at Portland Head Light in Cape Elizabeth on December 24, 1886. The shipwreck is memorialized on the rocks below the lighthouse.

The *Annie C. Maguire* may have been the most celebrated shipwreck at Portland Head, but there have been others nearby, including:

Bohemian, 1864
Bay State, 1916
Oakley L. Alexander, 1947
Alton A, 1972


Annie Maguire c. 1886
Courtesy of The Museum at Portland Head Light

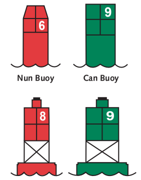
Bette Davis and Gary Merrill

Gary Merrill was a film and television character actor whose credits included more than fifty feature films, a half-dozen mostly short-lived TV series, and dozens of TV guest appearances. In 1950, Gary married actress Bette Davis. They lived at "Witchway," a 14-room house on a 15-acre estate on the shore near Zeb Cove in Cape Elizabeth from 1953 to 1960.

Merrill died in 1990 at Falmouth, Maine, and is buried there in the Pine Grove Cemetery.

His epitaph reads:

"A SELF PROFESSED
MR. DO NOTHING
WHO DID EVERYTHING
FOR EVERYBODY."



Aids to Navigation: Red Right Returning

Lateral Aids to Navigation generally indicate on which side a vessel should pass when channels are entered from seaward. In the absence of a route leading from seaward, the conventional direction of buoyage, generally follows a clockwise direction around landmasses. The most important characteristic of an aid is its color. The "3R" rule,"Red Right Returning," is the essential rule of thumb for using the lateral system. This means that when entering one body of water from a larger body of water (i.e., returning to a harbor from a bay or sound), keep the red aids to starboard (right) side and green aids to port (left) side. In addition, each aid is numbered, and these numbers increase as entering from seaward.
(from The U.S. Coast Guard)

Life Saving Station

Volunteers trained in seamanship provided rescue service from the station located at Dyer Cove at Two Lights (shown below) from the late 1890s to 1915, when the Coast Guard took over. The Coast Guard base is now located at Ferry Village, South Portland.


Courtesy of Cape Elizabeth Historical Society

Two Lights State Park

Two Lights State Park is a popular point of destination for Maine residents and the many visitors who enjoy the state's legendary rocky coast. Opened in 1961, the park encompasses 41 acres of rocky headlands. Standing high above the rolling surf, visitors have sweeping views of Casco Bay and the open Atlantic.

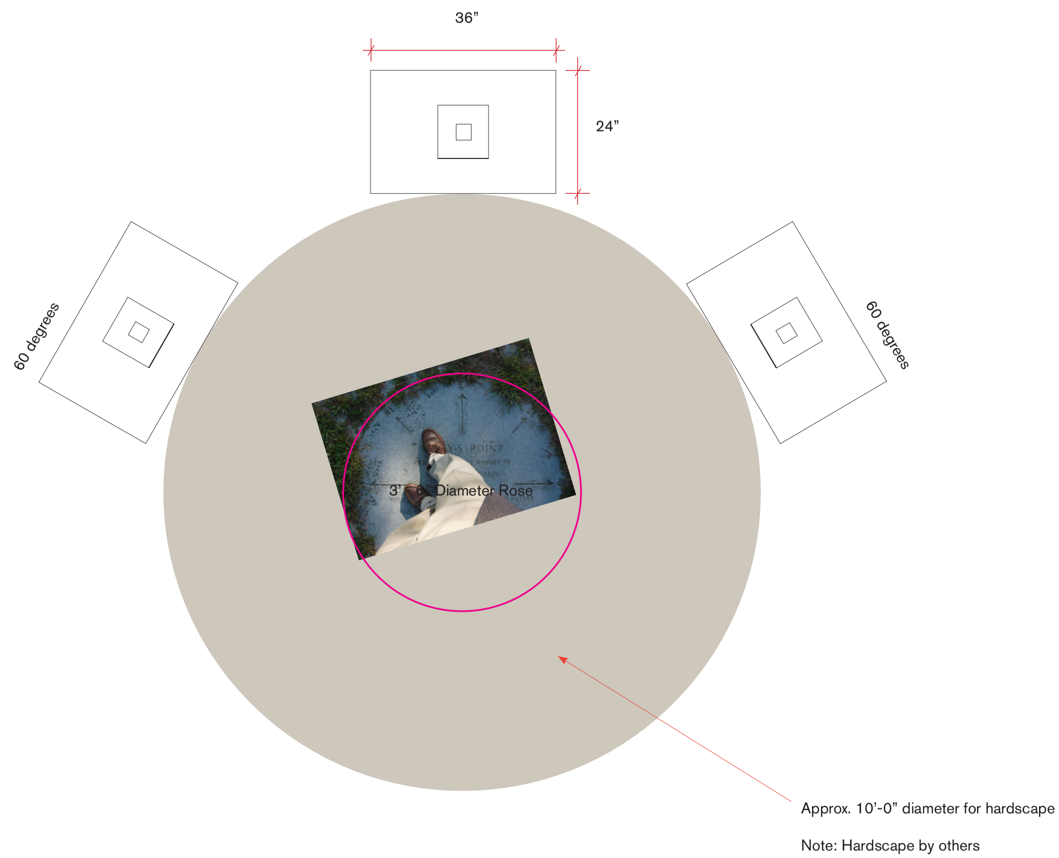
The park's name originated from the twin lighthouses located nearby at the end of Two Lights Road. Built in 1828, these were the first twin lighthouses on the coast of Maine. Although not open to the public,

the eastern light is an active, automated light station, visible from 17 miles at sea. The western light ceased operation in 1924 and is now a private home. It was at one time the home of the actor Gary Merrill. One of these towers was the subject of Edward Hopper's famous painting, *The Lighthouse at Two Lights*.


Gignoux Stable at Delano Park
Courtesy of Cape Elizabeth Historical Society

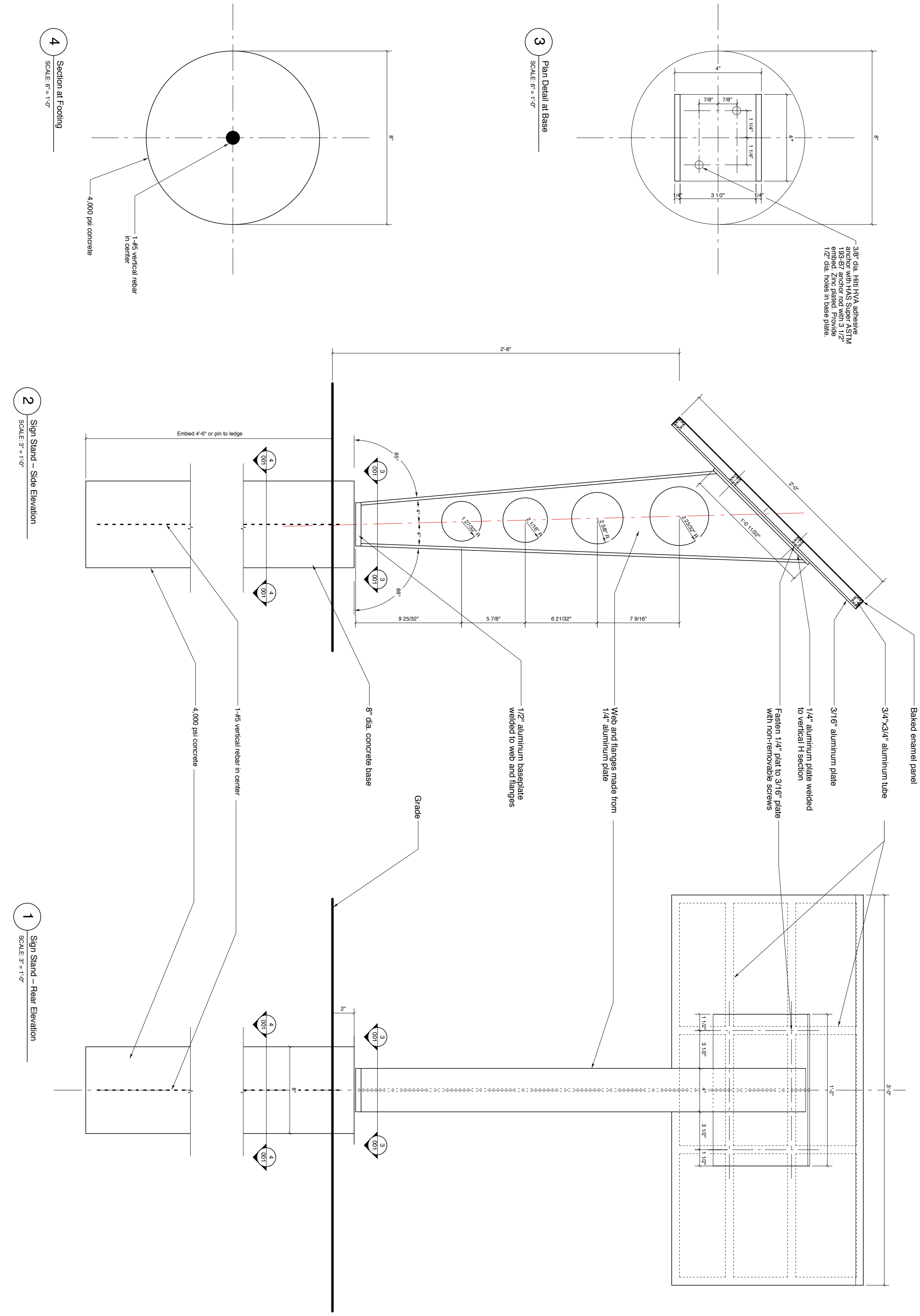
Delano Park

This area was developed by a group of Portland businessmen in the late 1880s on farmland once owned by James Delano, the second keeper of Portland Head Light. Consisting of approximately 32 acres, many of the homes were designed by Portland architect John Calvin Stevens, best known for his shingle-style design.



Interpretive Panels (1-side) Plan View - Details

Project: **Fort Williams - Kitty's Point**	Phase: **DD**	Date: **2.17.09**	**Woodworth Associates** **Graphic Design and Communications**
Title: **Interpretive Panels (3)**	Drawn By: **BW**	Scale: as noted	**Fort Andross, Box 64** **14 Maine Street** **Brunswick, Maine 04011** **207 373 9091** **Fax 207 373 9093** **office@woodworthassociates.com** **www.woodworthassociates.com**
Description: **For Pricing Only, Not for Construction**	Revised: By:	Sheet: **A3**	
Note: Drawings represented in this package are for design intent only. Final construction drawings are the responsibility of the fabricator.			



SK-01	**Sign Stand Details** **Drawn by: RR** **File Name:** SK-01 Sign Stand **Scale:** 3"=1'-0" **Project No. 2008–2.10** **Date:** 03.02.09 **Revised:**	**Fort Williams** **Kitty's Point Signs** Fort Williams Park Cape Elizabeth, Maine		**Renner | Woodworth** 35 Pleasant Street Portland, ME 04101 207.773.9699 207.773.9599 fax