# WATERFRONT FACILITIES MAINTENANCE MANAGEMENT SYSTEM

# FULTON FISH MARKET
# NEW YORK CITY

# ROUTINE INSPECTION

**AUGUST 2010**

NYCEDC
New York City Economic Development Corp.

OCEAN AND COASTAL
CONSULTANTS

**NEW YORK CITY**
**ECONOMIC DEVELOPMENT CORPORATION**

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# ROUTINE INSPECTION

## OCC PROJECT NO: 209093

## AUGUST 2010

*Submitted By:*

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# EXECUTIVE SUMMARY

During February and April of 2010, Ocean and Coastal Consultants Engineering, P.C. (OCC) performed a routine inspection of three structures at the Fulton Fish Market, including: (1) the Tin Building, (2) the West Apron, and (3) the New Market Building. The investigation was conducted in accordance with the standards of the Waterfront Facilities Maintenance Management System and included a Level I inspection for 100 percent of the substructure elements as well as a more detailed, Level III inspection of approximately 10 percent of the wrapped and posted/wrapped timber piles. The primary objectives were to assess the general overall condition of the structures; estimate the remaining service life; and provide recommended repairs with construction cost estimates.

The overall condition rating of the facility is **poor**. There are widespread advanced defects including heavy marine borer and fungal rot deterioration.

(A) TIN BUILDING

The Tin Building is currently in **poor** condition. The existing wrap repairs are generally failed while the existing concrete encasements generally have insufficient embedment into the mudline. The observed defects indicate that ongoing marine borer attack (*limnoria*) exists on the wrapped and posted/wrapped timber piles. In addition, extensive rot and decay have reduced structural capacity in the timber stringers, pile caps, and decking. OCC developed a recommended rehabilitation schedule based on the extent of the deterioration and the results of the corresponding structural analysis. These recommendations include **removing all live loading from inside the building, including any items being stored both permanently and temporarily, effective immediately** as well as monitoring the building for signs of settlement or overstressing. In the next one to three years, or before the next routine inspection cycle (2013), OCC recommends repairing approximately 1,500 lin ft of timber stringers that were observed to have inadequate remaining cross section by installing steel channel sister members. Also during this time phase, approximately 69 piles should receive full height structural concrete encasements. By performing these repairs, the Tin Building would be able to support a uniform live load of 40 psf, which is the minimum requirement for basic access.

After the next inspection cycle, it is likely that the structure will require extensive rehabilitation in order to maintain sufficient capacity to support its own dead load as well as remain open for occupancy. The most effective method for this would be to demolish the existing concrete deck, timber decking, stringers, and pile caps in order to install a new two-way reinforced concrete deck. Before casting the new deck, the remaining 222 piles without encasements should receive similar full height structural encasements, while the 27 existing encasements with insufficient embedment should receive lower encasement extensions. Table A summarizes the recommended phased repairs as well as our Opinion of Probable Costs (OPC) for each phase.

(B) WEST APRON

The West Apron is in overall **poor** condition. The support piles with existing wrap repairs are typically loose and failed while many of the concrete encasements are undermined due to mudline scour. In addition, there is open spalling surrounding the three (3) manholes as well as pattern cracking with efflorescence present in the concrete underdeck. Level III inspection indicated that the timber piles continue to experience attack from the marine borer despite having existing wrap repairs. From the results of the inspection and corresponding structural analysis, OCC was able to compile a recommended rehabilitative maintenance schedule that will restore a uniform live load rating of 100 psf. None of the recommended items require immediate attention.

In the next one to three years, approximately 52 of the piles should receive full height structural concrete encasements. Also, the 97 sq ft of open spalling should be patched using a shotcrete repair. Assuming these repairs are performed during the recommended time period, an additional 52 piles will likely require a structural encasement after the next inspection cycle. Also during that time frame, 18 of the existing encasements with observed scour around the mudline should receive a lower encasement extension to protect the remaining timber. After this phase of repairs is performed, the structure will have sufficient capacity to support a uniform live load of 100 psf, through 2016. This load rating is the minimum requirement for outdoor public assembly areas according to the New York City Building Code Reference Standard 9.

(C) NEW MARKET BUILDING

The New Market Building is currently in **poor** condition. Based on the results of the Level III inspection, it is likely that approximately 35 percent of the non-encased

piles do not have the minimum diameter required for safe loading under dead load conditions only. The observed defects indicate that deterioration from the marine borer, *limnoria*, is ongoing despite the piles having existing wrap repairs. In addition, several of the concrete encasements and encased pedestal clusters are being undermined due to mudline erosion.

OCC developed a phased rehabilitation schedule based on the observed defects and the results of the structural analysis. **Effective immediately, all live loading from inside the building should be removed and the building should be left vacant until further rehabilitative measures are performed**. In the next one to three years, approximately 109 piles should receive full height structural concrete encasements. The 26 pedestal cluster encasements observed with mudline scour should receive a protective encasement of lightweight concrete fill. Also during this time period, the 97 sq ft of open spalling should be repaired using a shotcrete patch. By performing these repairs, the building will have sufficient capacity to support a uniform live load of 40 psf for three years. Following the next routine inspection, an additional 64 piles will require a structural encasement repair. Also during this time period, the two piles with existing encasements where mudline scour has exposed the original pile should receive a lower encasement extension.

The table on the following page summarizes the recommended maintenance schedule for the each structure as well as the OPC for each structure and phase. A 25 percent contingency is included in the costs for each item.

**TABLE A SUMMARY OF RECOMMENDED REPAIR ITEMS**

| Structure | Immediate | Priority (1-3 yrs) | Routine (3-5 yrs) |
|---|---|---|---|
| Mob/ Demob | $0 | $210,000 | $250,000 |
| Tin Building | Remove all live loading from inside the building | • Install structural concrete encasements on 69 piles.<br>• Repair or replace approximately 1,500 lin ft of timber stringers<br>• Monitor building for signs of over-stressing | • Demolish all decking, stringers, and pile caps.<br>• Install structural concrete encasements on all 222 non-encased piles.<br>• Install bottom structural encasement extensions on 27 existing encasements.<br>• Install new 2-way reinforced concrete deck above repaired piles with layer of crushed stone for MEP conduits and bring up to match adjacent elevation. |
| | $0 | $1,325,000 | $4,034,000 |
| West Apron | None | • Install structural concrete encasements on 52 piles.<br>• Repair approximately 97 sq ft of open spalling.<br>• Repair 10 lin ft of severe pile cap. | • Install structural concrete encasements on 52 piles.<br>• Install bottom structural encasement extensions on 18 existing encasements. |
| | $0 | $655,000 | $712,000 |
| New Market Building | Remove all live loading from inside the building | • Install structural concrete encasements on 109 piles.<br>• Repair approximately 97 sq ft of open spalling.<br>• Install lightweight concrete bottom encasement on 26 concrete pedestals.<br>• Repair 55 lin ft of severe pile cap | • Install structural concrete encasements on 64 piles.<br>• Install bottom structural encasement extensions on 2 existing encasements.<br>• Replace approximately 525 lin ft of concrete firewall. |
| | $0 | $2,694,000 | $992,000 |
| TOTAL OPC | **$0** | **$4,884,000** | **$5,988,000** |

# FULTON FISH MARKET

# WATERFRONT FACILITIES MAINTENANCE MANAGEMENT SYSTEM

# ROUTINE INSPECTION

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# 1.0 INTRODUCTION

This report summarizes the findings of the Routine Inspection performed by Ocean and Coastal Consultants Engineering, P.C. (OCC) at the Fulton Fish Market facility located along the East River in Manhattan, New York. This inspection was originally performed over a three week period during February 2010 at the request of the New York City Economic Development Corporation (EDC). After subsequent discussions with EDC, OCC performed additional Level III effort inspection in April 2010 to remove pile wraps and assess the condition of the timber piles within. All investigation work was conducted in accordance with the standards of the Waterfront Facilities Maintenance Management System (WFMMS). The primary objectives were to assess the general overall condition of the structures; estimate the remaining service life; and provide recommended repairs with construction cost estimates.

The Fulton Fish Market facility is comprised of six distinct platform structures. The scope of this inspection contract included three (3) structures: the Tin Building, West Apron, and, New Market Building. The Inshore Platform and Transition Platform were not included because they are under contract for rehabilitation, and the North Platform was not included because it is essentially failed and in need of complete replacement. The scope of the routine inspection included both the underwater and above water elements of the platform structures, including the timber piles and pile caps; concrete firewalls; and timber and concrete decks. In addition to the platforms, the associated bulkhead structures were included in the inspection. The vast majority of the piles supporting each of the structures have been previously repaired. Typical repairs noted included concrete encasements, pile wraps, or a combination of posting with pile wraps.

The underwater investigation was conducted by a three (3) person inspection team consisting of Professional Engineer-Divers, Engineer-Divers and Technician-Divers. Diving operations were conducted using surface-supplied diving equipment staged from the adjacent platforms. The above water investigation was conducted by two (2) and three (3) person inspection teams consisting of Professional Engineer-Divers and Engineer-Divers free-floating under the platform with the aid of a 10 foot aluminum boat. All of the on-site personnel were experienced in the investigation, design, and construction of waterfront structures. OCC's key personnel involved in the field inspection and evaluation are listed in Appendix A.

The condition of the structures and locations of the structural elements were recorded by topside personnel on a previously prepared Microsoft Access database. The inspection team also obtained above and underwater photographs of the site to provide documentation of findings. The results of the field inspection and subsequent structural evaluation were combined to generate the EDC condition assessment rating for the structure.

The inspection team utilized basic measuring tools such as folding rulers, measuring tapes, and pick hammers to verify dimensions of each structure and those previously reported by others. Structure dimensions that were not recorded during the present investigation were obtained from previously documented information.

Routine Inspections typically include a Level I inspection effort for 100 percent of the accessible elements, as well as a Level II inspection effort for 10 percent of the elements. The purpose of Level I inspection effort is to confirm as-built structural plans and detect obvious major damage or deterioration. The purpose of Level II inspection effort is to detect and identify damaged/deteriorated areas hidden by bio-fouling, and to obtain a limited amount of dimensional measurements. Due to the existing repairs on most of the inspected piles, Level II inspections were only performed in conjunction with Level III inspections. Level III inspections were performed on approximately 10 percent of the wrapped and posted/wrapped piles and included removing the wrap material over the lower half of the pile to expose the timber below.

The information presented in this Routine Inspection Report includes observed conditions, analyses, recommendations, and Opinions of Probable Costs (OPCs). Chapter 2 describes the site, including overall dimensions of the three (3) structures evaluated. Chapter 3 presents the description of the structures, the observed conditions, a comparison with the conditions noted in the 2006 inspection report, structural analyses, and recommendations. Chapter 4 summarizes the recommended actions for each of the structures evaluated at the Fulton Fish Market facility, and provides estimated costs for the immediate, priority, and routine repair recommendations.

The appendices at the end of this report contain information on the key personnel involved in the project, copies of the calculations, backup data for cost estimates, and copies of the field notes taken during the investigation.

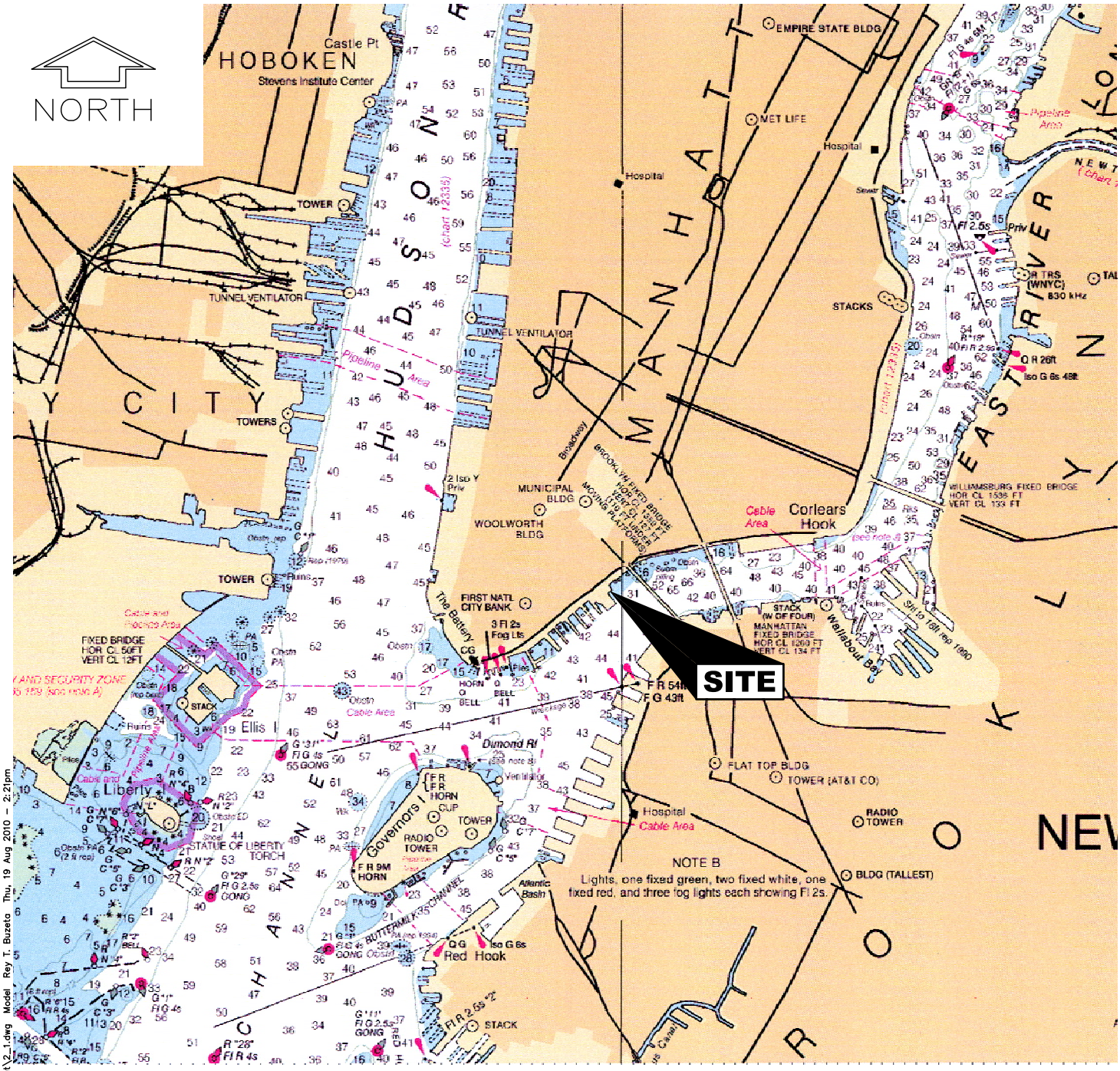
## 2.0 DESCRIPTION OF SITE

The Fulton Fish Market facility is located along the west side of the East River in lower Manhattan, opposite the south ends of Fulton and Beekman Streets (Figure 2-1). The facility is situated approximately 500 ft southwest of the Brooklyn Bridge, and is bordered by Pier 17 to the southwest, and a concrete seawall to the northeast. Figure 2-2 is a street-level Site Plan for the facility, which provides information on nearby roads and highways. A Vicinity Plan is presented in Figure 2-3, which includes the location of major landmarks, buildings and roads surrounding the facility. The Facility Plan presented in Figure 2-4 locates and identifies the three distinct structures of the Fulton Fish Market included in this inspection: (1) Tin Building, (2) West Apron, and (3) New Market Building.

The facility opened in 1822 and was a major seafood distribution center for the New York Tri-State region for 183 years, with the existing Tin Building constructed in the late 19$^{th}$ Century. In November of 2005, the Fish Market relocated to a new facility at Hunts Point in the South Bronx. Since then, the Tin Building and New Market Building have remained vacant to tenants. The West Apron was originally the primary loading and unloading area at the facility, but is presently being used as an automobile parking lot.

Consistent with many structures built in the nineteenth and early twentieth century, the Fulton Fish Market is located on a concrete deck supported by timber elements. These elements consist of: piles, pile caps, stringers between pile caps, deck boards, and bracing. The bulkhead along the western edge of the facility is primarily a concrete gravity seawall, with the exception being a 110 ft long section of block and mortar gravity wall at the northernmost extent of the site. Reinforced concrete firewalls below the decks partially subdivide the facility structures. Most of the timber piles throughout the facility have undergone previous repairs including posting, pile wraps, and/or concrete encasement. Detailed descriptions and photographs of each structure are presented in the applicable subsections found in Chapter 3 – Inspection of the Fulton Fish Market Facility

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CAPE MAY, NJ

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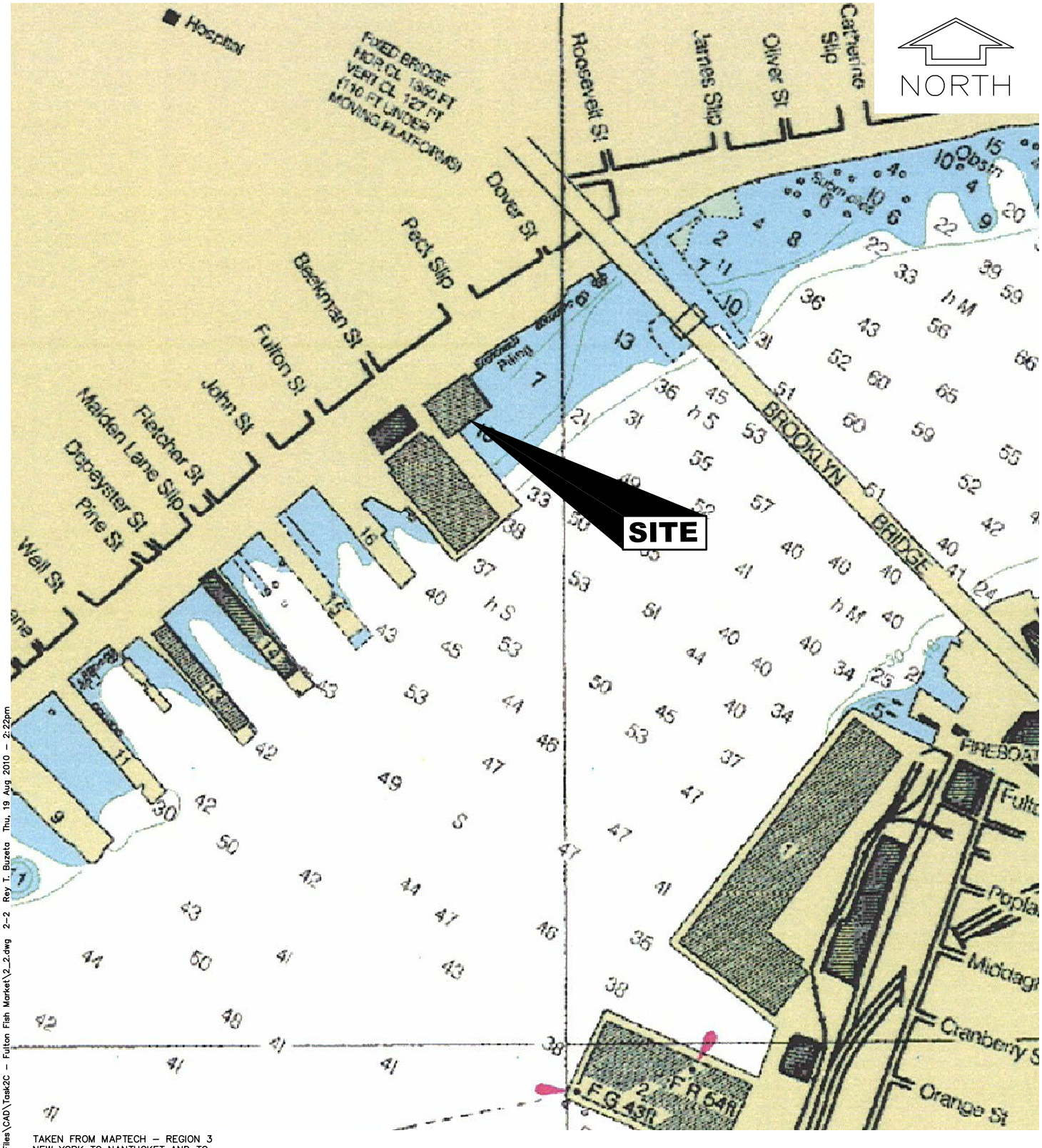
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FULTON FISH MARKET, MANHATTAN, NY

# LOCATION PLAN



FIG. 2–1

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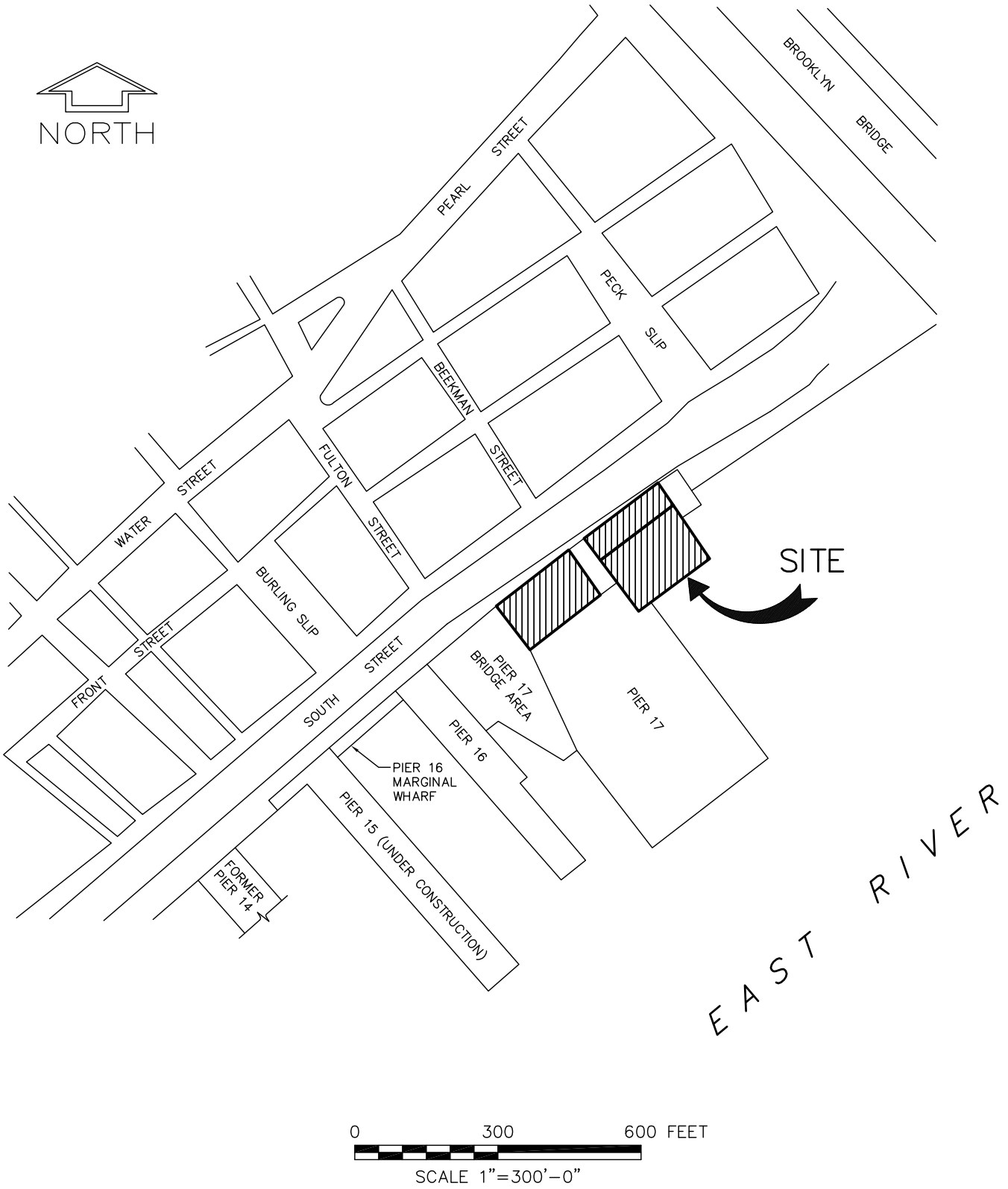
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SITE PLAN



FIG. 2–2

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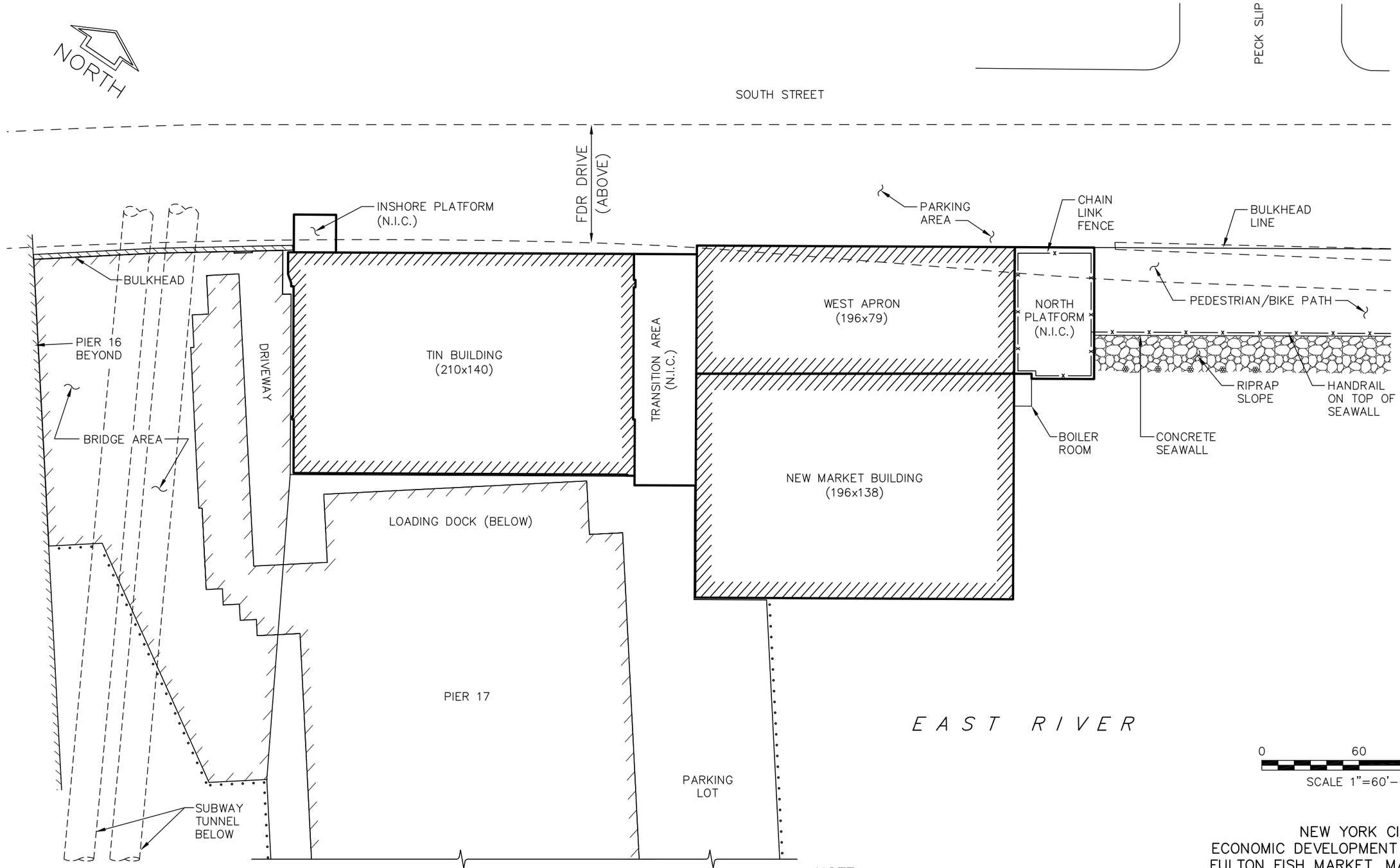

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VICINITY PLAN



FIG. 2-3

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0 60 120 FT.

SCALE 1"=60'-0"

NOTE

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "FACILITY PLAN", FIGURE 2-4, DATED JANUARY 2007.

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# FACILITY PLAN



FIG. 2-4

P:\2009\OCC_209093.01\3_Project_Files\CAD\Task2C - Fulton Fish Market\2_4.dwg Fig 2-4 Rey T. Buzeta Thu, 19 Aug 2010 - 3:06pm

# 3.0 INSPECTION OF FULTON FISH MARKET

The Routine Inspection of the Fulton Fish Market facility is separated into six (6) distinct platform structures. However, only the Tin Building, West Apron, and New Market Building platforms were included in the scope of this inspection.

The Fulton Fish Market facility underwent extensive rehabilitation repairs to the timber piles following an underwater investigation conducted by Han-Padron Associates in 1995. The rehabilitation repairs included the wrapping, posting or concrete encasement of a majority of the timber piles in an effort to restore structural capacity and prevent further deterioration of the timber due to widespread marine borer infestation. A subsequent above water and underwater inspection of the facility was conducted in 2002 by M.G. McLaren, P.C. Consulting Engineers. As a result of this inspection, EDC implemented priority repairs to the facility in 2005-06. These repairs included the concrete encasement of an additional 58 timber piles and miscellaneous timber cap and concrete deck repairs. Prior to 2010, the most recent routine inspection was performed in the summer of 2006 by OCC; however, no repairs have been performed since this inspection.

Because the timber piles on all of the structures have undergone previous repairs (e.g. wrapping or concrete encasement), direct examination of the timber under the repairs was not possible. Thus, for the purposes of this investigation, a timber pile wrap was noted as "Moderate" if the wrap was intact and appeared to be installed correctly, but was not tight around the pile. A loose pile wrap may be indicative of improper installation during construction (i.e. poor quality control) or that the repair is ineffective and the pile has continued to deteriorate inside the wrap. Wrapped piles were rated "Advanced" if any tears or open seams were observed, or if significant section loss could be felt on the pile underneath the wrap. A "Severe" rating was assigned to piles where the wraps were torn open wide enough to visually confirm greater than 30 percent reduction in the pile diameter, or more than 50 percent section loss. Based on the observed widespread advanced defects, the Fulton Fish Market is generally in **poor** condition.

## 3.1 TIN BUILDING

### 3.1.1 Description

Currently vacant, the Tin Building is a historic three-story structure previously used as office, cold storage, and warehouse space for the Fulton Fish Market. The approximate dimensions are 210 ft by 140 ft including the large cooler area in the eastern section of the building measuring 210 ft by 34 ft. Photo 3-1 and Photo 3-2 provide views of the exterior of the Tin Building while Photo 3-3 shows the interior.

Clusters of four to five timber piles support the building columns. These pile clusters are capped with timber mats consisting of 12 x 12 timbers. The lower street-level floor of the building consists of a reinforced concrete deck supported by 4 x 12 timber deck planks. Timber stringers, consisting of 6 x 12 pairs oriented in the east-west direction at 3 ft on center, support the timber and concrete decking. The stringers are, in-turn, supported by split pile caps consisting of two 6 x 12 timbers with a 6 x 12 filler between piles. The pile caps transfer the deck loads to the timber piles, which are spaced approximately 6 ft on center along each pile bent.

Beneath the cooler area, the concrete deck bears directly on timber pile caps spanning the east-west direction (perpendicular to the caps on the main structure). Below deck, the reinforced concrete firewalls run along the south and east edges of the Tin Building from the deck soffit to mean low water (approximately 8.5 ft). The firewalls on the interior run from the deck soffit to between 18 in. and 24 in. above mean low water (approximately 6.5 ft).

The pile plan on Figure 3-1 provides the layout and labeling scheme for the piles and bents under the Tin Building. Figure 3-2 consists of the deck framing plan, and Figure 3-3 provides a representation of the typical cross-sections found on the structure.

There are a total of 861 timber piles supporting the Tin Building. All of the piles have undergone various repairs including concrete encasements, posting and wrapping, and wrapping. Table 3-1 provides a summary of the repair types observed, by quantity and percentage of the total piles supporting the structure.

**TABLE 3-1 SUMMARY OF TIN BUILDING PILE REPAIRS**

| Repair Type | Quantity | Percent |
|---|---|---|
| Concrete Encasement | 570 | 66.2 |
| Post and Wrap | 260 | 30.2 |
| Wrap | 31 | 3.6 |
| TOTAL | 861 | 100.0 |

### 3.1.2 Observed Conditions

The Tin Building is currently in **poor** condition. The existing wrap repairs are generally failed while the existing concrete encasements have lost sufficient embedment into the mudline. Also, the timber pile caps, stringer, and decking all have moderate to severe deterioration due to rot.

(A) TIMBER PILES

Each of the inspected piles beneath the Tin Building has been previously repaired and as such, the condition of the timber pile itself was not always accessible. Therefore, the piles were rated based on the condition of the existing repair, as described earlier in this chapter. Table 3-2 summarizes the ratings of the inspected piles beneath the Tin Building while the condition rating plan is presented on Figure 3-4. The table shows the ratings of the wrapped piles following Level I inspection and following the more detailed Level III investigation. Figure 3-5 details the typical defects observed in the piles.

**TABLE 3-2 SUMMARY OF TIN BUILDING PILE RATINGS**

| Rating | Concrete Encasements | | Posted/Wrapped and Wrapped | | | |
|---|---|---|---|---|---|---|
| | | | Level I | | After Level III | |
| | Total | Percent | Total | Percent | Total | Percent |
| Minor | 374 | 65.6 | 7 | 2.4 | 5 | 1.7 |
| Moderate | 165 | 28.9 | 146 | 50.1 | 131 | 45.0 |
| Advanced | 22 | 3.9 | 107 | 36.8 | 109 | 37.5 |
| Severe | 5 | 0.9 | 31 | 10.7 | 46 | 15.8 |
| Not Accessible[1] | 4 | 0.7 | 0 | 0.0 | 0 | 0.0 |
| TOTAL | 570 | 100.0 | 291 | 100.0 | 291 | 100.0 |

[1]Piles are located in the center of five-pile clusters and adjacent bag encasements prevent access.



PHOTO 3-1. View of Tin Building exterior, looking northeast.



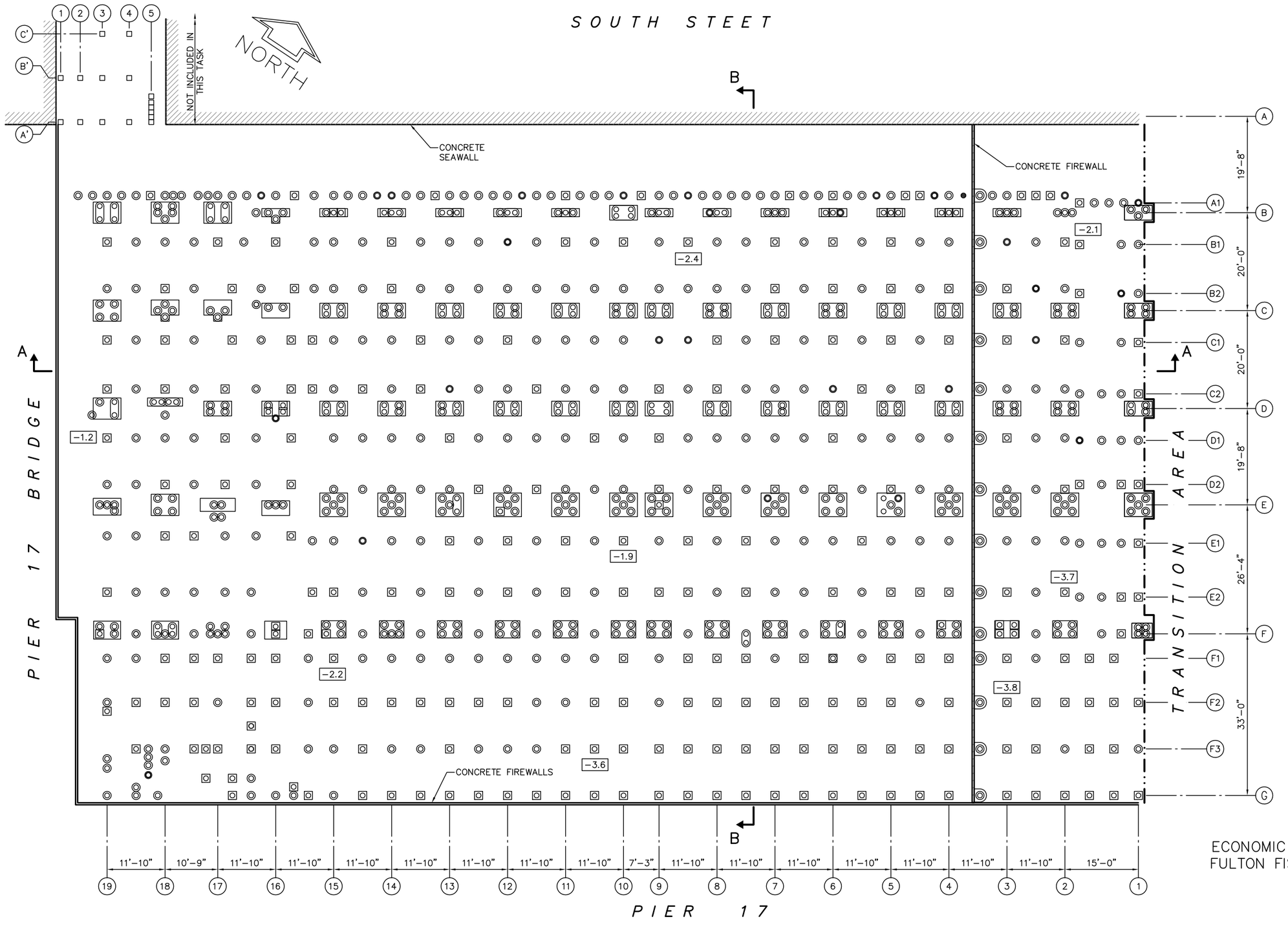
PHOTO 3-2. View of Tin Building exterior, looking southwest.

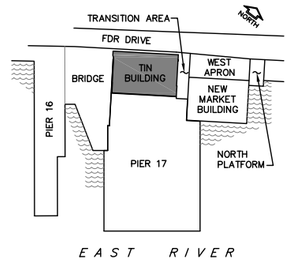


PHOTO 3-3. View inside the vacant Tin Building, looking east.



PHOTO 3-4. View of typical tear in wrap material with marine borer attack in timber, Bent 8.5, Row F2.




## KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE
- ABANDONED TIMBER PILE
- −1.9 APPROXIMATE MUDLINE ELEVATION IN FEET (MLW)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING PLAN", FIGURE 3–1, DATED JANUARY 2007.
2. FOR SECTIONS A–A AND B–B, SEE FIG. 3–3.

0 20 40 FT.

SCALE 1"=20'-0"

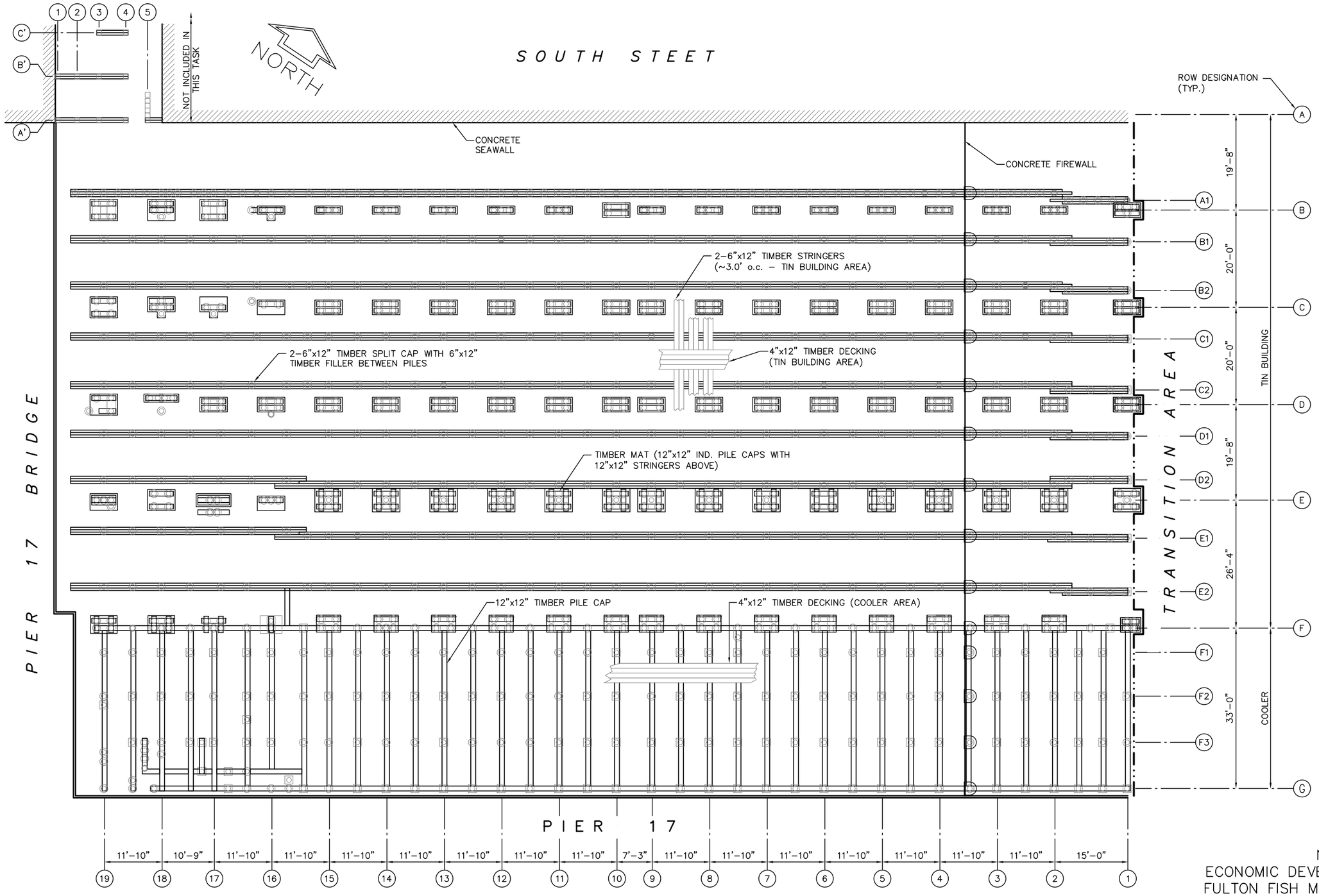
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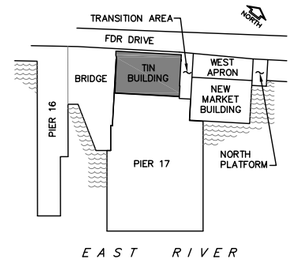
# TIN BUILDING PILE PLAN

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FIG. 3–1




KEY PLAN

N.T.S.

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING FRAMING PLAN", FIGURE 3-2, DATED JANUARY 2007.
2. CONCRETE DECK ABOVE TIMBER DECKING NOT SHOWN AND NOT ACCESSIBLE FROM BELOW.

0 20 40 FT.

SCALE 1"=20'-0"

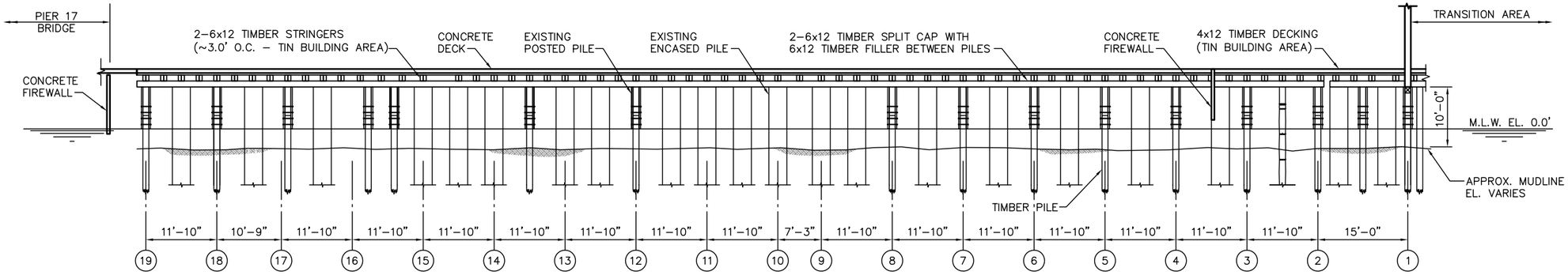
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# TIN BUILDING FRAMING PLAN



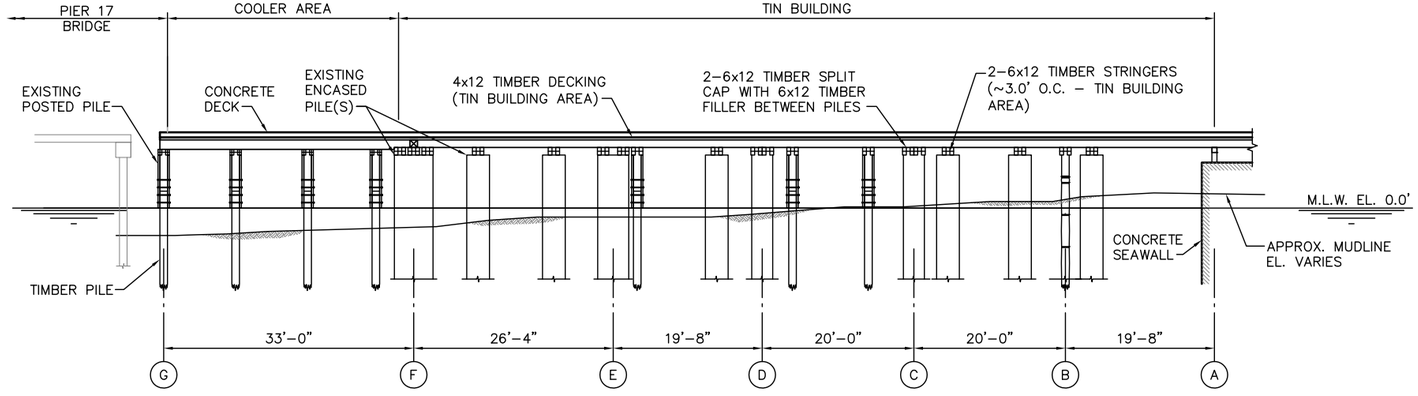
FIG. 3-2

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## SECTION A–A

SCALE 1"=20'–0"




## SECTION B–B

SCALE 1"=20'–0"

0 20 40 FT.

SCALE 1"=20'–0"

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING TYPICAL PIER CROSS–SECTION", FIGURE 3–3, DATED JANUARY 2007.
2. FOR LOCATION OF SECTIONS A–A AND B–B SEE FIG. 3–1.

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# TIN BUILDING
# TYPICAL PIER CROSS–SECTIONS



FIG. 3–3

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C – Fulton Fish Market\3_3.dwg 3–3 Rey T. Buzeta Thu, 19 Aug 2010 – 3:21pm

The most common repair method observed in this structure is a concrete encasement (66.2 percent of the piles). A majority of these encasements were constructed using fabric forms. Under the column pedestals, many of the encasements include two or more piles. The concrete encasement repairs are generally in **poor** condition due to insufficient embedment into the mudline. Over 33 percent of the concrete encasements were found to have mudline scour such that the diver could feel at least the underside of the concrete. At 27 of the encasements (5 percent), the scour was great enough to feel deteriorated timber pile exposed below. Heavy concrete overpour at the mudline prevented a visual or accurate tactile inspection of the exposed timber, with the only access being 1/2 in. to 6 in. of separation between the concrete overpour and encasement. The newer, fiberglass formed encasements were all in minor condition with sound concrete and sufficient embedment.

A total of 291 of the timber piles were either posted and wrapped or wrapped. The wrap repairs are generally in **serious** condition. They are typically loose, with the diver able to displace the wrap from 1 in. and 3 in. on approximately 97 percent of the piles. The wrap material was visibly failed, including tearing or failed seams, on 47 percent of the piles. Approximately 16 percent of the failed wraps have severely deteriorated timber exposed (Photo 3-4).

Many of the wrap repairs required that the wrap material be folded and pinched to seal against the timber at the post to pile interface. The stiffness of the wrap material has caused the material to tear along these seams, allowing an entry point for marine borers.

The wrap material was removed from 23 of the wrapped or wrapped and posted piles as part of the Level III inspection. The piles chosen were generally rated as moderate and advanced during the initial Level I inspection. However, approximately 65 percent of the piles opened up were downgraded to severe due to the extensive heavy marine borer and soft rot that was observed on the exposed timber piles. The average pile diameter for these severe piles was approximately 8.7 in., which represents a loss of approximately 54 percent of the original cross sectional area (assuming an original diameter of 12 in.).

SOUTH STREET

NORTH

NOT INCLUDED IN THIS TASK

APPROX M.L.W. ELEVATION

CONCRETE SEAWALL

CONCRETE FIREWALL

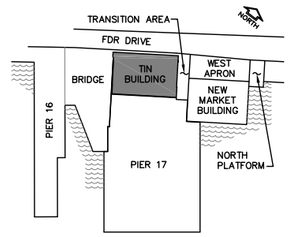
CONCRETE FIREWALLS

PIER 17 BRIDGE

TRANSITION AREA

PIER 17

EAST RIVER




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL

## PILE CONDITION LEGEND

- SEVERE PILE
- ADVANCED PILE
- MODERATE PILE
- LEVEL III INSPECTION (WRAP REMOVAL)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING PILE PLAN", FIGURE 3–1, DATED JANUARY 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

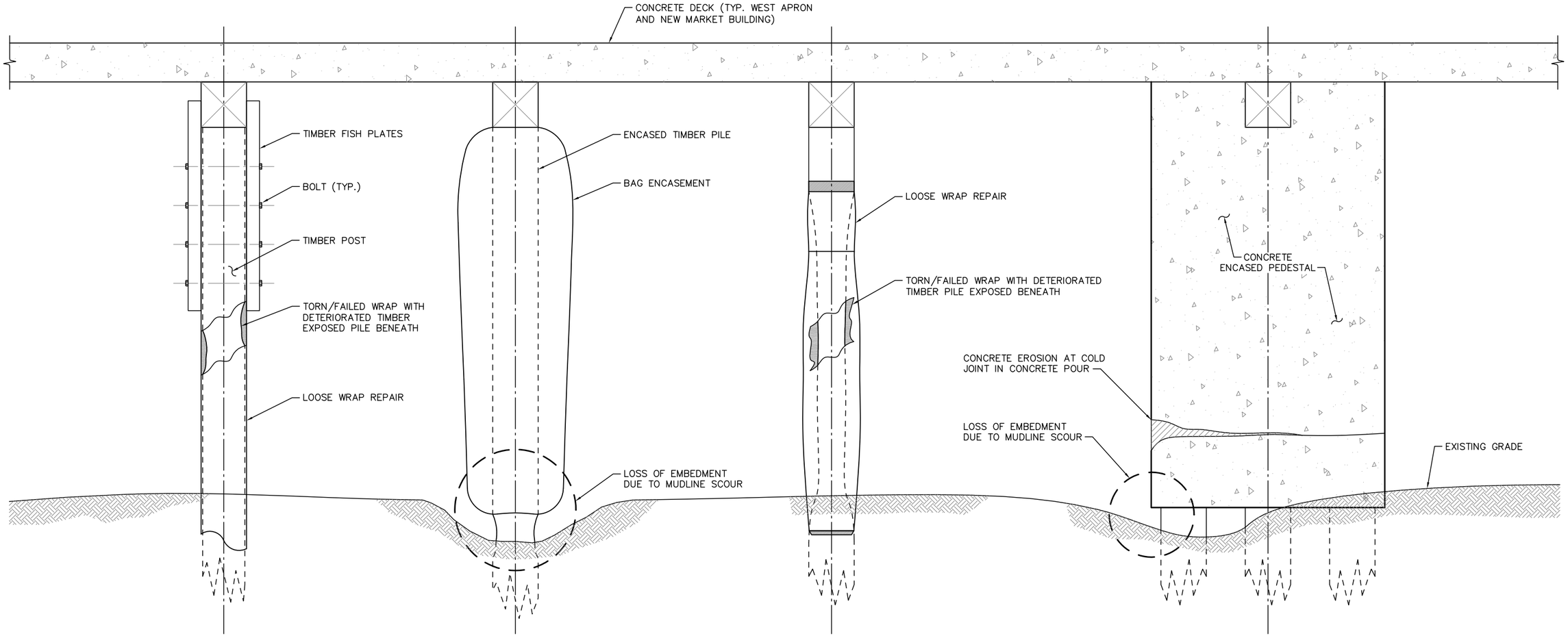
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# TIN BUILDING
# PILE CONDITION PLAN



FIG. 3–4

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0 1 2 3 4 5 FT.

SCALE ⅜"=1'–0"

**NOTES:**

1. LOCATION AND EXTENT OF DETERIORATION SHOWN VARIES.
2. BENT SPACING VARIES.
3. DECK AND FRAMING VARIES.

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## TYPICAL EXISTING CONDITIONS



FIG. 3–5

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(B) UNDERDECK, PILE CAPS, AND STRINGERS

The pile caps supporting the Tin Building are 6 x 12 timber split caps beneath the main building and 12 x 12 single caps beneath the cooler area. The pile caps were in overall **poor** condition (Figures 3-6 and 3-7). Widespread heavy rot is present in the bottom half of the timber section with pick penetrations up to 3 in. deep (Photo 3-5). Approximately 50 percent of the split caps supporting the main building are rated advanced or severe due to heavy rot deterioration while approximately 45 percent are moderate. The single cap supporting the cooler area was typically in better condition than under the main building, with approximately 60 percent of the caps rated moderate with the remaining 40 percent having only minor defects. Table 3-3 presents the Tin Building's pile cap ratings.

**TABLE 3-3 SUMMARY OF TIN BUILDING PILE CAP RATINGS**

| Rating | Main Building | | Cooler Area | | Total | |
|---|---|---|---|---|---|---|
| | Total (lin ft) | Percent | Total (lin ft) | Percent | Total (lin ft) | Percent |
| Minor | 87 | 4.0 | 480 | 39.1 | 567 | 16.5 |
| Moderate | 995 | 45.0 | 704 | 57.3 | 1,699 | 49.4 |
| Advanced | 964 | 43.6 | 44 | 3.6 | 1,008 | 29.3 |
| Severe | 163 | 7.4 | 0 | 0.0 | 163 | 4.8 |
| TOTAL | 2,209 | 100.0 | 1,228 | 100.0 | 3,437 | 100.0 |

The concrete deck of the Tin Building rests on 4 x 12 timber deck planks that are generally in **poor** condition due to widespread rot. Typical pick penetration was between 1/4 in. and 1 in. deep. Approximately 5.6 percent of the underdeck was rated advanced or severe due to pick penetration greater than 1 in. and separation of the timber planking up to 1 in. wide, as well as broken and deteriorated planks (Photo 3-6).

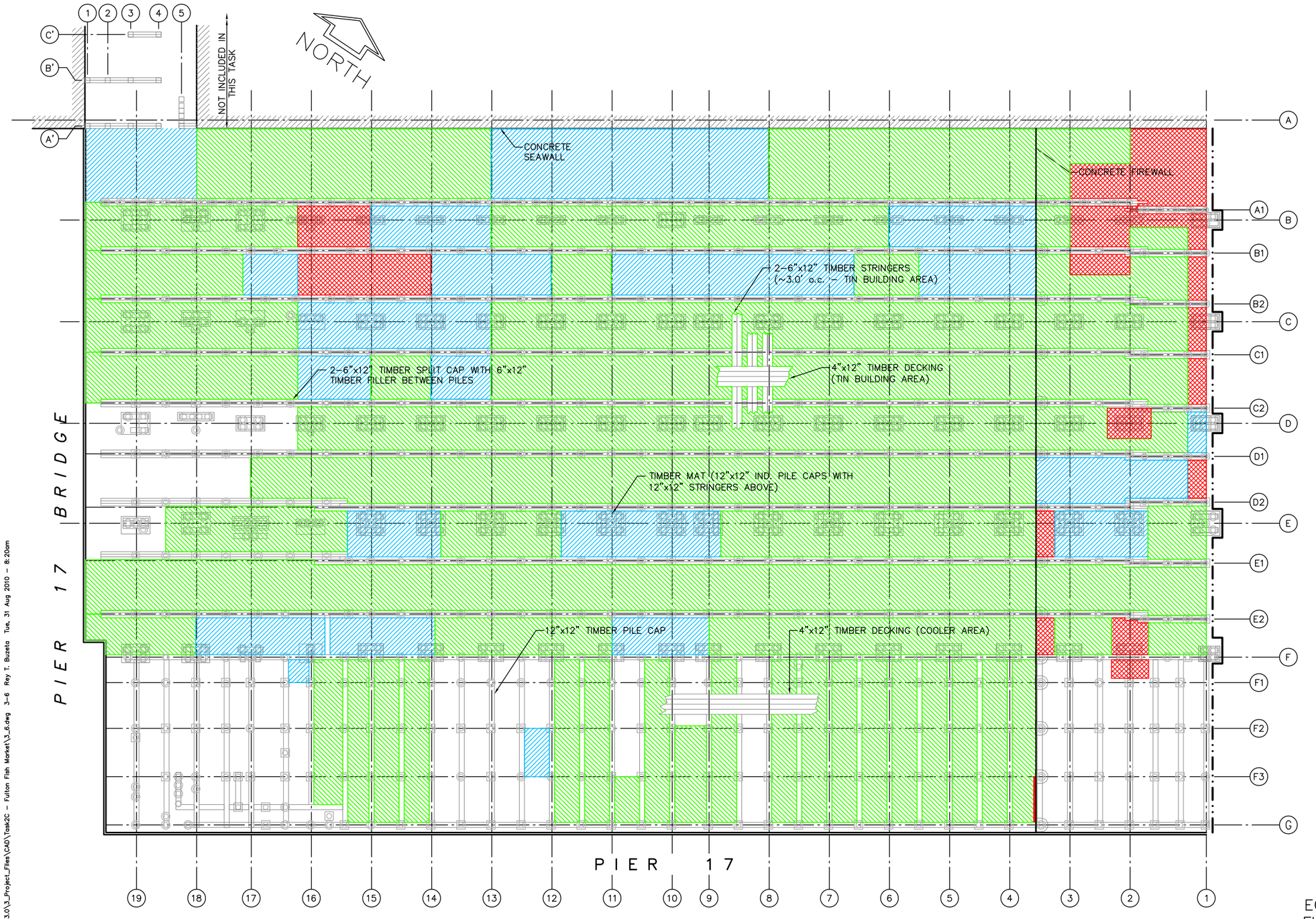
In the main building portion of the Tin Building, the pile caps support east-west running stringers, which comprise two 6 x 12 timbers, spaced 3 ft on-center. The condition of the stringers typically coincided with the condition of the timber decking. Table 3-4 summarizes the underdeck ratings.

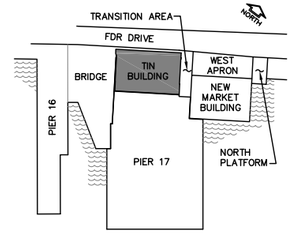



PHOTO 3-5. Typical heavy rot in timber pile cap near Bent C1, Pile 5.5, looking west.



PHOTO 3-6. Heavy rot and separation in the 4 x 12 timber deck planks.




KEY PLAN

N.T.S.

## DECK CONDITION LEGEND

FIREWALL

BOTTOM OF DECK

- MODERATE ROT (14600 SQ.FT., 48% OF TOTAL AREA)
- ADVANCED ROT (4311 SQ.FT., 14% OF TOTAL AREA)
- SEVERE ROT (1142 SQ.FT., 4% OF TOTAL AREA)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING FRAMING PLAN", FIGURE 3-2, DATED JANUARY 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.
3. CONDITION RATING INCLUDE THE TIMBER STRINGERS AND TIMBER DECKING.

0 20 40 FT.

SCALE 1"=20'-0"

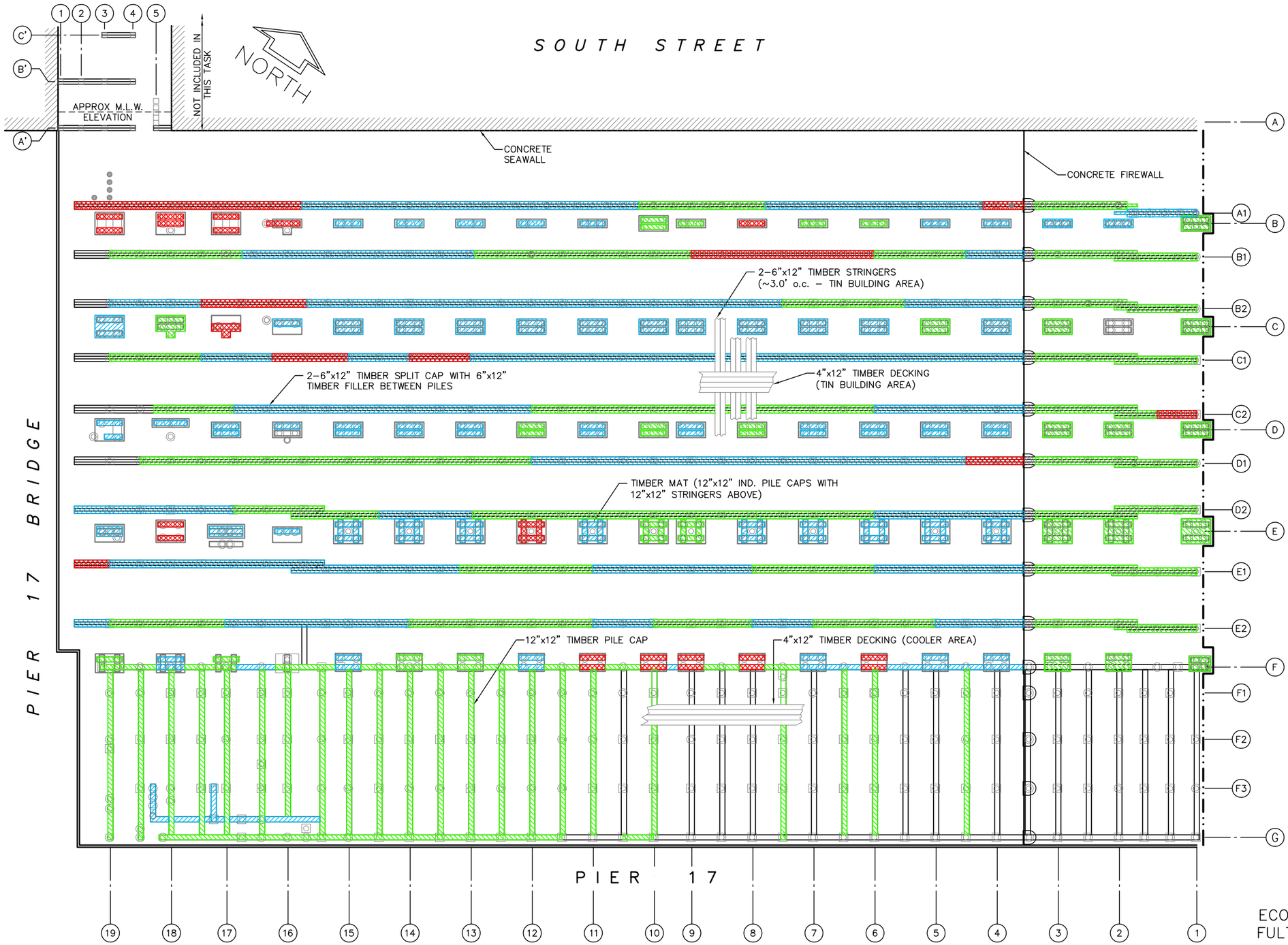
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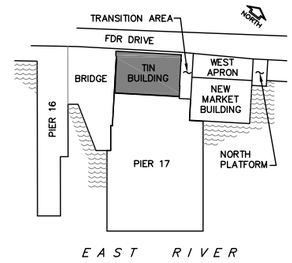
# TIN BUILDING
# DECK AND FIREWALL CONDITION PLAN

3-14

FIG. 3-6

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KEY PLAN

N.T.S.

## FRAMING CONDITION LEGEND

- MODERATE ROT
- ADVANCED ROT
- SEVERE ROT

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "TIN BUILDING FRAMING PLAN", FIGURE 3–2, DATED JANUARY 2007.
2. DEFINITIONS IN REPORT.
3. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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# TIN BUILDING
# PILE CAP CONDITION PLAN



FIG. 3–7

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**TABLE 3-4 SUMMARY OF TIN BUILDING UNDERDECK RATING**

| Rating | Area (sq ft) | Percent |
|---|---|---|
| Minor | 5,100 | 16.6 |
| Moderate | 19,450 | 63.1 |
| Advanced | 4,905 | 15.9 |
| Severe | 1,345 | 4.4 |
| Total | 30,800 | 100.0 |

(C) SEAWALL AND FIREWALLS

The concrete and granite block seawall located along the inshore side of the Tin Building is in **fair** condition. The only defect observed is limited to light scaling and erosion of the concrete in the tidal zone. No scour exists along the length of the wall.

The concrete firewalls are in **fair** condition. There was a 10 ft stretch, located on the northernmost firewall in the cooler area that was found to be missing; however, the firewalls typically only exhibited light erosion along the bottom 6 in. to 1 ft.

### 3.1.3 Comparison with Previous Inspection Results

The most recent inspection of the Tin Building, prior to 2010, was performed as part of the 2006 Routine Inspection of Fulton Fish Market by OCC. The 2006 inspection report identified the Tin Building as being in **poor** condition due to widespread moderate and advanced defects to the wrapped timber piles, as well as extensive rot in the timber decking and framing.

In general, the observed conditions have worsened since the 2006 inspection, which is expected considering no repairs have been performed during this time. The previous report identified 47 concrete encasements as having evidence of erosion at the mudline with six instances where the timber pile was exposed and deteriorated below the undermined encasement. During the 2010 inspection, 187 of the encasements were found to have some level of erosion with exposed timber piles at 26 of the encasements.

In addition, the 2006 report identified moderate to severe deterioration in the wrap repair material with heavy marine borer and rot deterioration in the areas where the timber has become exposed. Table 3-5 compares the condition rating percentages for the total inspected piles beneath the Tin Building between the 2006 and 2010 inspections.

**TABLE 3-5 TIN BUILDING PILE RATING COMPARISON**

| Rating | 2006 OCC Inspection | 2010 OCC Inspection |
|---|---|---|
| Minor | 74% | 43% |
| Moderate | 17% | 38% |
| Advanced | 18% | 16% |
| Severe | 1% | 3% |

The 2006 report identified the pile caps and stringers as being in fair condition with localized areas of advanced and severe rot. It appears that this condition has worsened as it was observed as being more widespread during this inspection.

The following table compares the priority repair recommendations provided by OCC following the 2006 inspection with the findings from the current investigation. Because none of the 2006 recommendations have been implemented, the quantity of deteriorated elements has significantly increased.

**TABLE 3-6 TIN BUILDING COMPARISON WITH PREVIOUS REPAIR RECOMMENDATIONS**

| Structural Element | 2006 Recommendations | 2010 Findings |
|---|---|---|
| Concrete Encasements | None | 187 found undermined. |
| Wrapped Piles | Encase approximately 200 piles. | 257 piles with loose and/or failed wraps. |
| Underdeck/Stringers | Repair approximately 6,400 sq ft of decking; Repair approximately 260 lin ft of stringers. | 25,700 sq ft of decking found to be moderate to severe, including stringers. |
| Pile Caps | Repair approximately 400 lin ft. | 2,870 lin ft of pile caps found to be moderate to severe. |

### 3.1.4 Structural Condition Assessment

(A) STRUCTURAL ANALYSIS

A structural analysis was performed using pile lengths and diameters obtained during the routine inspection to determine allowable pile loads and minimum current pile conditions to provide sufficient capacity now and in the future. In addition, due to the observed condition of the pile caps and stringers, an analysis was performed to determine their capacity with varying degrees of deterioration. All loading from the building superstructure was assumed to be fully supported by the column pedestal clusters.

Although the building is currently vacant, the structure was analyzed using two load scenarios: zero live load (dead load only) and dead load plus a 40 psf uniform live load (minimum requirement for occupancy).

Pile dimension data used for the analysis was taken from the Level III inspection notes. The piles chosen for Level III inspection were selected as a representative sample set based on their location and original Level I inspection rating. The diameter used for the analysis was 6.8 in., which represents the diameter with an 84 percent exceedance probability. Using the methods described in the 2005 edition of the National Design Specification for Wood Construction (NDS), the piles were found to provide sufficient capacity to support a uniform live load of 40 psf.

Pile cap and stringer analyses were initially performed assuming original construction conditions to determine the maximum allowable loading for both flexural and shear failure. From this information, a maximum allowable section loss was then determined. It was determined that the timber stringers can maintain safe capacity against flexural failure with a loss of cross sectional area of up to 32.5 percent under dead load only. This roughly corresponds to those rated advanced or severe, which account for approximately 20 percent of the inspected stringers. Also, the analysis of the pile caps revealed that, under dead load only, the pile caps can maintain safe flexural capacity with up to 60 percent loss of cross sectional area. A loss of section this great, however, is beyond what is generally allowable under standard engineering practices and repairs would likely be required before the deterioration reaches these levels.

Unless the observed defects are addressed, the condition of the structural elements will continue to deteriorate and eventually reduce the structure's live load capacity. The graph on Figure 3-8 illustrates the diminishing capacity of the timber piles due to projected future deterioration rates. Varying deterioration rates were considered, including annual section loss of 10 percent, 15 percent, and 20 percent, with a separate plot for each scenario. The graph shows when the allowable pile load crosses below maximum applied load under both of the load scenarios (40 psf live load and dead load only). When the plot crosses below each threshold, 16 percent of the piles will no longer be able to support the applied load.

(B) SERVICE LIFE ASSESMENT

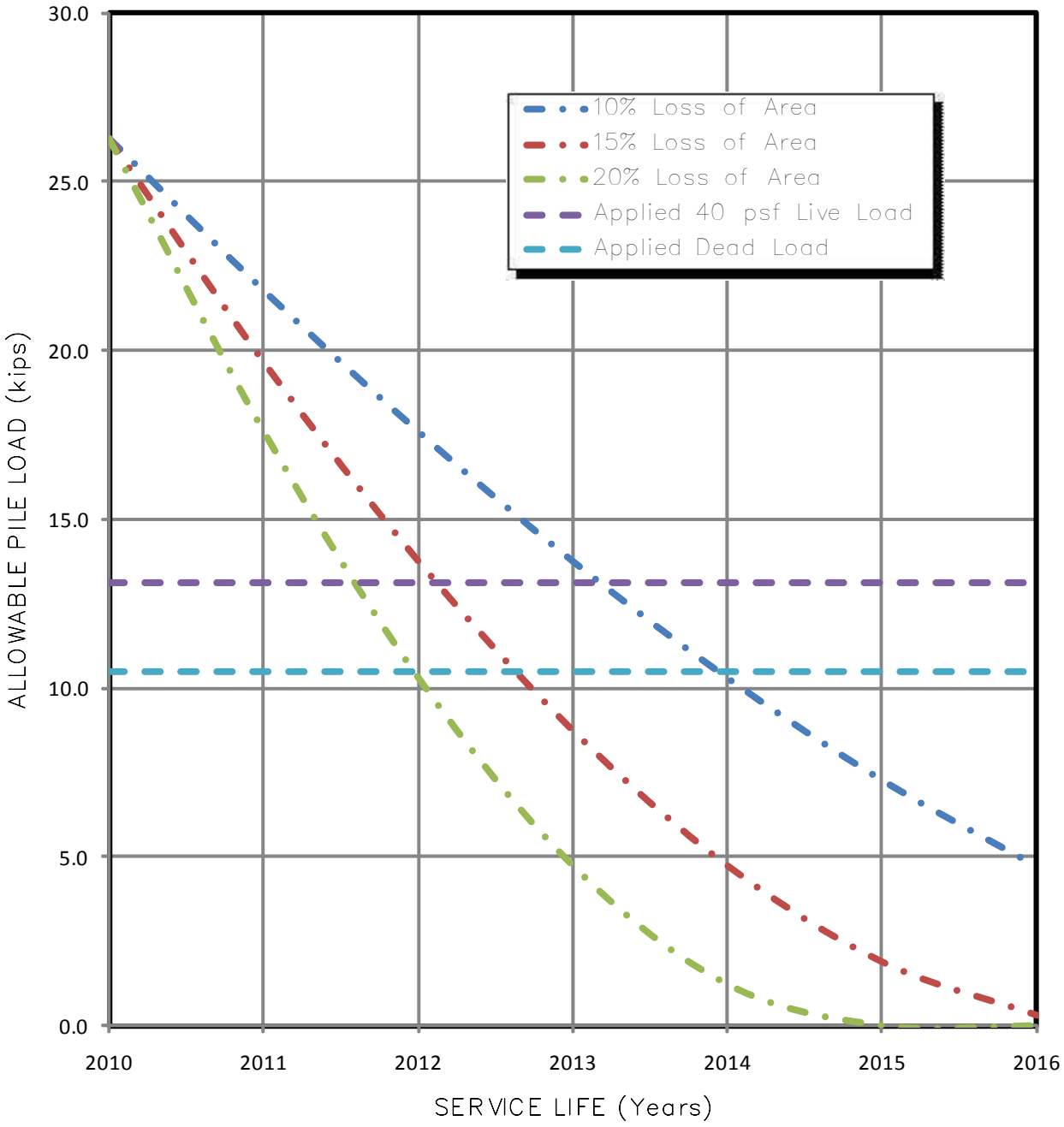
The graph illustrates that under modest marine borer attack (10% loss of area annually) the piles will maintain sufficient capacity to support the structure's dead weight only for the next three years. In order to maintain the 40 psf load rating in three years time, the piles must have a minimum current diameter of 6.85 in. Currently, 23 percent of the piles do not meet this minimum diameter. The fact that approximately 20 percent of the timber stringers do not have sufficient capacity to support the dead load of the structure means that no live loading should be introduced until structural rehabilitation is performed.

### 3.1.5 Recommendations

Based on the observed conditions of the primary structural elements of the Tin Building, OCC has developed a recommended rehabilitation cycle based on Immediate, Priority, and Routine repair items. These repair items should be implemented during the recommended time frame to maximize the structure's useful service life and ensure that sufficient load capacity is provided for the future use of the structure.

(A) IMMEDIATE ACTION

Due to the widespread heavy deterioration in the timber stringers, decking, and pile caps, OCC recommends that all live loading is removed from inside the Tin Building. Approximately 20 percent of the timber stringers no longer have adequate cross section to resist flexural failure under a 40 psf live load, which represents the minimum load rating for occupancy under the New York City Building Code Reference Standard 9. Although the building is currently vacant, the structure should not be used for any short or long term storage unless additional rehabilitation is performed.




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TIN BUILDING
PILE CAPACITY GRAPH



FIG. 3–8

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C – Fulton Fish Market\3_8.dwg Figure 3–8 Rey T. Buzeta Thu, 19 Aug 2010 – 3:37pm

(B) PRIORITY ACTION (1-3 YEARS)

(1) Vacant Building

If the building is intended to be left vacant and access inside remains restricted to all but essential personnel, there are no repairs that are currently necessary as priority recommendations. The pile clusters are effectively all encased in concrete and the representative pile diameter (i.e. 84 percent are greater diameter) for the piles supporting the main deck will maintain dead load capacity until approximately 2013. Because of the extensive timber deck, stringer, and pile cap deterioration, it is possible that cracking and settlement of the concrete deck may occur. If no repairs are performed, OCC recommends EDC perform an additional routine or rapid inspection of the substructure in 2 years (2012) to monitor for signs of distress in the structure and update recommended actions.

(2) Limited Building Access

If limited access inside the building is necessary, then OCC recommends several rehabilitative measures to restore a load rating of 40 psf to the lowest floor of the building. This uniform loading is the minimum allowable rating to allow for building occupancy by the New York City Building Code Reference Standard 9. These repairs include replacing or sistering the advanced and severe timber stringers and pile caps, which comprises approximately 1,500 lin ft of timber. This repair would be only a short-term repair until a more extensive substructure repair can be implemented. In addition, repairing the piles with less than a 6.85 in. diameter will ensure that the piles will maintain safe capacity for a 40 psf live load rating in three years. This comprises a total of 69 piles which should receive a structural concrete encasement such as that detailed on Figure 3-9.

(C) ROUTINE ACTION (3-5 YEARS)

Since there are no current plans for future occupancy of the building and EDC would like to minimize costs, the tin building substructure will likely require extensive rehabilitation when a final use has been selected. Because of the extensive existing deterioration and difficulty in performing durable repairs to the timber deck, stringers, and caps, OCC recommends an effective replacement of the existing concrete deck, timber decking, timber stringers, and timber pile caps.

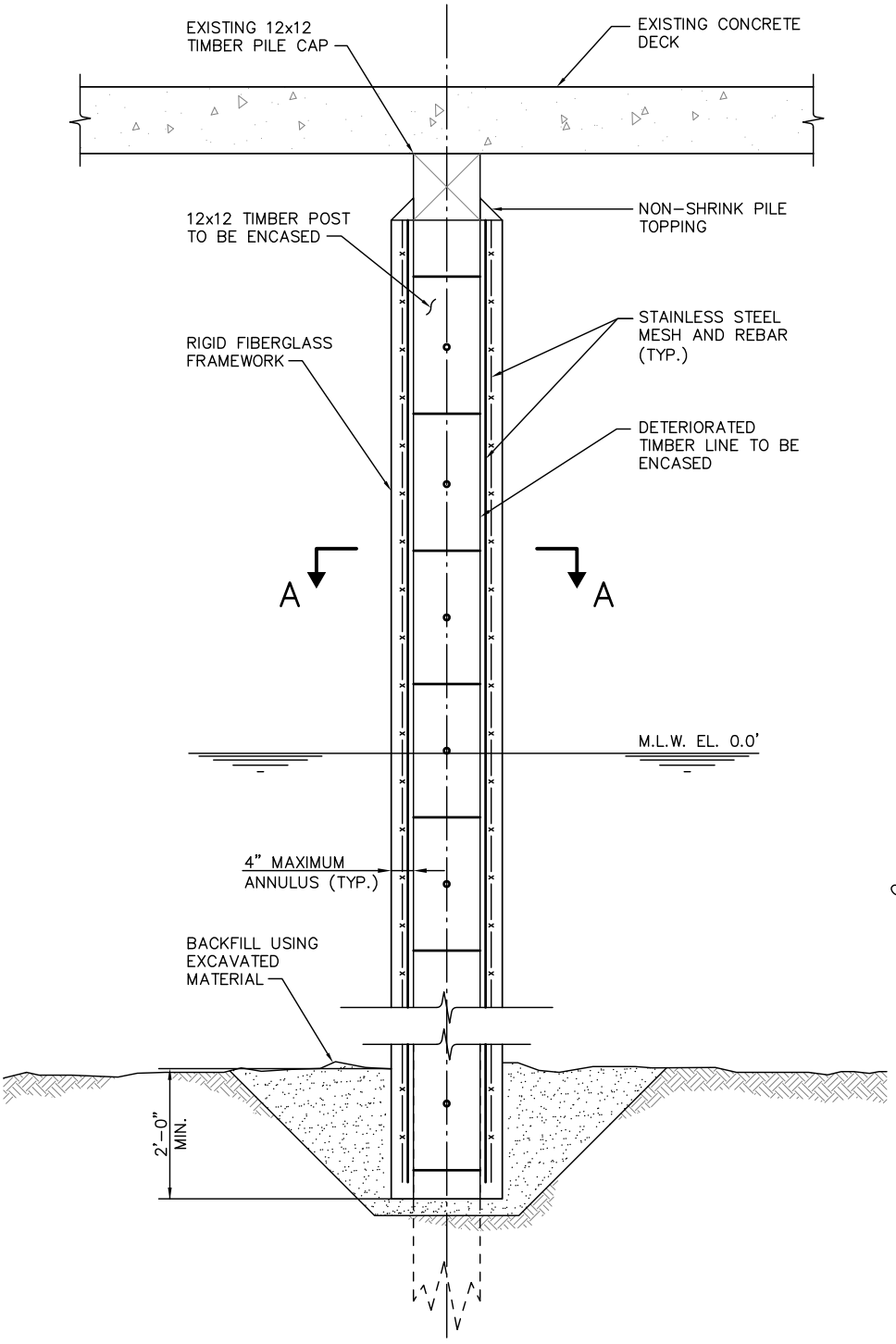
In this option the concrete and timber superstructure elements would be demolished leaving only the piles exposed. The open deck will provide easier access to repair the support piles. Once the deck is opened, all of the remaining non-encased piles should receive full length structural concrete encasements. In addition, the existing encasements with scour and exposed timber would either receive bottom structural encasement extensions that provide sufficient embedment into the mudline (Figure 3-10) or would be completely replaced with new concrete encasements constructed above pile stubs. A new, two-way reinforced concrete deck would be cast-in-place onto the repaired piles. A layer of crushed stone could be placed above the new concrete deck to carry any mechanical, electrical, or plumbing conduits while also providing the additional height needed to bring the new finished floor elevation up to match that of the adjacent walkway. This alternative represents a long-term rehabilitation option while still preserving the building and adhering to the requirements of the National Register of Historic Places. Figure 3-11 compares the existing cross section to the proposed cross-section.

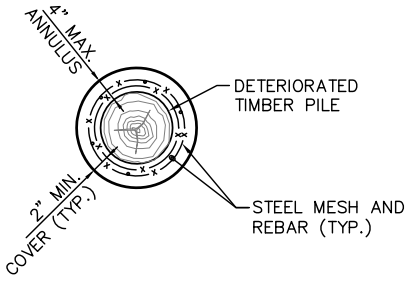
The table below summarizes the recommended rehabilitation schedule for the Tin Building as well as the opinion of probable costs (OPC) for each rehabilitation phase.

**TABLE 3-7 TIN BUILDING SUMMARY OF RECOMMENDED REPAIRS**

<table>
<tr><th></th><th>Immediate</th><th>Priority (1-3 yrs.)</th><th>Routine (3-5 yrs.)</th></tr>
<tr><td rowspan="4"></td><td rowspan="4">Remove all loading from inside the building.</td><td rowspan="2">Repair approximately 1,500 lin ft of timber stringers.</td><td>Demolish all decking, stringers, and pile caps.</td></tr>
<tr><td>Install structural concrete encasements on all 222 non-encased piles.</td></tr>
<tr><td>Install 69 structural concrete encasements</td><td>Install bottom structural encasement extensions on 27 existing encasements.</td></tr>
<tr><td>Monitor building for signs of over-stressing.</td><td>Install new 2-way reinforced concrete deck above repaired piles with layer of crushed stone for M,E,P conduits and bring up to match adjacent elevation.</td></tr>
<tr><td>TOTAL OPC</td><td>$0</td><td>$1,325,000*</td><td>$4,034,000*</td></tr>
</table>

*Does not include a cost for mobilization/demobilization




SECTION A-A

## NOTES:

1. EXISTING TIMBER PILE, POST AND FISHPLATES ARE CURRENTLY WRAPPED. FISHPLATES AND WRAP MATERIAL SHALL BE REMOVED COMPLETELY.
2. MANY PILES DO NOT HAVE EXISTING POST REPAIRS. WRAP MATERIAL SHALL BE REMOVED COMPLETELY.
3. REPAIR ASSUMES ADHERENCE WITH EDC GENERAL PERMIT (i.e. 8" DIAMETER INCREASE).
4. CONFIGURATION OF PILE CAP AND DECK VARIES WITH EACH STRUCTURE.




SCALE 3/8"=1'-0"

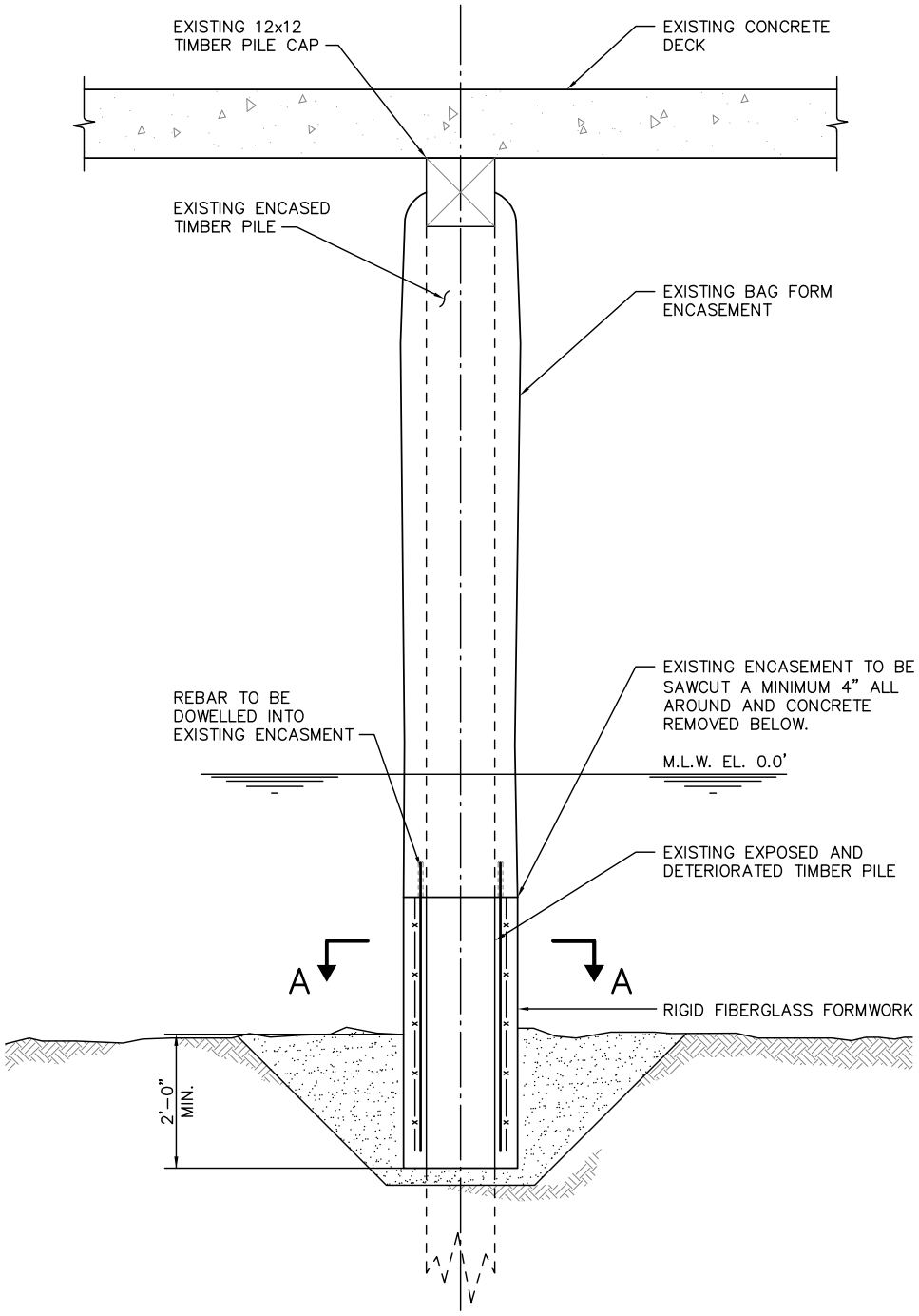
NEW YORK CITY
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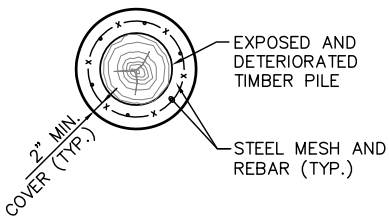
# TIN BUILDING
# PROPOSED ENCASEMENT REPAIR

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C - Fulton Fish Market\3_9.dwg 3-9 Rey T. Buzeta Thu, 19 Aug 2010 - 3:42pm



FIG. 3-9




SECTION A–A

0 1 2 3 4 5 FT.

SCALE 3/8"=1'–0"

## NOTES

1. CONFIGURATION OF PILE CAP AND DECK VARIES WITH EACH STRUCTURE.

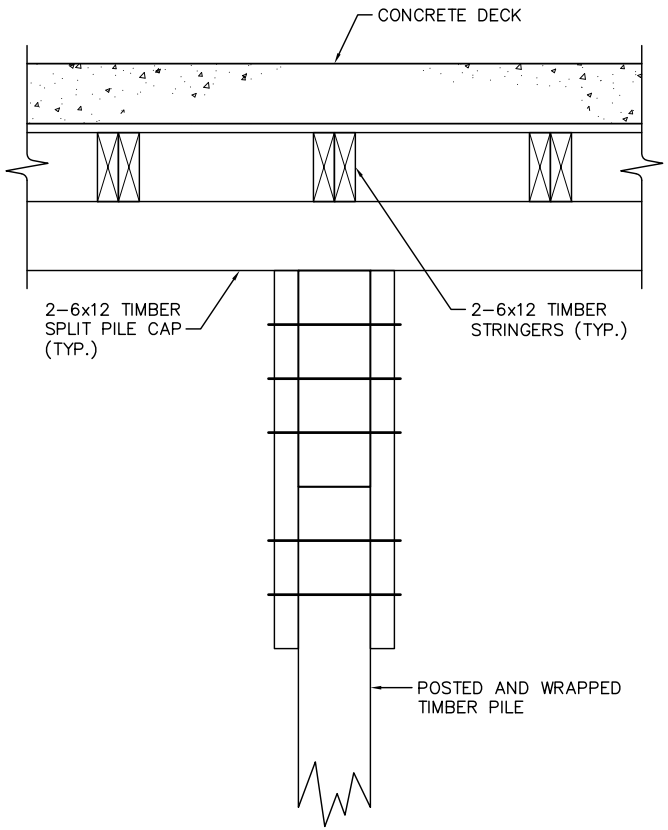
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# TIN BUILDING
# PROPOSED LOWER
# ENCASEMENT EXTENSION

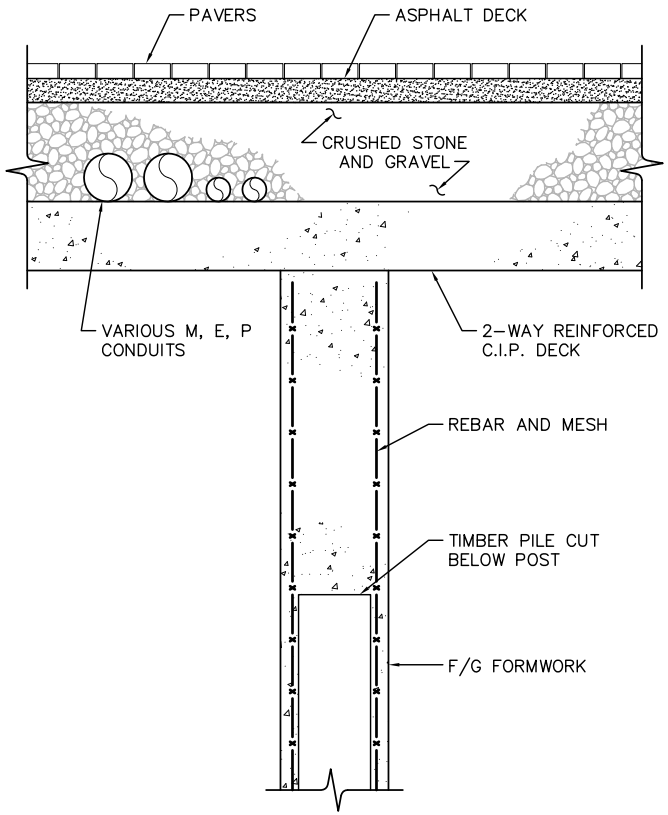
P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C - Fulton Fish Market\3_10.dwg 3-10 Rey T. Buzeta Thu, 19 Aug 2010 - 4:17pm



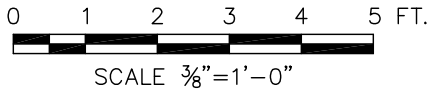
FIG. 3–10




EXISTING




PROPOSED




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## TIN BUILDING
## PROPOSED REPAIR SECTION

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C – Fulton Fish Market\3_11.dwg Fig 3–11 Rey T. Buzeta Thu, 19 Aug 2010 – 4:18pm



FIG. 3–11

## 3.2 WEST APRON

### 3.2.1 Description

The West Apron is an asphalt-covered platform located between the New Market Building and the concrete seawall. The dimensions of this area are approximately 195 ft by 80 ft. The reinforced concrete deck of the West Apron is supported by 12 x 12 timber pile caps, spaced 12 ft on center, and oriented in the east-west direction. Timber piles are spaced 6 ft on center. Photo 3-7 provides an overall view of the topside of the West Apron.

The same concrete and granite block seawall that runs along the inshore side of the Tin Building continues along the inshore side of the West Apron. The wall consists of approximately 130 lin ft of 8-ft wide by 9-ft tall precast concrete block sections and approximately 65 lin ft of four courses of granite blocking. Between Bent 2 and Bent 2.5, a pile supported low-level concrete overhang extends out from the wall that prevents access to the A-row piles.

A total of 407 timber piles support the West Apron. Approximately 38 percent of the support piles have been wrapped or wrapped and posted, while the remaining 62 percent were encased in concrete. Because an accurate assessment of the condition of the timber behind the wrap could not be made without Level III effort, the piles were rated based upon the condition of the repair. Subsequent to the initial inspection, a total of 12 piles were selected for Level III inspection, which included removal of the wrap repair material to expose the timber pile below. Table 3-8 provides a summary of the repair types observed by quantity and percentage of the total piles supporting the structure.

**TABLE 3-8 SUMMARY OF WEST APRON PILE REPAIRS**

| Repair Type | Quantity | Percent |
|---|---|---|
| Concrete Encasement | 253 | 62.2 |
| Post and Wrap | 103 | 25.3 |
| Wrap | 51 | 12.5 |
| TOTAL | 407 | 100.0 |

The West Apron provides access to the New Market Building, and is currently utilized as a parking lot. Figures 3-12 through 3-14 provide pile and framing plans and a typical cross section.




PHOTO 3-7. Topside view of West Apron, looking north.

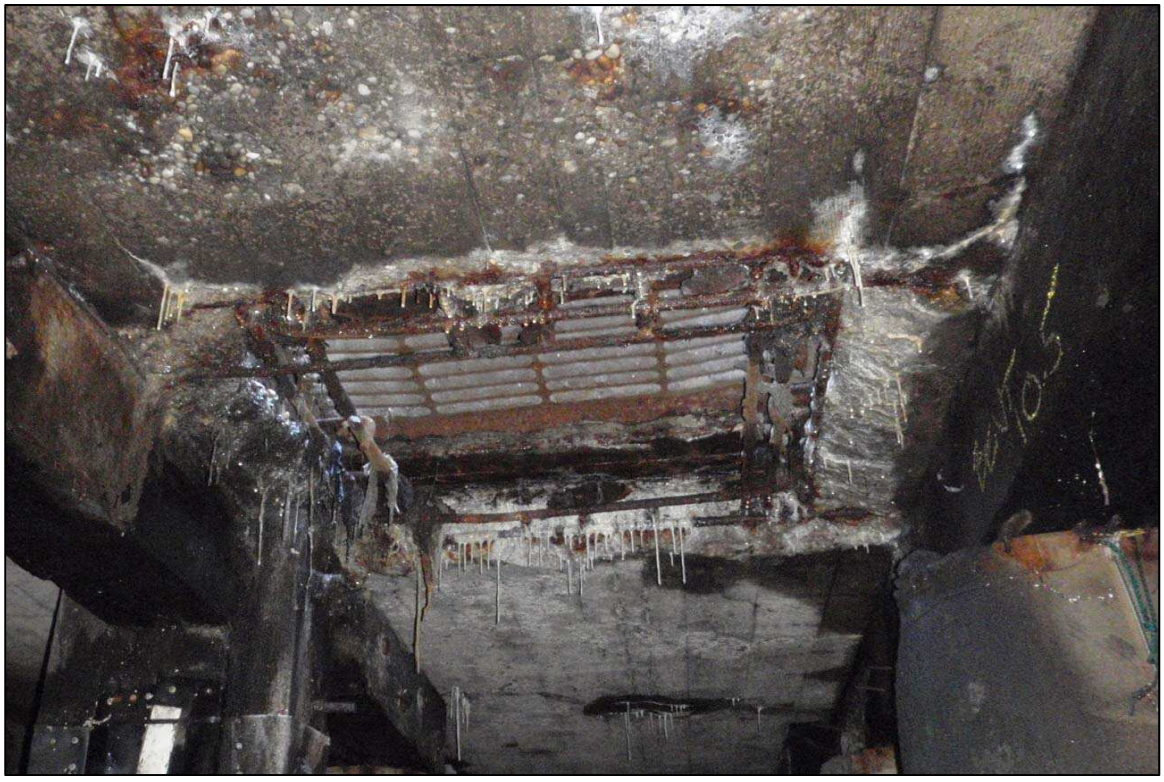
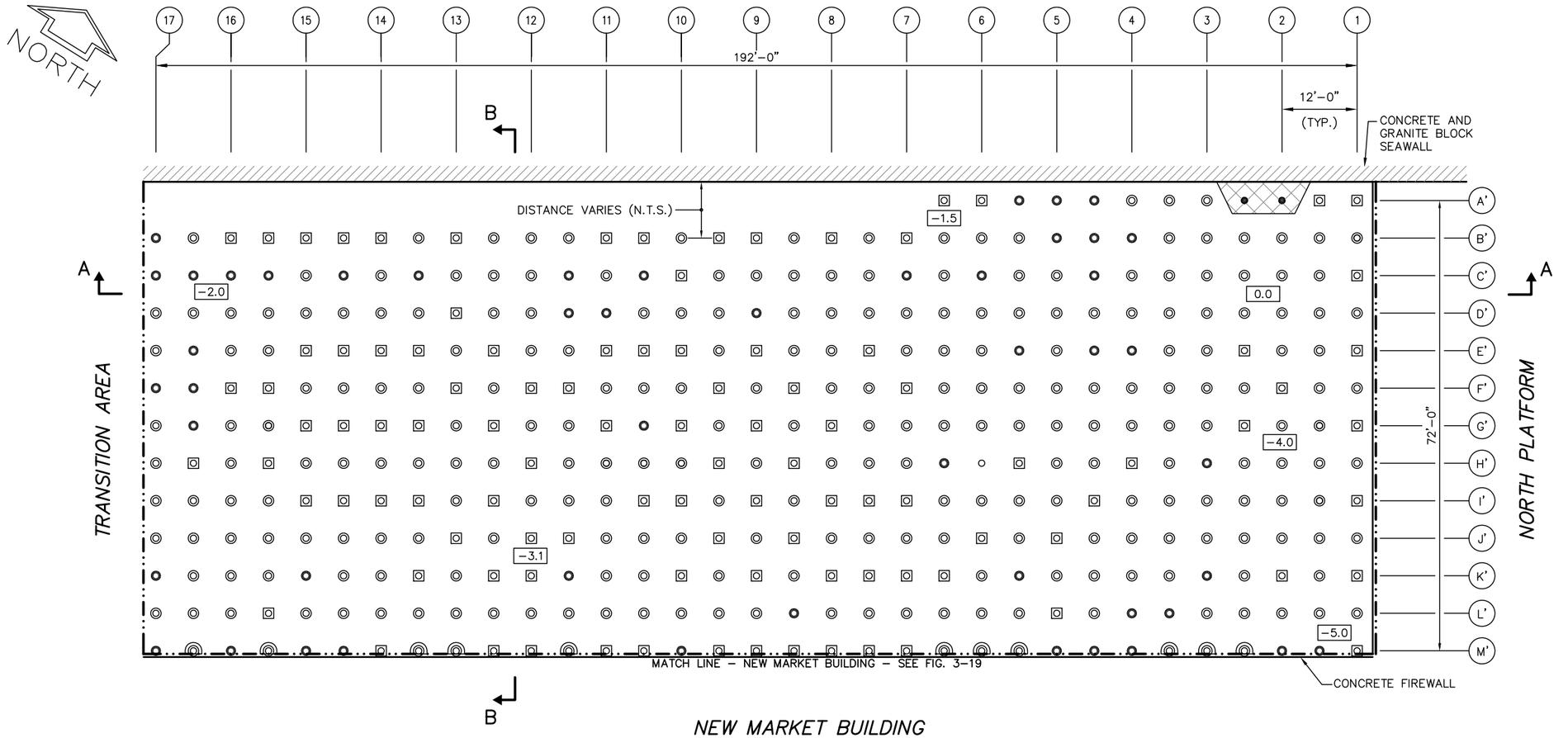
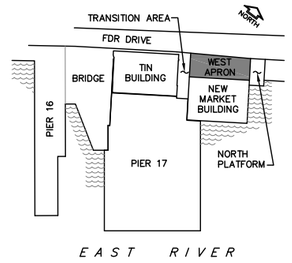


PHOTO 3-8. Heavy open spalling with exposed and corroded reinforcing located around deck drain at Bent 10.5.




NEW MARKET BUILDING




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- NO ACCESS
- -1.5 APPROXIMATE MUDLINE ELEVATION IN FEET (MLW)

## NOTE

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON PILE PLAN", FIGURE 3-15, DATED JANUARY 2007.

0 20 40 FT.

SCALE 1"=20'-0"

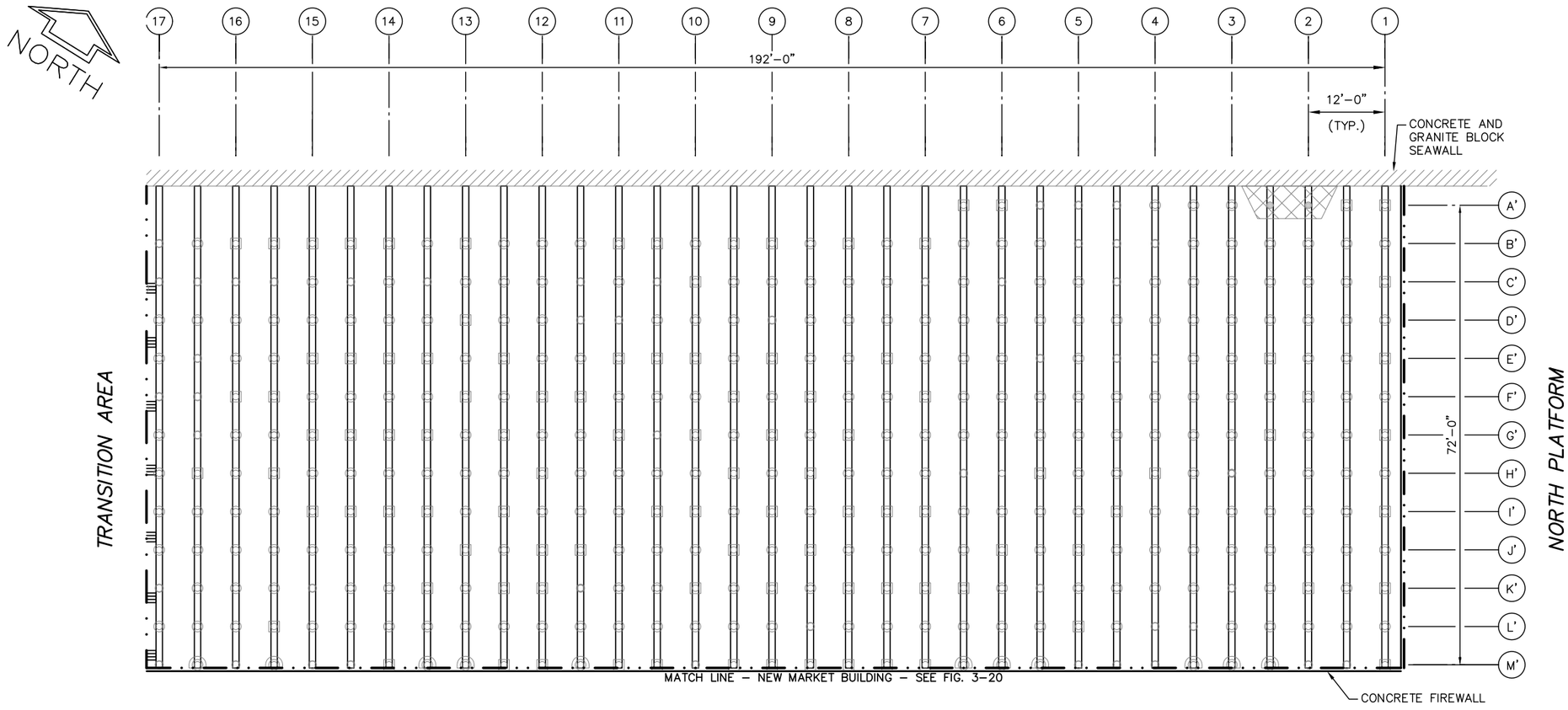
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# WEST APRON PILE PLAN

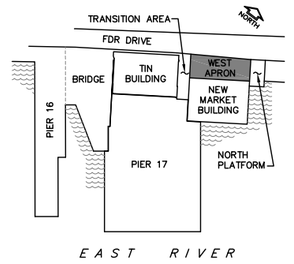


FIG. 3-12

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*NEW MARKET BUILDING*




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- NO ACCESS (PILECAP ENDS ENCASED IN SEAWALL)

## NOTE

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON FRAMING PLAN", FIGURE 3–16, DATED JANUARY 2007.

0 20 40 FT.

SCALE 1"=20'-0"

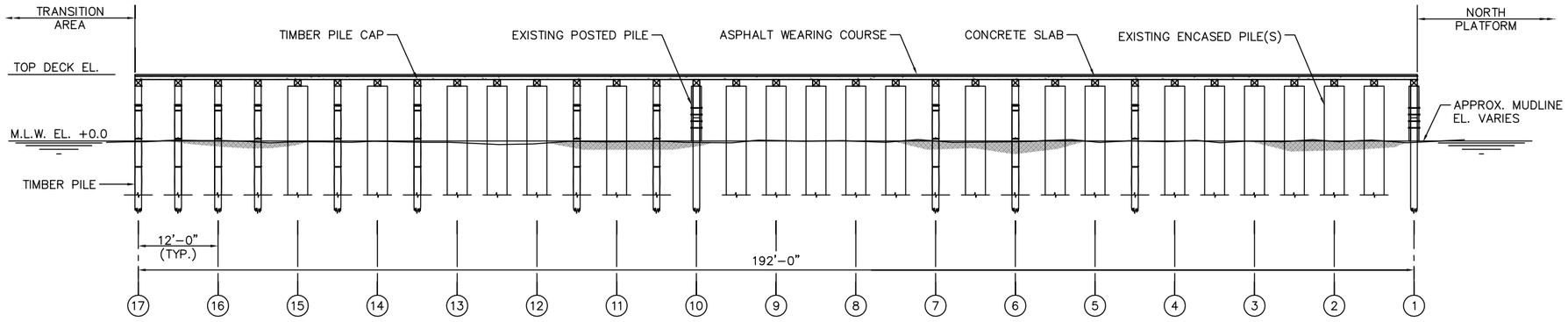
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# WEST APRON FRAMING PLAN



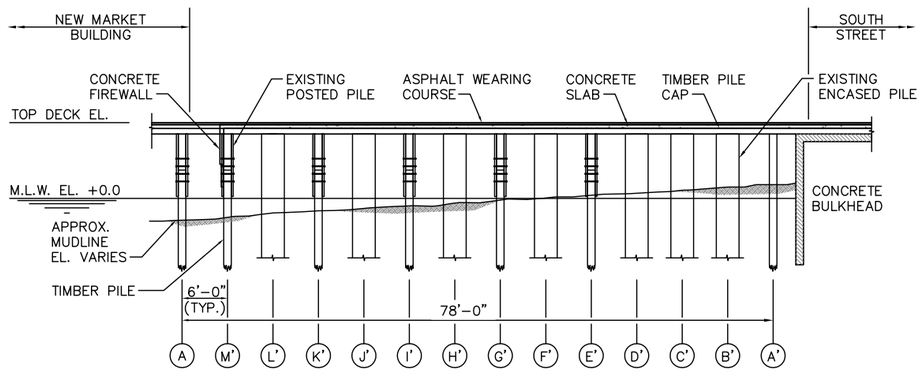
FIG. 3–13

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## SECTION A–A

SCALE 1"=20'-0"




## SECTION B–B

SCALE 1"=20'-0"

### NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON TYPICAL PIER CROSS–SECTION", FIGURE 3–17, DATED JANUARY 2007.
2. FOR LOCATION OF SECTIONS A–A AND B–B, SEE FIG. 3–7.

0 20 40 FT.

SCALE 1"=20'-0"

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# WEST APRON
# TYPICAL PIER CROSS–SECTIONS



FIG. 3–14

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### 3.2.2 Observed Conditions

The West Apron is in overall **poor** condition. The support piles with existing wrap repairs are typically loose and failed, and many of the concrete encasements are undermined due to mudline scour. In addition, there is open spalling surrounding the three manholes as well as pattern cracking and efflorescence present.

(A) TIMBER PILES

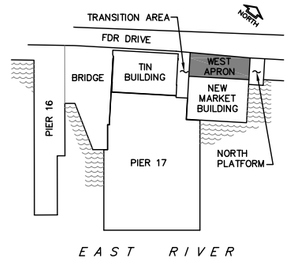
A total of 407 timber piles were inspected beneath the West Apron, all of which have received prior repairs. Because the existing repairs prevented access to the timber pile itself, the pile conditions were rated based on the condition of the repair. Inspection of the original timber pile was performed on the 12 piles that were included in the Level III inspection. The ratings of the inspected piles supporting the West Apron are quantified in Table 3-9 and illustrated on Figure 3-15 including the adjusted ratings following the Level III inspection.

**TABLE 3-9 SUMMARY OF WEST APRON PILE RATINGS**

| Rating | Concrete Encasements | | Posted/Wrapped and Wrapped | | | |
|---|---|---|---|---|---|---|
| | | | Level I | | After Level III | |
| | Total | Percent | Total | Percent | Total | Percent |
| Minor | 212 | 83.8 | 8 | 5.2 | 7 | 4.5 |
| Moderate | 23 | 9.1 | 64 | 41.6 | 60 | 39.0 |
| Advanced | 13 | 5.1 | 81 | 52.6 | 79 | 51.3 |
| Severe | 5 | 2.0 | 1 | 0.6 | 8 | 5.2 |
| TOTAL | 253 | 100.0 | 154 | 100.0 | 154 | 100.0 |

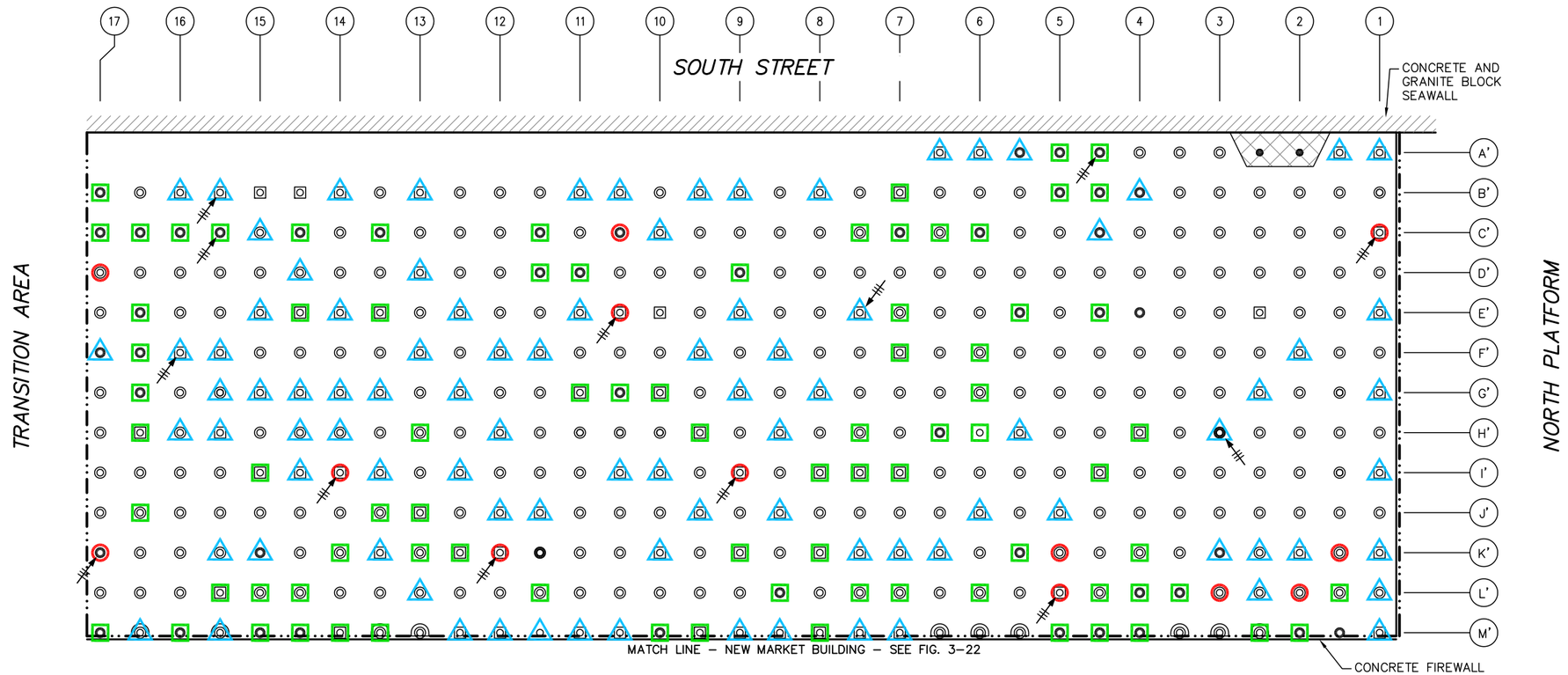
Over 60 percent of the piles have received concrete encasements and they are generally in **fair** condition. A majority of the concrete encasements were constructed with fabric forms. The concrete quality was typically sound with only scattered instances of light scaling. Approximately 16 percent of these encasements have scour around the mudline such that the concrete has become undermined. In 18 cases, the original timber pile has become exposed with marine borer deterioration varying between moderate to heavy. The precise level of deterioration was not easily determined due to the lack of visual access caused by excess concrete on the adjacent mudline.




KEY PLAN

N.T.S.




*NEW MARKET BUILDING*

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- NO ACCESS

## PILE CONDITION LEGEND

- SEVERE PILE
- ADVANCED PILE
- MODERATE PILE
- LEVEL III INSPECTION (WRAP REMOVAL)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON PILE PLAN", DRAWING NO. 3–15, DATED JANUARY, 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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# WEST APRON
# PILE CONDITION PLAN

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FIG. 3–15

The timber piles which were not encased in concrete were either wrapped or posted and wrapped. These repairs were found to be in **poor** condition due to widespread loose and failed wraps. Approximately 95 percent of the wrap repairs had movement in the wrap material between 1/2 in. and 3 in. and over half of the repairs had evidence of failure. The failure mode of the wrap material varied between opened seams, with visible water flowing into and out of the repair, and open tears in material where it was creased and folded to form to the irregularly shaped timber below. In addition, where the wrap material was found to be open enough to gain visual access of the pile below, rot and marine borer deterioration was typically found ranging from light to severe.

Similar to the wrap repairs beneath the Tin Building, the observed conditions illustrate that the repairs were likely installed poorly and on piles with significant section loss. Wrap repairs do not restore any structural capacity to heavily deteriorated piles and installing them on irregularly shaped piles is typically ineffective due to the difficulty in achieving a tight seal. Without a perfect seal, water can flow into and out of the repair, providing existing marine borers with fresh oxygen while also providing an entry point for new marine borers.

After removing the wrap material from 12 piles, 11 were found to have advanced or severe deterioration due to extensive marine borer and soft rot deterioration. The marine borer deterioration was caused by *Limnoria*, which attacks the timber from the outside and reduces the diameter of the pile. The average pile diameter of the 11 advanced or severe piles was approximately 8.5 inches. The marine borer deterioration appeared to be active due to the irregularly shaped piles and roughened surface of the timber.

In addition, a buildup of silt and clay was consistently found between the timber pile and the wrap material over the bottom 18 to 24 in. of the pile. This illustrates that the wrap material was not completely sealed and water was able to flow into the repair. When the water velocity inside of the wrap material slows, the sediment in the water is allowed to settle at the bottom.

(B) CONCRETE UNDERDECK AND SEAWALL

The cast-in-place concrete deck of the West Apron was found in **fair** condition with isolated open spalling and pattern cracking. The open spalls were typically located around the three manholes with several other smaller instances, totaling approximately 97

sq ft (Photo 3-8). The underdeck between Bent 2 and Bent 4 was found to have existing shotcrete repairs that remain fully intact.

The underdeck was also found to have light pattern cracking with efflorescence present. One crack was found extending from Bent 7 to Bent 17 and into the adjacent Transition Platform (Photo 3-9).

The granite block and concrete seawall running along the inshore side of the West Apron was in **fair** condition. The face of the concrete and granite had typical light scaling and minor grout loss between 1/2 in. and 3 in. deep (Photo 3-10). There were two isolated locations where vertical grout loss reached 18 in. and 22 in. near Bent 10.5 and Bent 8.5, respectively. A condition plan is shown on Figure 3-16.

(C) TIMBER CAPS

The pile caps consist of single timber 12 x 12 members and are in **satisfactory** condition (Figure 3-17). Generally, no significant defects exist and typical pick penetration was approximately 1/4 in. or less; however, there is one location, at Bent 1.5, with approximately 10 lin ft of severe rot. The typical members have full section remaining and in the locations where the underdeck had been repaired with shotcrete, the overspray has protected the caps from any further deterioration.

### 3.2.3 Comparison with Previous Inspection Results

The previous routine inspection of the West Apron was also performed during the 2006 OCC inspection of the Fulton Fish Market. The West Apron was determined to be in satisfactory condition during this inspection. The 2006 inspection noted loose and torn wrap repairs on approximately 25 percent of the wrapped piles with moderate to heavy marine borer and rot deterioration in the areas with exposed timber. In addition, the report cites deterioration of the concrete underdeck over approximately 560 sq ft, including open spalling localized around the manholes and drains. During the 2006 inspection, the undermining of the concrete encasements was not found. Also, the timber pile caps and stringers were typically found to be minor with little or no defects noted.

The findings from the previous report generally coincide with the observed conditions from this inspection. Since the 2006 inspection, shotcrete repairs were performed to repair the larger areas of open spalling on the concrete underdeck. These shotcrete patches are currently intact and appear effective.

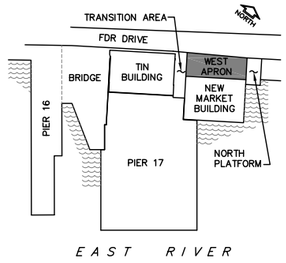


PHOTO 3-9. Typical underdeck cracking with efflorescence staining.



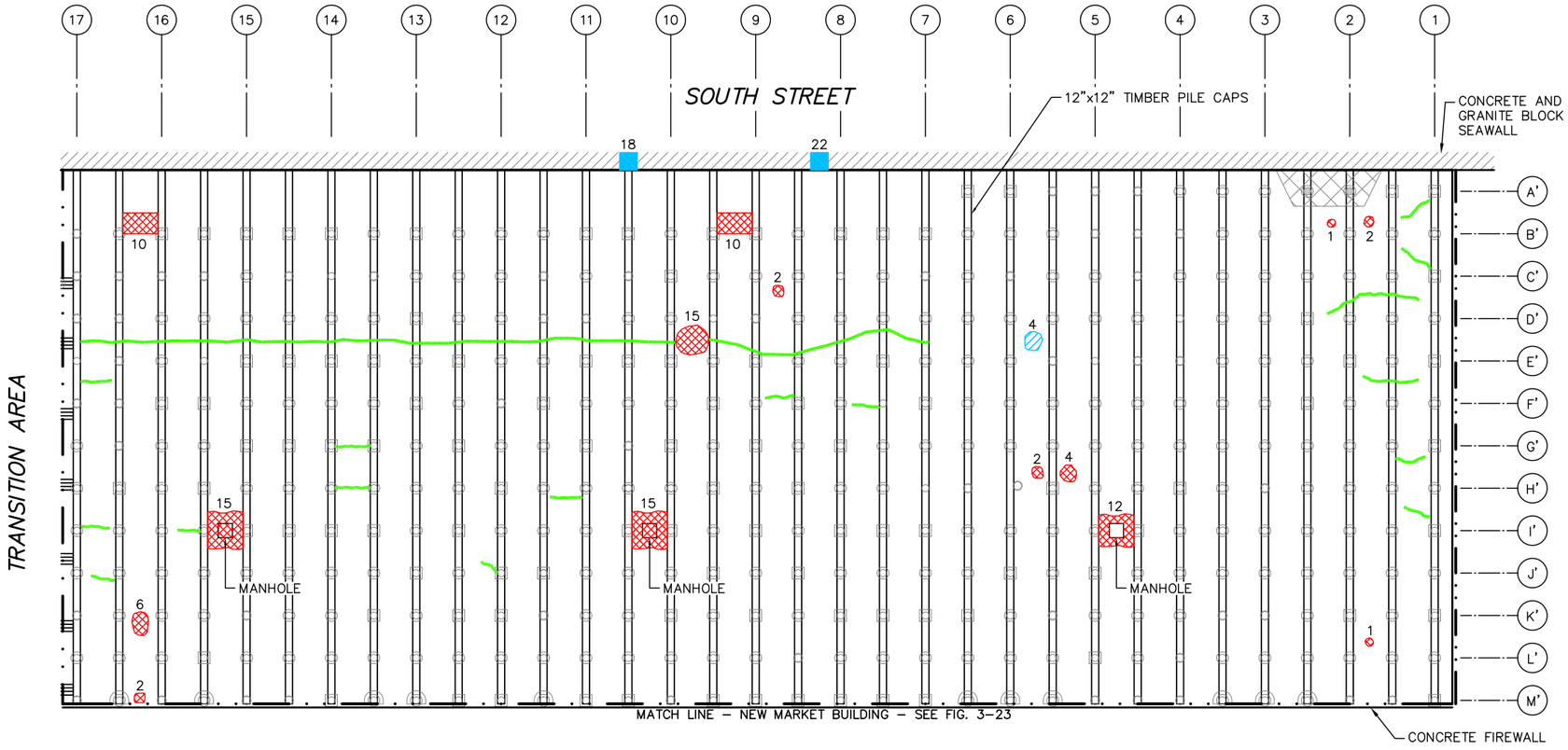
PHOTO 3-10. Typical concrete erosion at the inshore Seawall.

NORTH




KEY PLAN

N.T.S.




NEW MARKET BUILDING

## DECK CONDITION LEGEND

BOTTOM OF DECK

- CRACK
- CLOSED SPALL (5 SQ. FT.) — 5
- OPEN SPALL (10 SQ. FT.) — 10
- NO ACCESS
- 22 — LOSS OF GROUT 22" DEEP

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON FRAMING PLAN", FIGURE 3–16, DATED JANUARY 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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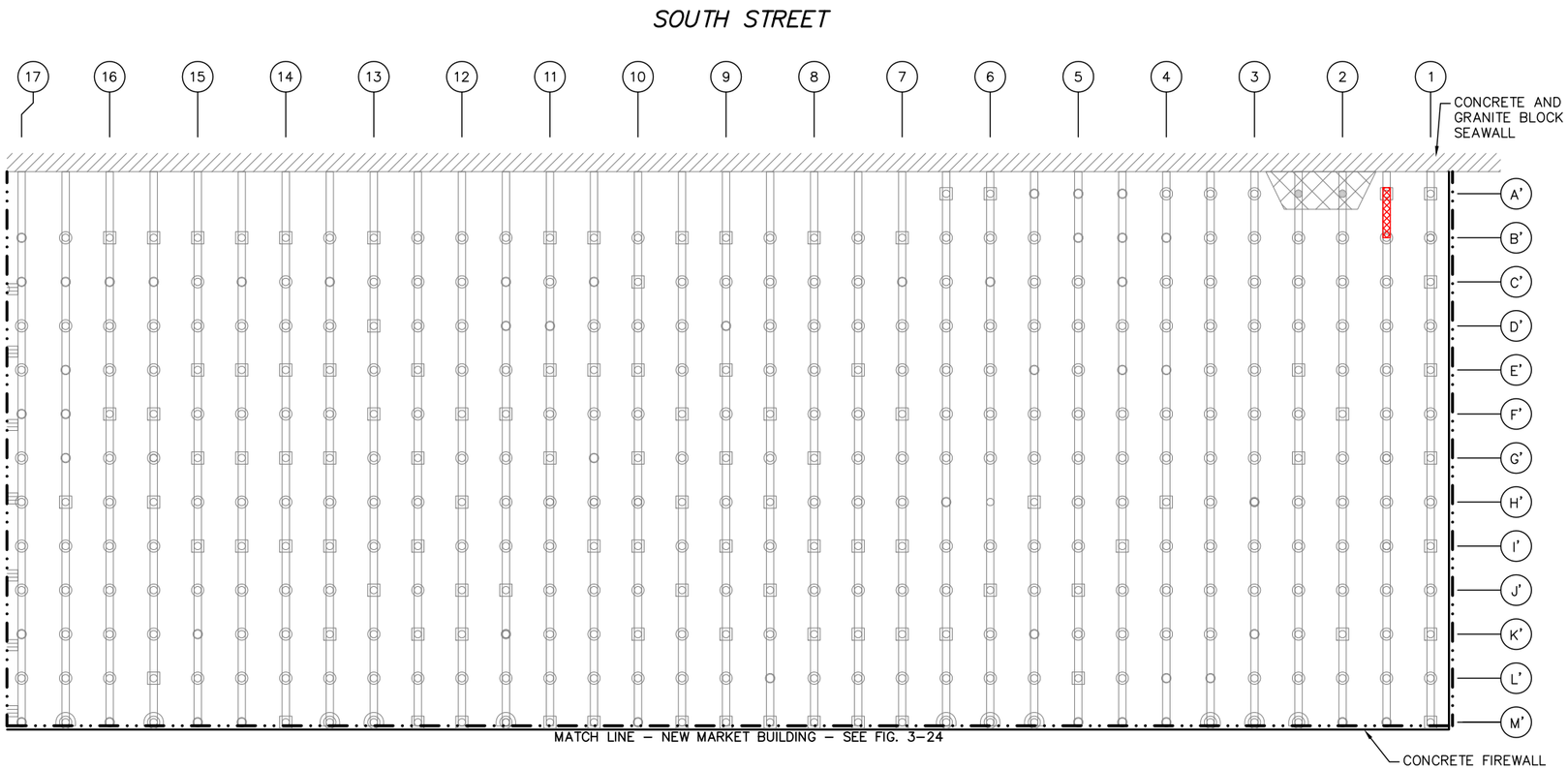
# WEST APRON
# DECK AND SEAWALL CONDITION PLAN



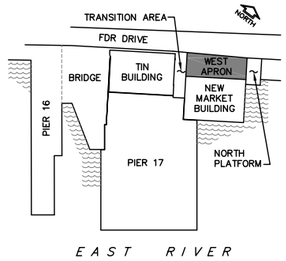
FIG. 3–16

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NORTH




NEW MARKET BUILDING




KEY PLAN

N.T.S.

## FRAMING CONDITION LEGEND

- MODERATE ROT
- ADVANCED ROT
- SEVERE ROT
- NO ACCESS (PILECAP ENDS ENCASED IN SEAWALL)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "WEST APRON FRAMING CONDITION PLAN", FIGURE 3–16, DATED JANUARY 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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# WEST APRON
# FRAMING CONDITION PLAN



FIG. 3–17

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Aside from the underdeck repairs, no repairs have performed to rehabilitate the deteriorated piles and as such, the extent of the deterioration has increased since the previous inspection. The following table compares the priority repair recommendations from the 2006 inspection with the findings from this inspection.

**TABLE 3-10 WEST APRON COMPARISON WITH PREVIOUS REPAIR RECOMMENDATIONS**

| Structural Element | 2006 Recommendations | 2010 Findings |
|---|---|---|
| Concrete Encasements | None | 41 encasements found to be undermined. |
| Wrapped Piles | Encase approximately 116 piles. | 146 wraps found to be loose or failed. |
| Underdeck | Repair approximately 620 sq ft. | 97 sq ft of open spalling observed. |
| Pile Caps | Repair approximately 10 lin ft. | Approximately 10 lin ft of severe timber. |

### 3.2.4 Structural Condition Assessment

(A) STRUCTURAL ANALYSIS

A structural analysis was performed using data obtained during the inspection to determine the structure's load capacity under current and projected future pile conditions. Because the framing and underdeck were generally found in fair condition, the analysis was limited to the loads governed by the pile capacity only. An average pile length of 20.5 ft was used, which includes the exposed pile height from the pile cap down to a point of fixity, approximately 10 ft below the mudline. The pile was analyzed under both buckling and compression and was assumed to have fixed - pinned connections.

Because the West Apron is currently used as a parking facility and is accessible as an outdoor assembly area, two load scenarios were considered. A 40 psf live load is the minimum uniform load required for parking facilities, while a 100 psf uniform live load is required for outdoor assembly areas. The analysis determined that the minimum pile diameter required to support a uniform live load of 40 psf is 5.2 in. and currently, approximately 8 percent of the piles have a minimum diameter of less than this. In addition, to support a uniform live load of 100 psf, the minimum current pile diameter is 5.6 in. Approximately 25 percent of the piles do not meet this minimum requirement. While these calculated diameters represent the minimum for the corresponding loads,

OCC recommends using a lower bound diameter of 6 inches for timber piles due to the inherent variation in section and possibility of internal deterioration.

The observations of the routine inspection indicate that the wrap repairs are essentially failed and that the timber piles will continue to experience marine borer deterioration until further rehabilitation is performed. The graph on Figure 3-18 illustrates the reduction in pile capacity under future marine borer attack. Deterioration rates of 10 percent, 15 percent, and 20 percent loss of area annually were considered based on observed rates in similar structures around New York Harbor.

The graph contains separate plots for allowable pile loads for each rate of deterioration along with horizontal lines that show the applied load under each load scenario considered. The analysis was performed using a representative pile diameter of 5.5 in., which represents the 84 percent exceedance value. Therefore, when the data curves cross the applied load, 16 percent of the piles will no longer provide adequate capacity under the corresponding uniform live load.

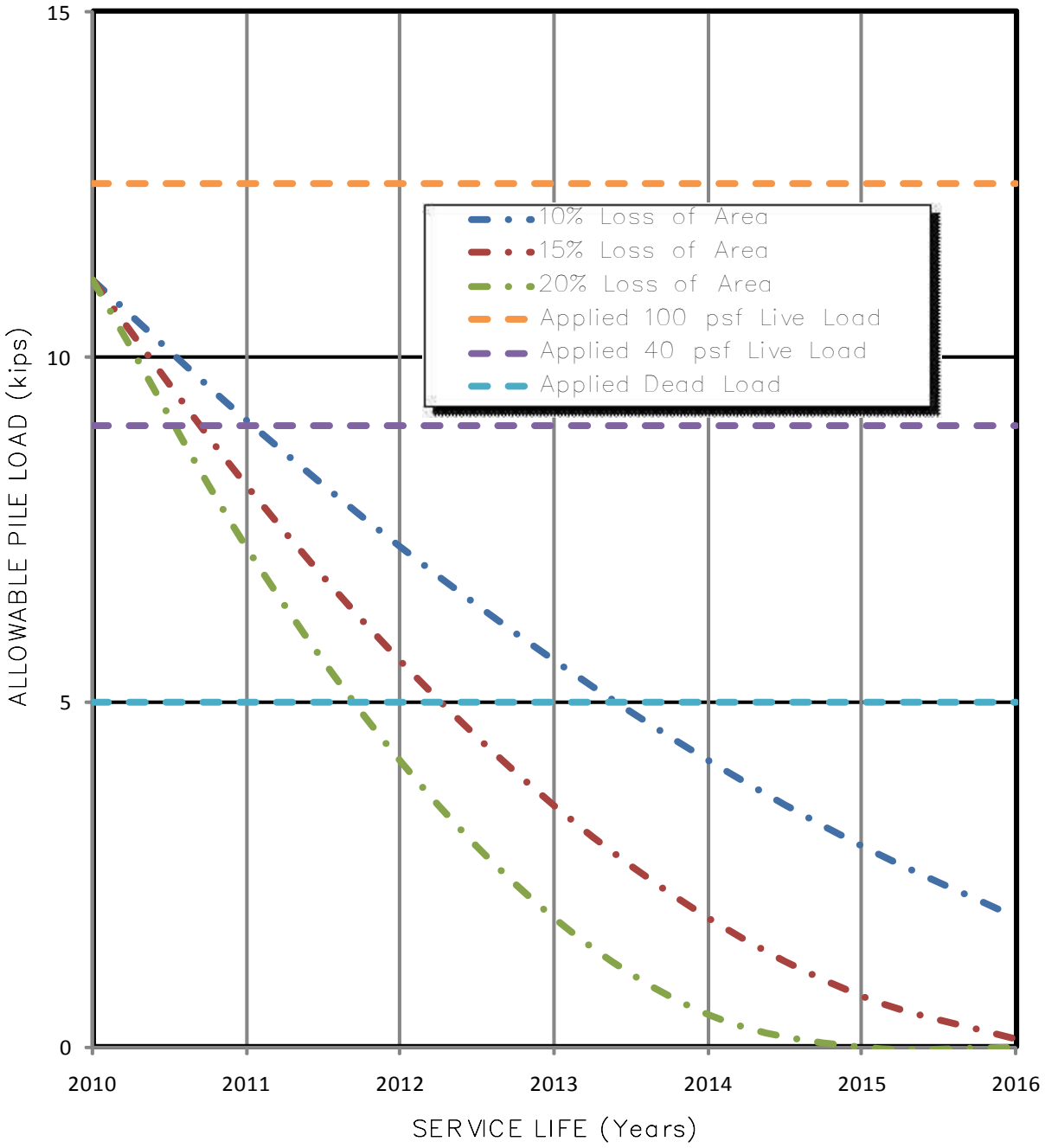
(B) SERVICE LIFE ASSESMENT

The graph shows that under modest marine borer deterioration, the allowable pile load will be approximately equal to the load applied from a 40 psf live load in one year. In approximately three years, the representative pile will no longer support the dead load. Since we are recommending a practical minimum diameter of 6 in., and this provides over 100 psf of live load capacity, we have used 100 psf in our assessment of future repairs.

In order to meet the minimum requirements to maintain a 100 psf live load in three years, piles must have a current minimum diameter of 6.85 in. Approximately 33 percent of the piles do not meet this requirement. Piles with a current minimum diameter of 7.6 in. would meet the minimum requirements for a 100 psf live load in six years. Approximately, 42 percent of the piles do not meet this current diameter.

### 3.2.5 Recommendations

The following rehabilitation cycle outlines the recommended Priority, and Routine repair items based on the observed conditions of the structural elements at the West Apron. Table 3-11 summarizes the recommended rehabilitation cycle.




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WEST APRON
PILE CAPACITY GRAPH



FIG. 3–18

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(A) IMMEDIATE ACTION

There are no defects at the West Apron that require immediate action.

(B) PRIORITY ACTION (1-3 YEARS)

The West Apron is currently being used as a parking lot and there are no current plans to change its future use. In addition to being an active parking lot, being an outdoor area susceptible to public assembly requires that it be subject to a 100 psf uniform live load rating. Therefore, it is recommended that all piles with less than a 6.85 in. diameter be repaired during this time period, which totals 52 piles. The repair should be a full height structural concrete encasement and would provide a uniform live load rating of 100 psf for the next three years. Also, the approximately 10 lin ft of severe pile cap should be repaired utilizing a steel channel sister member and the approximately 97 sq ft of open spalling should be repaired with a shotcrete patch.

(C) ROUTINE ACTION (3-5 YEARS)

Assuming that all of the recommended priority repair items are performed in the next 1 to 3 years, an additional 17 piles should receive structural concrete encasements to extend the 100 psf load rating an additional 3 years; however, OCC recommends budgeting for encasement of an additional 52 piles in this phase so that a final phase of 50 piles, in 5 to 8 years, can complete the structural encasement of all timber piles under the West Apron.. In addition, the 18 existing concrete encasements that were observed to have advanced or severe timber exposed in the scoured mudline should receive partial structural bottom encasement extensions.

**TABLE 3-11 WEST APRON SUMMARY OF RECOMMENDED REPAIRS**

| | Immediate | Priority (1-3 yrs.) | Routine (3-5 yrs.) |
|---|---|---|---|
| | None | Install structural concrete encasements on 52 piles. | Install structural concrete encasements on 52 piles. |
| | | Repair approximately 97 sq ft of open spalling. | Install bottom encasement extensions on 18 existing encasements. |
| | | Repair 10 lin ft of severe pile cap with steel channel sister. | |
| TOTAL OPC | $0 | $655,000* | $712,000* |

*Does not include a cost for mobilization/demobilization

## 3.3 NEW MARKET BUILDING

### 3.3.1 Description

The New Market Building is comprised of three (3) floors previously used as office space, cooler area, and warehouse space. Photo 3-11 and Photo 3-12 provide overall views of the exterior of the New Market Building. The ground floor was the primary market space for seafood distributors. The dimensions of the building are approximately 195 ft by 140 ft including the cooler area measuring 195 ft by 30 ft. Building columns are supported by clusters of six to twelve timber piles that have since received concrete encasements from the pile cap to the mudline that encompasses all of the piles in the cluster. The concrete deck is supported by 12 x 12 timber pile caps oriented in the east-west direction and spaced 12 ft on center. The cold storage area has additional lateral support provided by 6 x 12 horizontal timber bracing attached 2 ft below MLW and 6 x 12 diagonal timber braces. Three north-south reinforced concrete firewalls extend from the deck soffit down 1.5 to 6.5 ft above MLW with an additional east-west firewall located along Bent 16.5.

The layout of the piles, framing, and firewalls is shown in Figures 3-19 and 3-20, respectively. All of the piles and pile clusters have undergone previous repairs, consisting of concrete encasements, posting and wrapping, or wrapping. A representative cross section showing existing repair methods is shown in Figure 3-21.

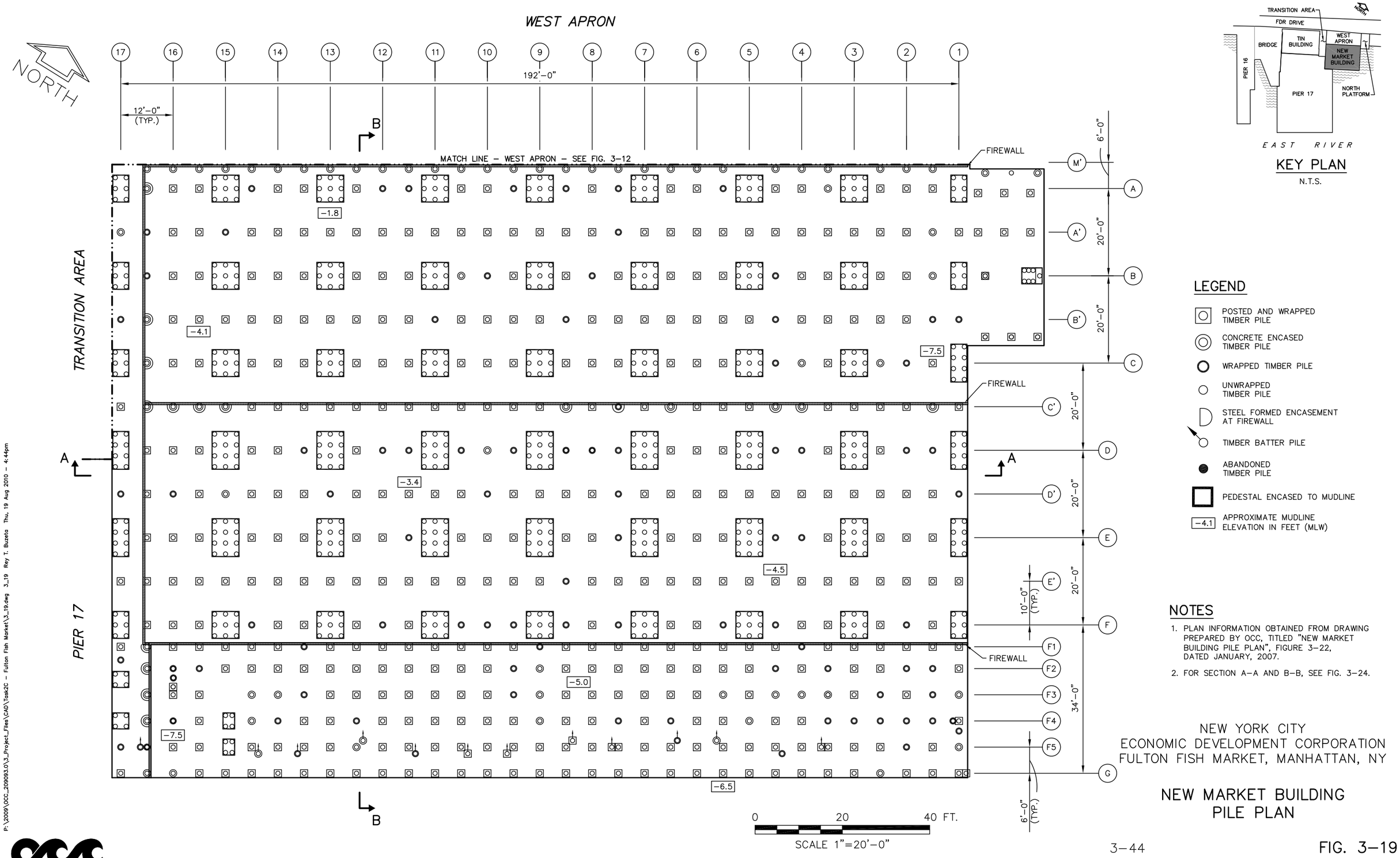
A total of 1,055 timber piles support the New Market Building. However, approximately half of these piles (507) are contained within the pile clusters and are no longer accessible. All of the single piles have received repairs that prevent direct access to the timber pile. Therefore, like the other platforms, the pile ratings were assessed on the quality of the existing repair. In addition, because the pedestal piles have been encased, each pedestal was rated as a whole, based on the condition of the repair. A total of 63 piles were selected for Level III inspection, which included removal of the wrap material to expose the original timber pile for inspection. Table 3-12 provides a summary of the repair types observed by quantity and percentage of the total piles supporting the structure.



PHOTO 3-11. Overview of the New Market Building, looking northwest.




PHOTO 3-12. Overview of New Market Building, looking northeast.







KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE
- ABANDONED TIMBER PILE
- PEDESTAL ENCASED TO MUDLINE
- -4.1 APPROXIMATE MUDLINE ELEVATION IN FEET (MLW)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARKET BUILDING PILE PLAN", FIGURE 3-22, DATED JANUARY, 2007.
2. FOR SECTION A-A AND B-B, SEE FIG. 3-24.

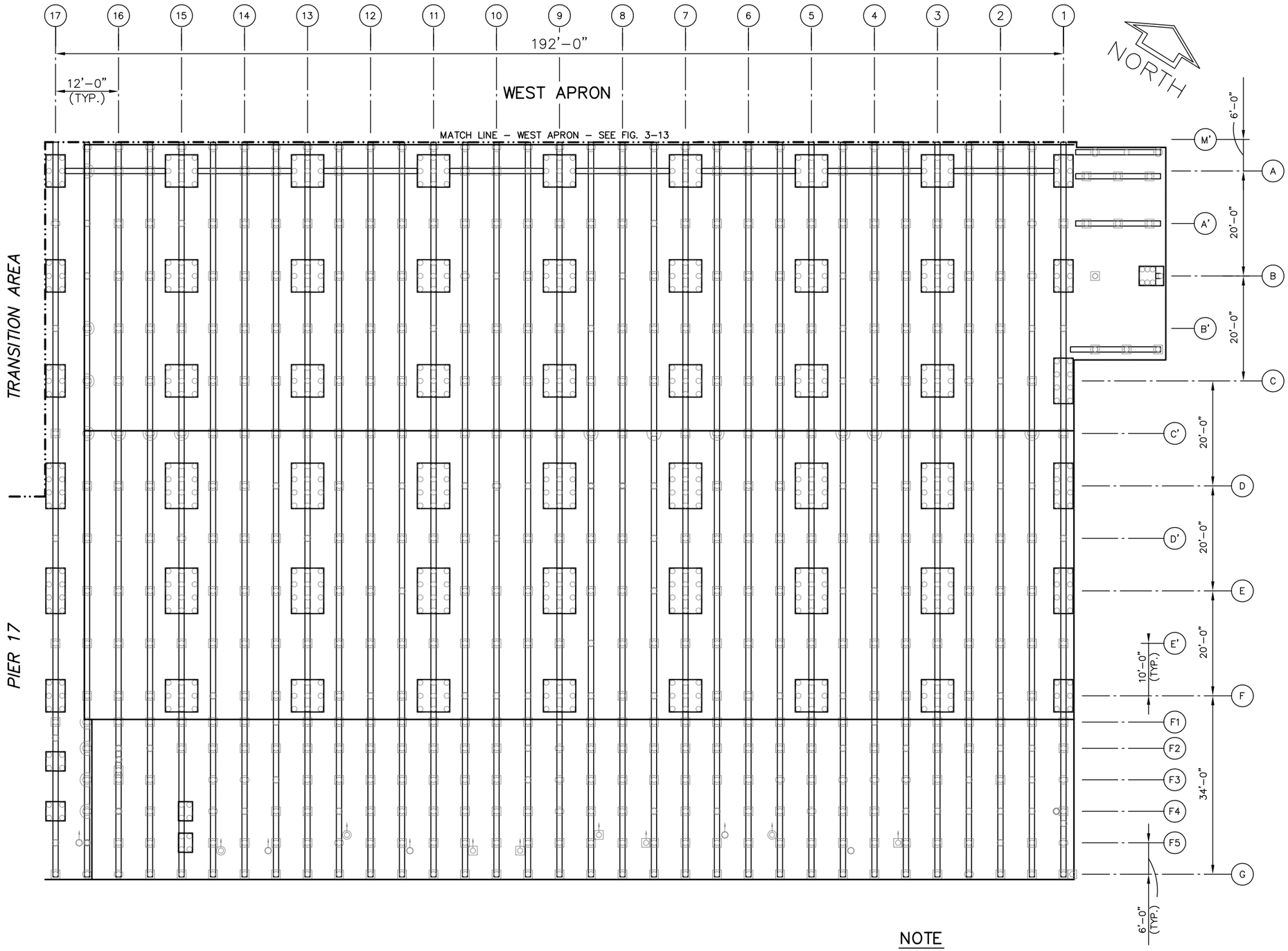
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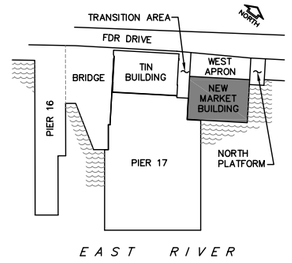
# NEW MARKET BUILDING PILE PLAN

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FIG. 3-19




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE
- ABANDONED TIMBER PILE

0 20 40 FT.

SCALE 1"=20'–0"

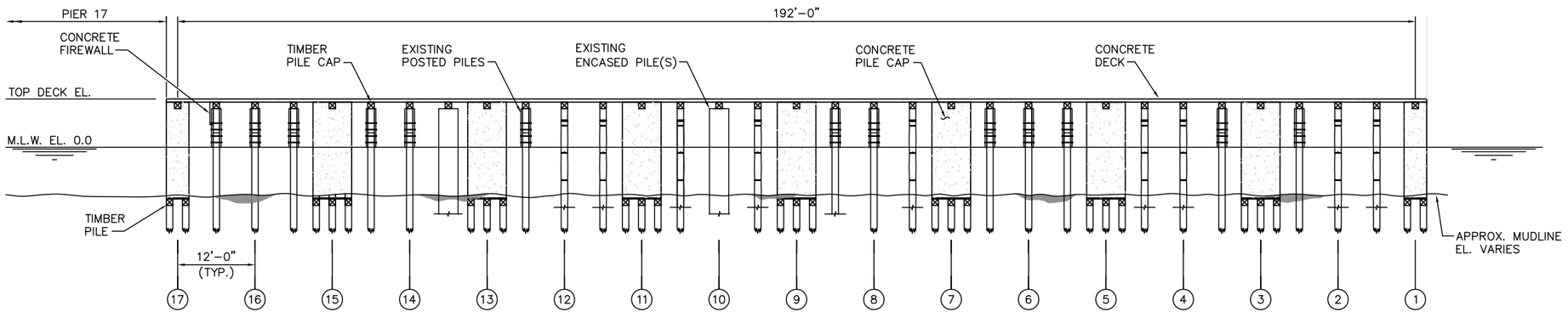
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# NEW MARKET BUILDING FRAMING PLAN

## NOTE

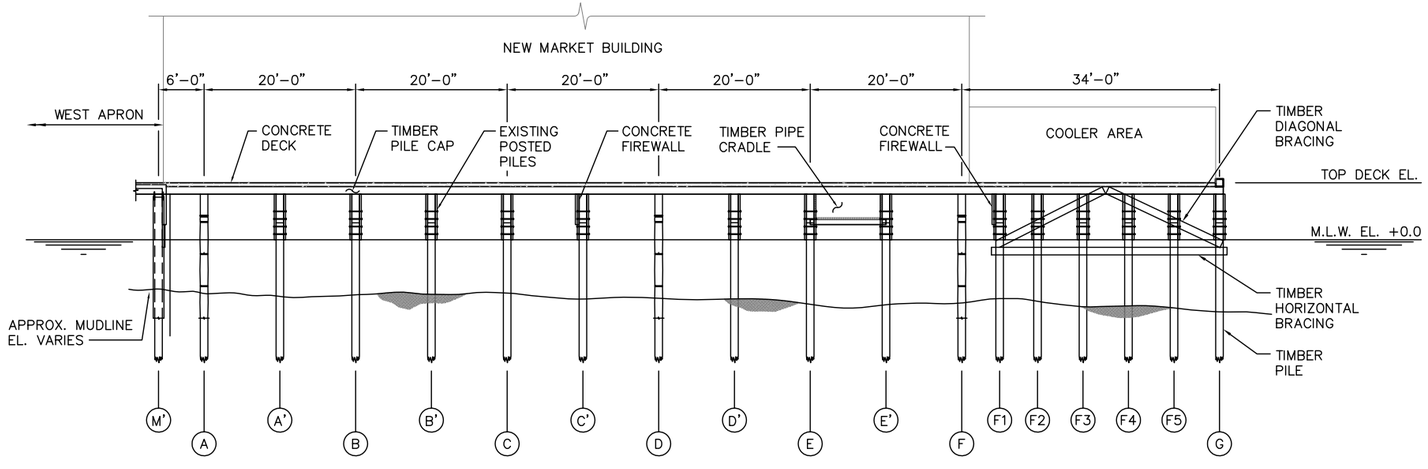
1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARKET BUILDING FRAMING PLAN", DRAWING NO. 3–23, DATED JANUARY, 2007.

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## SECTION A–A

SCALE 1"=20'–0"




## SECTION B–B

SCALE 1"=20'–0"

0 20 40 FT.

SCALE 1"=20'–0"

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARKET BUILDING TYPICAL PIER CROSS SECTIONS", FIGURE 3–24, DATED JANUARY 2007.
2. FOR LOCATION OF SECTIONS A–A AND B–B, SEE FIG. 3–13.

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# NEW MARKET BUILDING
# TYPICAL PIER CROSS–SECTIONS



FIG. 3–21

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**TABLE 3-12 SUMMARY OF NEW MARKET BUILDING REPAIR QUANTITIES**

| Repair Type | Quantity | Percent |
|---|---|---|
| Concrete Encasement | 75 | 12.1 |
| Pedestal Encasement | 59 | 9.5 |
| Post and Wrap | 393 | 63.4 |
| Wrap | 93 | 15.0 |
| TOTAL | 620 | 100.0 |

### 3.3.2 Observed Conditions

The New Market Building is currently in **poor** condition. Almost 80 percent of the support piles with existing wrap repairs have wraps that are loose and failed. In addition, several of the concrete encasements and encased pedestal clusters are being undermined due to mudline erosion.

(A) TIMBER PILES

The timber piles supporting the New Market Building have all received prior repairs including wraps, posts and wraps, and concrete encasements. Approximately 78 percent of the inspected piles received either a post and wrap or a wrap repair and they are typically in **poor** condition (Figure 3-22). Of these piles, 80 percent were found to be loose or failed with typical deflection of the wrap material between 1/2 in. and 3 in. The condition of the wrap repairs is similar to the observed condition of the wrap repairs at the Tin Building and West Apron, with failed seams and tears due to poor installation on irregularly shaped piles (Photos 3-13 through 3-15). In locations where the opening in the wrap material was large enough to inspect the timber below, marine borer and rot deterioration was found ranging from light to heavy with up to 100 percent loss of the cross sectional area.

Of the 63 selected for Level III inspections, 85 percent were found to have advanced or severe deterioration caused by heavy marine borer infestation and soft rot. The marine borer deterioration appears to be caused by *Limnoria* due to the reduction in pile diameter. In addition, the timber appeared roughed and irregularly shaped, which indicates progressive deterioration. A buildup of silt and clay was observed behind the wrap material in the bottom 18 in. to 24 in. of the piles, suggesting that the wrap repairs were essentially failed. The average remaining pile diameter for the



PHOTO 3-13. Typical wrapped and posted and wrapped timber piles. Note folds and creases in the wrap material at the post/pile interface.

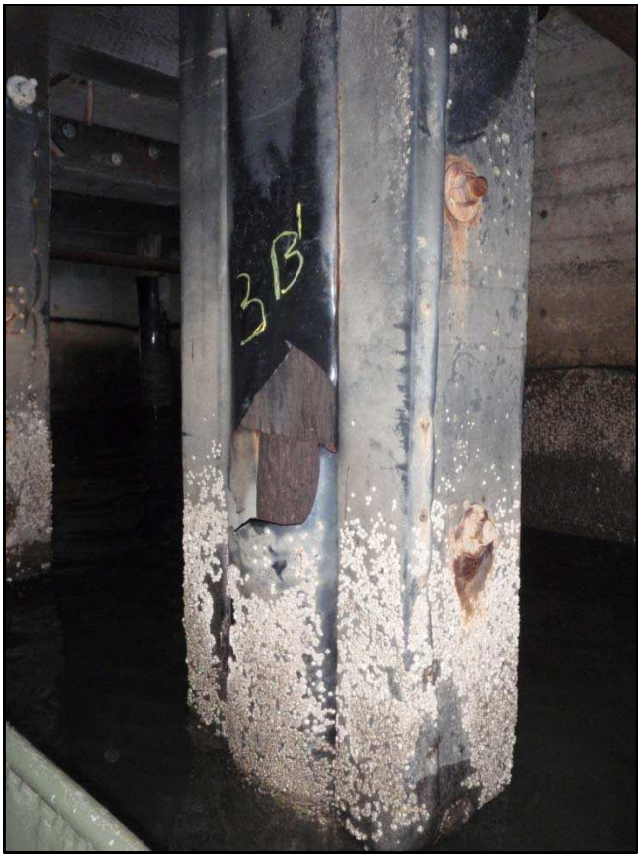


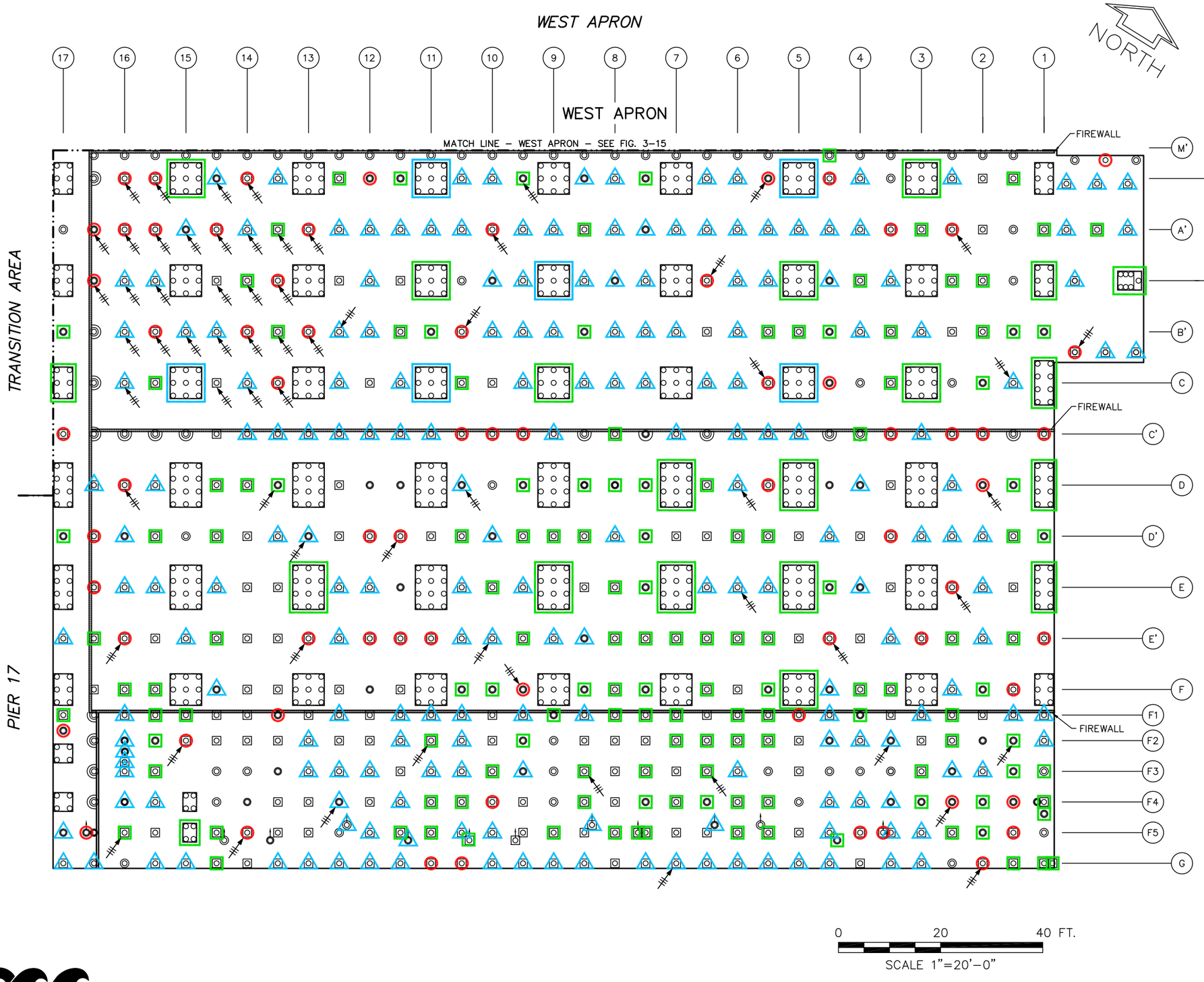

PHOTO 3-14. Torn wrap repair at post/pile interface with heavily rotted timber exposed at Bent 3, Pile B'.

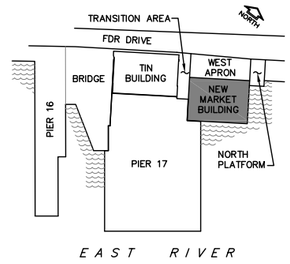


PHOTO 3-15. Failed wrap repair exposing heavily rotted and timber. Note eroded firewall with exposed reinforcing




PHOTO 3-16. Concrete erosion on the column pedestal at Bent 1, Row A. Note exposed timber mat.




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE
- ABANDONED TIMBER PILE
- PEDESTAL ENCASED TO MUDLINE

## PILE CONDITION LEGEND

- SEVERE PILE
- ADVANCED PILE
- MODERATE PILE
- LEVEL III INSPECTION (WRAP REMOVAL)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARCKET BUILDING PILE PLAN", DRAWING NO. 3–22, DATED JANUARY, 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

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# NEW MARKET BUILDING PILE CONDITION PLAN

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FIG. 3–22

advanced and severe piles was approximately 8.1 in., which corresponds to a loss of cross sectional area of approximately 58 percent. Table 3-13 illustrates the ratings for the repaired timber piles, including the adjusted ratings for those piles that were included in the Level III inspection.

**TABLE 3-13 SUMMARY OF NEW MARKET BUILDING PILE RATINGS**

| Rating | Concrete Encasement | | Posted/Wrapped and Wrapped | | | |
|---|---|---|---|---|---|---|
| | | | Level I | | After Level III | |
| | Total | Percent | Total | Percent | Total | Percent |
| Minor | 73 | 97.3 | 95 | 19.6 | 84 | 17.3 |
| Moderate | 2 | 2.7 | 159 | 32.6 | 135 | 27.7 |
| Advanced | 0 | - | 197 | 40.6 | 198 | 40.7 |
| Severe | 0 | - | 35 | 7.2 | 69 | 14.3 |
| TOTAL | 75 | 100.0 | 486 | 100.0 | 486 | 100.0 |

The concrete encased support piles beneath the New Market Building are in **satisfactory** condition. Over 97 percent of the encasements are in minor condition with little or no mudline scour and sufficient embedment of the concrete. The concrete quality remains sound on both the older and newer generation encasement repairs. Only two encasements have mudline scour and in no instance was the original timber exposed.

(B) CONCRETE PEDESTALS

The New Market Building columns are individually supported by 58 pedestals. However, each pedestal is encased from the pile cap to the mudline. Because of this, the timber piles are inaccessible and the pedestals were rated as a whole. Overall, the pedestal encasements are in **fair** condition with widespread moderate mudline scour and concrete erosion.

**TABLE 3-14 SUMMARY OF NEW MARKET BUILDING CONCRETE PEDESTAL RATINGS**

| Rating | Total | Percent |
|---|---|---|
| Minor | 32 | 55.2 |
| Moderate | 19 | 32.7 |
| Advanced | 7 | 12.1 |
| Severe | 0 | 0.0 |
| TOTAL | 58 | 100.0 |

Most of the pedestals were found to have some level of scour. However, 26 pedestals have moderate to advanced scour. The scour at these pedestals typically encompasses a majority of the perimeter and extends between 6 in. and 10 in. deep with up to 6 ft of horizontal penetration. Although the timber piles beneath the encasement could be felt, a visual inspection was not possible due to the concrete overpour and debris on the adjacent mudline.

In addition, a majority of the pedestals exhibit light to moderate concrete scale and erosion localized around the cold joints in the concrete pour. The erosion was deepest at the corners of the pedestals with between 2 in. and 6 in. of penetration. This erosion typically continued along the faces of the pedestal with the depth of penetration decreasing away from the corners. At one pedestal, the concrete erosion has exposed the encased timber mat, which has evidence of marine borer and rot deterioration (Photo 3-16).

(C) CONCRETE UNDERDECK AND FIREWALLS

The underdeck of the New Market Building is currently in **fair** condition due to localized open spalling as well as patches of poor consolidation (Figure 3-23). There is a total of 33 sq ft of open spalling in the concrete underdeck as well as 402 sq ft of poorly consolidated concrete. The open spalling consists of several small localized areas with exposed reinforcing steel. While the exposed reinforcing steel has corrosion, it appears as though nearly full section remains. The poorly consolidated areas of concrete exhibit a loss of cementitious paste between the exposed coarse aggregate. In several locations throughout the underdeck, prior shotcrete repairs exist and remain intact.

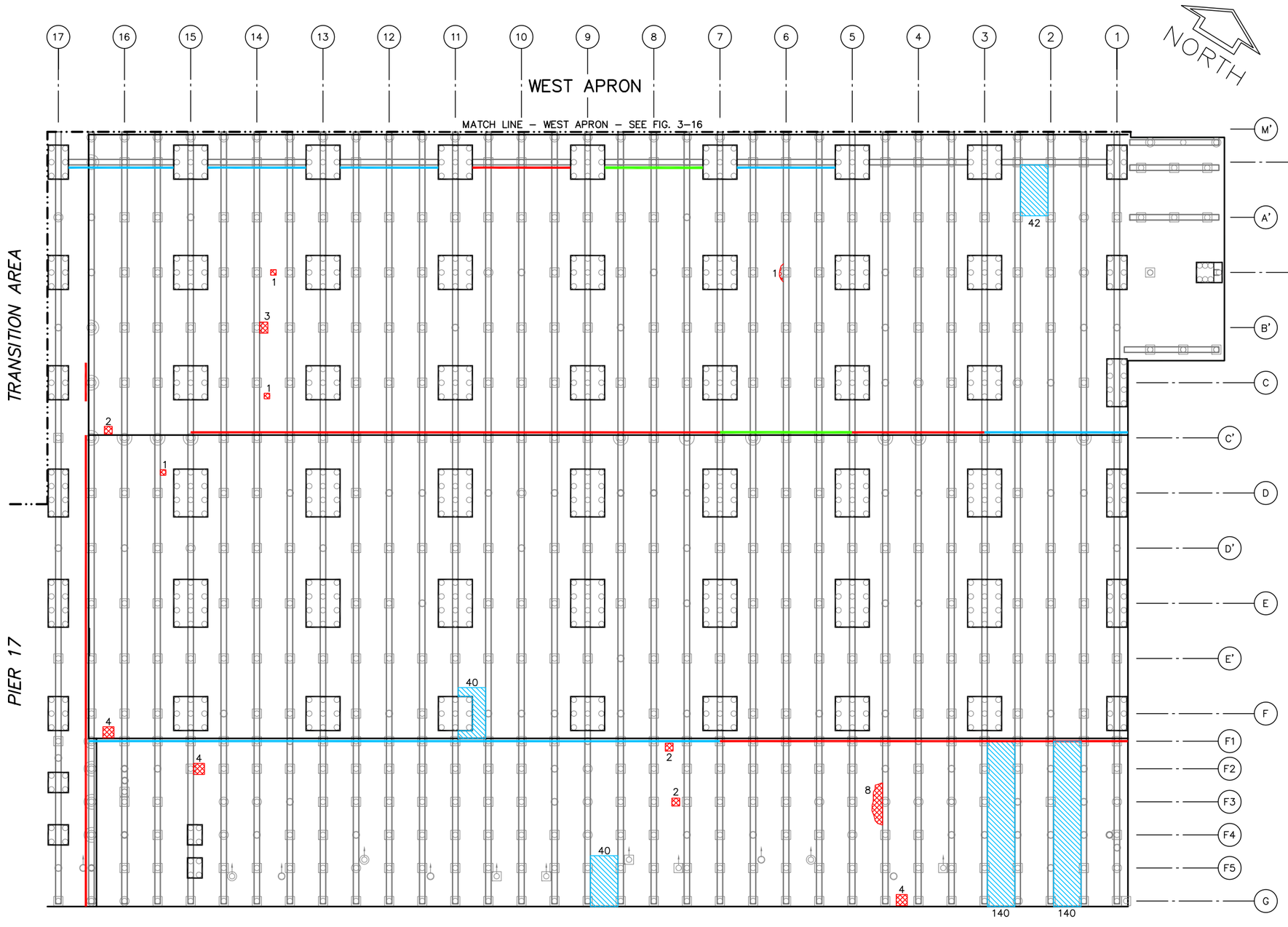
The concrete firewalls beneath the New Market Building are in **serious** condition due to widespread deterioration. The bottom 6 in. to 3 ft of the reinforced concrete firewall is cracked or failed with exposed and corroded reinforcing steel in approximately 525 lin ft, which comprises approximately 75 percent of the total firewalls in the structure (Photo 3-17). Although this does not pose a direct threat to the structural integrity of the pier, the platform becomes more susceptible to the spread of fire.

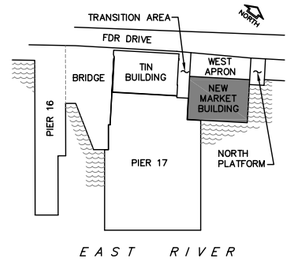


PHOTO 3-17. Broken section of firewall with exposed reinforcing steel.



PHOTO 3-18. Impact damage to pile at Bent 11, Row G.




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE
- ABANDONED TIMBER PILE

## DECK CONDITION LEGEND

CONCRETE CONDITION

- MODERATE
- ADVANCED
- SEVERE

BOTTOM OF DECK

- 20 — CRACK (20 MILS WIDE)
- 5 — CLOSED SPALL (5 SQ. FT.)
- 10 — OPEN SPALL (10 SQ. FT.)

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARKET BUILDING FRAMING PLAN", DRAWING NO. 3–23, DATED JANUARY, 2007.
2. CRACKING ON TOP DECK SURFACE NOT SHOWN FOR CLARITY.
3. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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# NEW MARKET BUILDING
# DECK AND FIREWALL CONDITION PLAN



FIG. 3–23

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(D) TIMBER CAPS AND BRACING

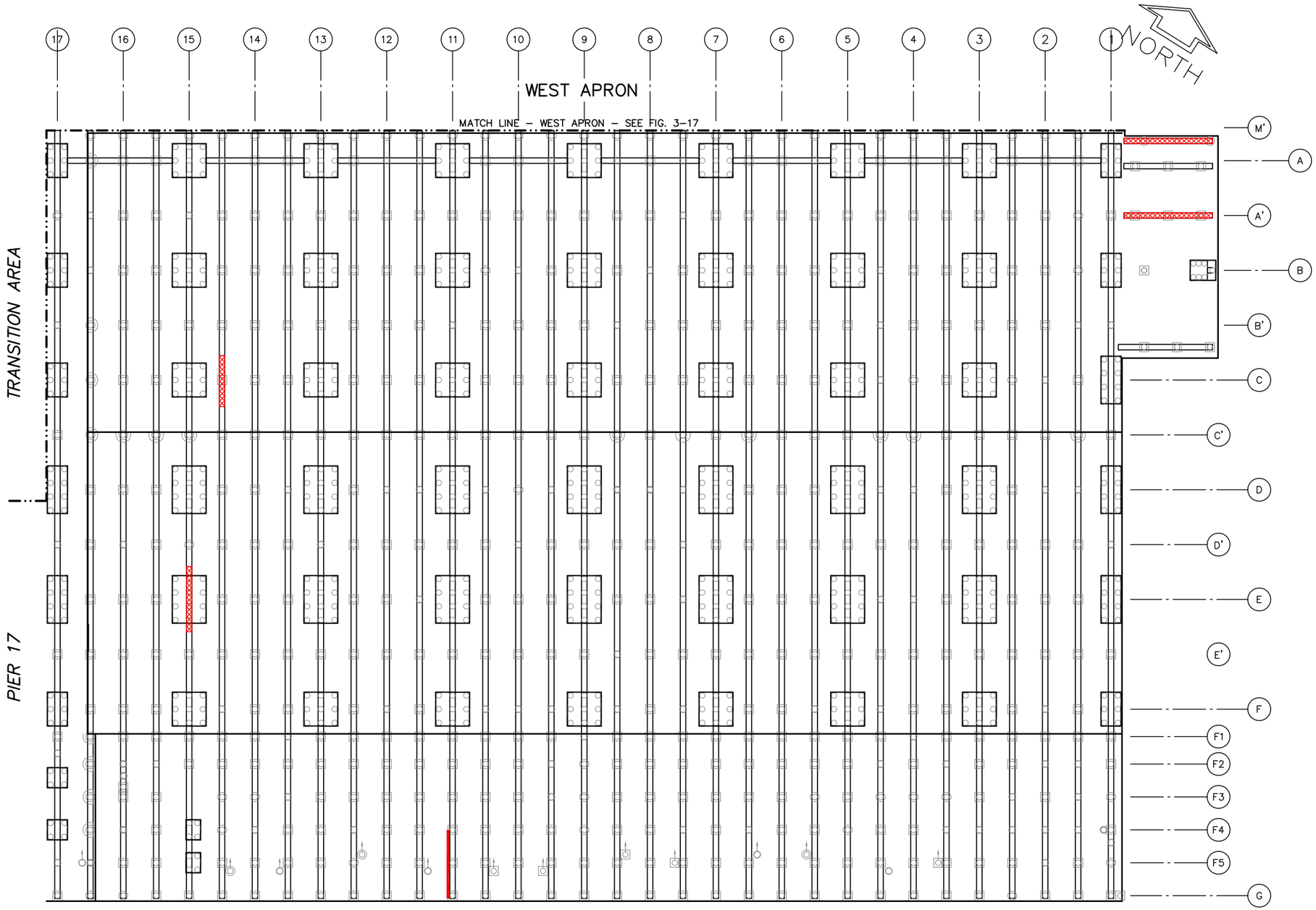
The pile caps supporting the New Market Building are in **fair** condition with only localized area of severe deterioration (Figure 3-24). The total extent of severe pile cap is approximately 52 lin ft, with heavy rot and pick penetration up to 2.5 in. deep. The majority of the timber caps have little or no defects with typical pick penetrations of 1/4 in. and full cross section remaining. In the areas where the adjacent underdeck has received shotcrete repairs, the overspray has provided additional protection to the timber caps.

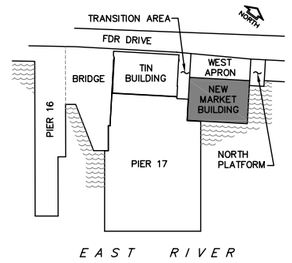
The horizontal and diagonal bracing, located at the offshore cold storage area, remains in **fair** condition. There is one location where apparent impact damage has broken one of the diagonal braces. At Bent 11, the offshore pile has been impacted and deflected to the south, which caused the attached diagonal bracing to snap at its midpoint (Photo 3-18). The remaining braces remain in minor condition with only moderate end grain rot present throughout the members. Typical penetration in the end grain is between 3 in. and 8 in. However, this typically does not extend far enough into the timber to affect the integrity of the connection.

### 3.3.3 Comparison with Previous Inspection Results

During the 2006 inspection, the New Market Building was found in fair condition. The report cites approximately 22 percent of the wrapped piles as having loose or failed wraps with marine borer and rot deterioration in the exposed timber behind the wrap material. In addition, the inspection identified three of the concrete encased piles to have insufficient embedment into the mudline with exposed and deteriorated timber below the concrete. Other significant defects that the previous inspection report identified include cracking with efflorescence staining in the concrete column pedestals as well as light to moderate erosion of the concrete at the location of the cold joints. Also, failure, breakage, and spalling of the concrete firewall was observed for 60 percent of the linear footage.

No repairs have been performed to the support piles beneath the New Market Building since the 2006 inspection. The only rehabilitation performed consisted of shotcrete repair performed in conjunction with the underdeck repairs at the West Apron. Also, scour observed around the mudline at the concrete encased column pedestals was




KEY PLAN

N.T.S.

## LEGEND

- POSTED AND WRAPPED TIMBER PILE
- CONCRETE ENCASED TIMBER PILE
- WRAPPED TIMBER PILE
- UNWRAPPED TIMBER PILE
- STEEL FORMED ENCASEMENT AT FIREWALL
- TIMBER BATTER PILE

## FRAMING CONDITION LEGEND

- SEVERE ROT
- SEVERE BROKEN BRACING

## NOTES

1. PLAN INFORMATION OBTAINED FROM DRAWING PREPARED BY OCC, TITLED "NEW MARKET BUILDING FRAMING PLAN", DRAWING NO. 3–23, DATED JANUARY, 2007.
2. MINOR DEFECTS NOT SHOWN FOR CLARITY.

0 20 40 FT.

SCALE 1"=20'–0"

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# NEW MARKET BUILDING FRAMING CONDITION PLAN



FIG. 3–24

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not observed during the previous inspection. In Table 3-15, the priority repair recommendations from the 2006 inspection are compared against the observed conditions from this inspection. With the continued exposure to the marine environment, the extent of the deterioration has increased across the structure.

**TABLE 3-15 NEW MARKET BUILDING COMPARIONS WITH PREVIOUS REPAIR RECOMMENDATIONS**

| Structural Element | 2006 Recommendations | 2010 Findings |
|---|---|---|
| Concrete Encasements | None | 2 encasements undermined. |
| Concrete Pedestals | None | 26 pedestals undermined. |
| Wrapped Piles | Encase approximately 243 piles. | 382 wraps loose and/or failed. |
| Underdeck | Repair approximately 560 sq ft. | Approximately 33 sq ft of open spalling. |
| Firewalls | Repair approximately 320 lin ft. | Approximately 525 lin ft of failed, broken, spalled firewall. |
| Pile Caps | Repair approximately 35 lin ft. | Approximately 52 lin ft of severely rotted timber. |

### 3.3.4 Structural Condition Assessment

(A) STRUCTURAL ANALYSIS

OCC performed a structural analysis of the support piles beneath the New Market Building to determine the minimum acceptable pile diameters under the current pile conditions and anticipated future deterioration. All loading from the building superstructure was assumed to be supported by the encased concrete pedestal clusters. The single piles were assumed to be spaced 6 ft on-center in the north-south direction and 10 ft on-center in the east-west direction. An average pile length of 22.7 ft was assumed, which includes an additional 10 ft from the mudline to an assumed point of fixity. Based on the Level III inspection data, a representative diameter with an 84 percent exceedance probability was calculated to be 5.2 in.

Two loading scenarios were considered for this analysis: zero live loading (dead load only) and a uniform live load of 40 psf (minimum requirement for occupancy). It was determined that the representative pile does not have sufficient capacity to support the dead load of the structure and that a minimum pile diameter of 6.0 in. is required to

support this weight. Approximately 35 percent of the piles currently do not have the minimum required diameter.

In order to assess the future structural capacity of the timber piles, OCC estimated rates of deterioration based on rot decay and marine borer infestation in the pile. Using these rates, graphs of allowable pile load vs. time were generated to predict the when the piles will reach their allowable loads. Because the design pile diameters were based on 84 percent exceedance on a Gaussian distribution, when the allowable capacity curve reaches the typical pile load value, 16 percent of the piles will not have the allowable safe capacity.

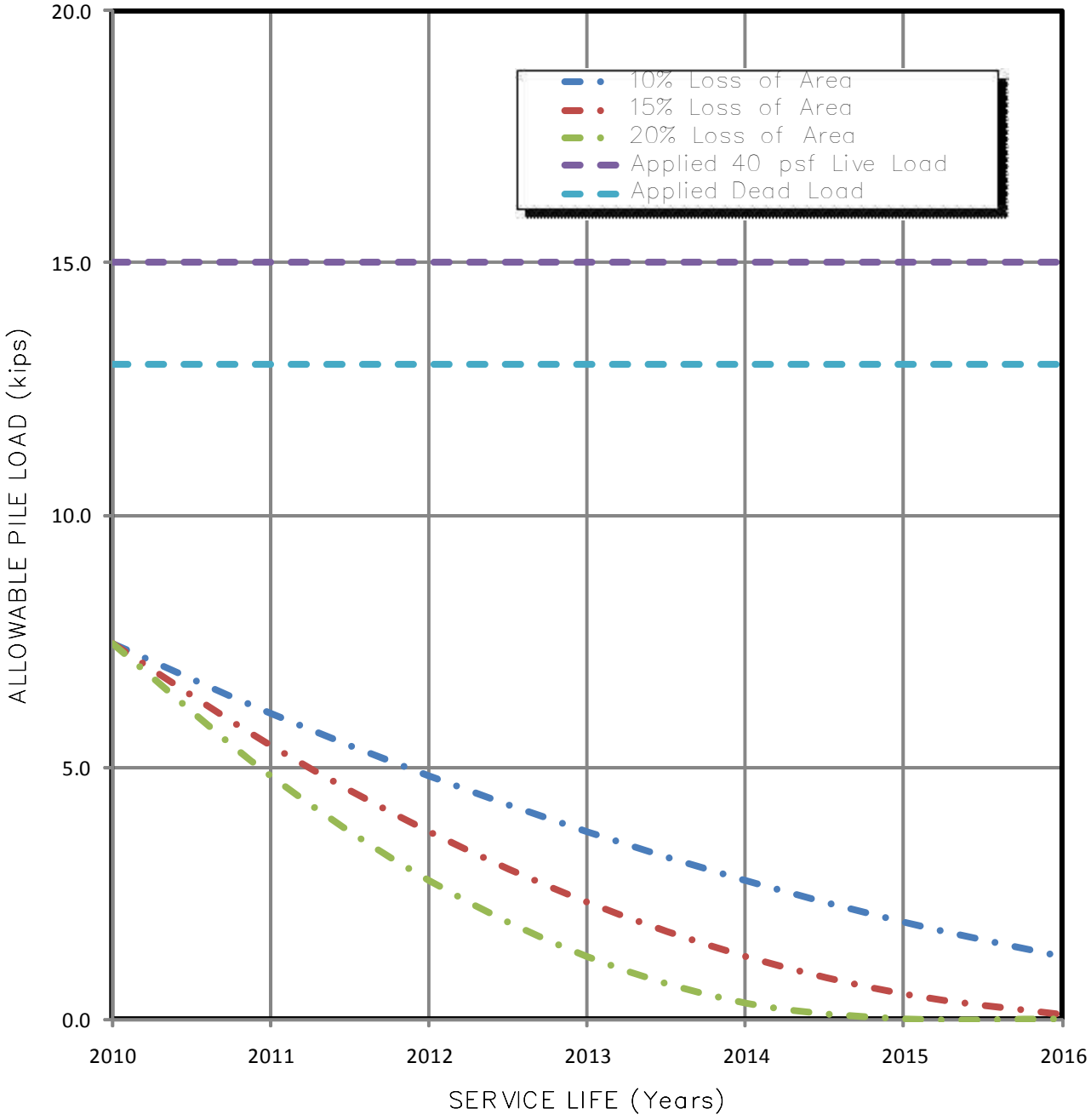
The graph on Figure 3-25 shows the diminishing pile capacity versus time for the timber piles with separate plots for 10 percent, 15 percent, and 20 percent annual section loss. The graph also illustrates where the allowable loading crosses the applied load under two loading scenarios (Dead Load only and Dead Load plus 40 psf). The graphs indicate that piles are currently well below the applied load from both a 40 psf uniform live load and the dead load of the structure.

(B) SERVICE LIFE ASSESMENT

Based on the current pile conditions and the results of the structural analysis, all live loading should be removed from the building immediately and pile rehabilitation will be required within the next 1 to 3 years in order to ensure the safety of the building. To support the weight of the dead load only in three years, piles must have a current pile diameter of 6.8 in. and approximately 38 percent of the piles do not meet this requirement. If the building were to reopen to occupancy, piles are required to have a current minimum pile diameter of 7.1 in. to maintain safe capacity for three years. Currently, approximately 48 percent of the piles have less than a 7.1 in. minimum diameter. The minimum diameter currently required to remain safe for occupancy for six years is 7.84 in. and approximately 56 percent of the piles fail to meet this diameter.

### 3.3.5 Recommendations

The observed deficiencies to the structural support elements of the New Market Building have led OCC to recommend the following rehabilitation cycle. These repair items are recommended on a phased level of urgency in order to utilize the remaining useful service life of the structure. Table 3-16 summarizes the recommended




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NEW MARKET BUILDING
PILE CAPACITY GRAPH



FIG. 3-25

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C - Fulton Fish Market\3_8.dwg Figure 3-25 Rey T. Buzeta Thu, 19 Aug 2010 - 4:14pm

rehabilitation cycle and provides an estimated OPC for each phase.

(A) IMMEDIATE ACTION

The Level III inspection data and subsequent structural analysis has shown that the timber piles beneath the New Market Building do not have the structural capacity to support any live loading. It is recommended that all live loading be removed from inside the building and that the building remain vacant until additional rehabilitative measures can be performed to restore structural capacity to the timber piles.

(B) PRIORITY ACTION (1-3 YEARS)

The New Market Building has widespread failed and loose pile wraps with ongoing marine borer deterioration that will rapidly reduce the loading capacity of the structure. Results from the routine inspection and subsequent structural analysis indicate that approximately 35 percent of the wrapped and posted/wrapped piles do not have sufficient capacity to support the dead load of the structure. Using the maximum allowable pile loading to back out the maximum tributary area, OCC determined that repairing a total of 109 piles would restore sufficient capacity to support a uniform live load rating of 40 psf. The piles to be repaired should be chosen on their relative location, as opposed to their current condition rating. The ability to support a 40 psf live load assumes that the existing concrete deck has the capacity to accommodate the increase in span. Further investigation and analysis needs to be performed to determine the amount of reinforcing currently in the deck and whether it would provide the required capacity.

In addition, the 26 column clusters with observed scour and mudline erosion should receive a lightweight concrete protective bottom encasement. The rate of marine borer deterioration in this area has been known to extremely high and would likely cause significant section loss to the exposed original timber piles. Installing this protective repair will protect the remaining timber section in the piles from future deterioration and would prevent the need for a larger scale structural repair down the road. Also, a shotcrete repair should be installed at the approximately 97 sq ft of open spalling and the 52 lin ft of severe pile cap should receive a steel channel sister repair.

Should these repair items not be performed during the recommended time frame, it is likely that the concrete deck will begin to crack, settle, and eventually fail. The extent of the required rehabilitation would then be greater and more costly.

(C) ROUTINE ACTION (3-5 YEARS)

Assuming that only enough piles are repaired to restore dead load capacity to the structure, an additional 64 piles should receive structural concrete encasements. This will provide the structure with enough capacity to support a uniform live load of 40 psf for an additional three years and be acceptable for basic occupancy. Also during this time period, 2 bottom structural encasement extensions should be installed on the existing encasements with insufficient embedment. In addition, the 525 lin ft of failed firewall should be replaced in-kind.

Following the next inspection, the recommended rehabilitation cycle should be revised to incorporate any additional deficiencies that may require attention.

**TABLE 3-16 NEW MARKET BUILDING SUMMARY OF RECOMMENDED REPAIRS**

<table>
<tr><th></th><th>Immediate</th><th>Priority (1-3 yrs.)</th><th>Routine (3-5 yrs.)</th></tr>
<tr><td rowspan="4"></td><td rowspan="4">Remove all live loading from inside the building.</td><td>Install structural concrete encasements on 109 piles.</td><td>Install structural concrete encasements on 64 piles.</td></tr>
<tr><td>Repair approximately 97 sq ft of open spalling.</td><td>Install bottom structural encasement extensions on 2 existing encasements.</td></tr>
<tr><td>Install lightweight concrete bottom encasement on 26 concrete pedestals.</td><td rowspan="2">Replace approximately 525 lin ft of concrete firewall.</td></tr>
<tr><td>Repair 52 lin ft of severe pile caps.</td></tr>
<tr><td>TOTAL OPC</td><td>$0</td><td>$2,694,000*</td><td>$992,000*</td></tr>
</table>

*Does not include a cost for mobilization/demobilization

# 4.0 SUMMARY OF RECOMMENDATIONS

The facility-wide substructure rehabilitation that was performed following the 1995 inspection has outlived its useful service life and the structures are in need of further repairs. The observed conditions of the wrapped and posted and wrapped timber piles are consistent throughout all three structures. Piles with loose and/or failed wrap repairs have continued to be weakened by rot and marine borer infestation and therefore a structural repair is now required. In addition, the older generation bag form concrete encasements were installed without sufficient embedment into the mudline. The mudline has been scoured away at many of these encasements, exposing the original timber pile and allowing for marine borer attack.

The structural analysis performed using data from the inspection determined that approximately 35 percent of the wrapped and posted/wrapped piles beneath the New Market Building no longer have the capacity to support the dead weight of the structure. It is recommended that all live loading should be removed from inside the building effective immediately and the building should remain vacant until additional rehabilitative measures can be performed to restore structural capacity to the timber piles. The widespread heavy rot in the timber stringers, pile caps, and decking of the Tin Building would normally be a higher priority item; however, the building is currently vacant. It is recommended that all live loading be removed from the structure, included any temporarily or permanently stored items. Before any live loading can be reintroduced to the structure, extensive rehabilitation is required.

Aside from removing live loading from the Tin Building and New Market Building, there are no other immediate recommendations. Each of the three structures requires rehabilitation in the next 1 to 3 years to maintain safe functioning capacity. It is recommended that 109 piles beneath the New Market Building receive structural concrete encasements, which will restore sufficient capacity to support a uniform live load of 40 psf. In addition to the pile encasements, the 26 column cluster pedestals with observed scour should receive a bottom extension comprising unreinforced lightweight concrete to protect the exposed original timber piles. Also, the 97 sq ft of open spalling should receive a shotcrete patch and the 52 lin ft of severe pile caps should receive a steel channel sister repair.

Repair of approximately 1,500 lin ft of timber stringers and 69 structural concrete encasements are recommended to restore a 40 psf live load rating to the Tin Building. Also, encasing 52 piles beneath the West Apron, as well as repairing the 10 lin ft of severe pile cap and 97 sq ft of open spalling, would ensure a 100 psf uniform live load for three years, which is required for all areas subject to outdoor public assembly. All of these repairs are recommended to be completed in the next 1 to 3 years, or before the next inspection cycle.

Even with the live loading removed from the Tin Building, it is likely that conditions will worsen such that, following the next inspection cycle, the structure will require significant rehabilitation. Due to the limited access and tightly spaced piles, the most effective option would be to demolish the existing concrete deck, timber decking, stringers, and pile caps. This will provide easy access to install full height structural concrete encasements to all of the piles that do not have existing encasements. At this time, the existing encasements with scoured mudlines should receive bottom structural encasement extensions. Once the pile repairs have been performed, a new two-way reinforced concrete deck can be cast on top of the repaired piles with a layer of crushed stone to house any mechanical, electrical, or plumbing conduits while also providing the addition height needed to bring the finished surface elevation of the structure up to match the adjacent sidewalk.

Table 4-1 summarizes the facility-wide recommended rehabilitation cycle and provides an OPC for each structure and phase. Each OPC includes a 25 percent contingency. The total OPCs given below include one mobilization/demobilization cost for each repair phase.

**TABLE 4-1 SUMMARY OF RECOMMENDED REHABILITATION CYLCE**

| Structure | Immediate | Priority (1-3 yrs) | Routine (3-5 yrs) |
|---|---|---|---|
| Mob/ Demob | $0 | $210,000 | $250,000 |
| Tin Building | Remove all live loading from inside the building | • Install structural concrete encasements on 69 piles.<br>• Repair or replace approximately 1,500 lin ft of timber stringers<br>• Monitor building for signs of over-stressing | • Demolish all decking, stringers, and pile caps.<br>• Install structural concrete encasements on all 222 non-encased piles.<br>• Install bottom structural encasement extensions on 27 existing encasements.<br>• Install new 2-way reinforced concrete deck above repaired piles with layer of crushed stone for MEP conduits and bring up to match adjacent elevation. |
| | $0 | $1,325,000 | $4,034,000 |
| West Apron | None | • Install structural concrete encasements on 52 piles.<br>• Repair approximately 97 sq ft of open spalling.<br>• Repair 10 lin ft of severe pile cap. | • Install structural concrete encasements on 52 piles.<br>• Install bottom structural encasement extensions on 18 existing encasements. |
| | $0 | $655,000 | $712,000 |
| New Market Building | Remove all live loading from inside the building | • Install structural concrete encasements on 109 piles.<br>• Repair approximately 97 sq ft of open spalling.<br>• Install lightweight concrete bottom encasement on 26 concrete pedestals.<br>• Repair 55 lin ft of severe pile cap | • Install structural concrete encasements on 64 piles.<br>• Install bottom structural encasement extensions on 2 existing encasements.<br>• Replace approximately 525 lin ft of concrete firewall. |
| | $0 | $2,694,000 | $992,000 |
| TOTAL OPC | **$0** | **$4,884,000** | **$5,988,000** |

## APPENDIX A - KEY PERSONNEL

| Name | Title | Organ-ization | Contact |
|---|---|---|---|
| Greg Clancy | Vice-President | EDC | gclancy@nycedc.com |
| Alex Rau | Superintendent | Turner | arau@tcco.com |
| Stanley M. White, P.E. | Managing Engineer | OCC | stwh@ocean-coastal.com |
| Stephen A. Famularo, P.E. | Project Manager – Dive Supervisor | OCC | safa@ocean-coastal.com |
| Matthew L. Teeden, E.I.T. | Project Engineer – Diver | OCC | mate@ocean-coastal.com |
| Bryan N. Jones, P.E. | P.E. – Diver | OCC | brjo@ocean-coastal.com |
| Ronnie A. Munoz, E.I.T. | Engineer – Diver | OCC | romu@ocean-coastal.com |
| David M. Slade | Technician – Dive Supervisor | OCC | dasl@ocean-coastal.com |
| Michael S. Balboni | Technician – Dive Supervisor | OCC | msba@ocean-coastal.com |

New York City Economic Development Corporation (EDC)
110 William Street
New York, NY 10038

Turner Construction Company (Turner)
140 58th Street
Box 40
Brooklyn, NY 11220

Ocean and Coastal Consultants Engineering, P.C. (OCC)
35 Corporate Drive, Suite 1200
Trumbull, CT 06611

# APPENDIX B - CALCULATIONS

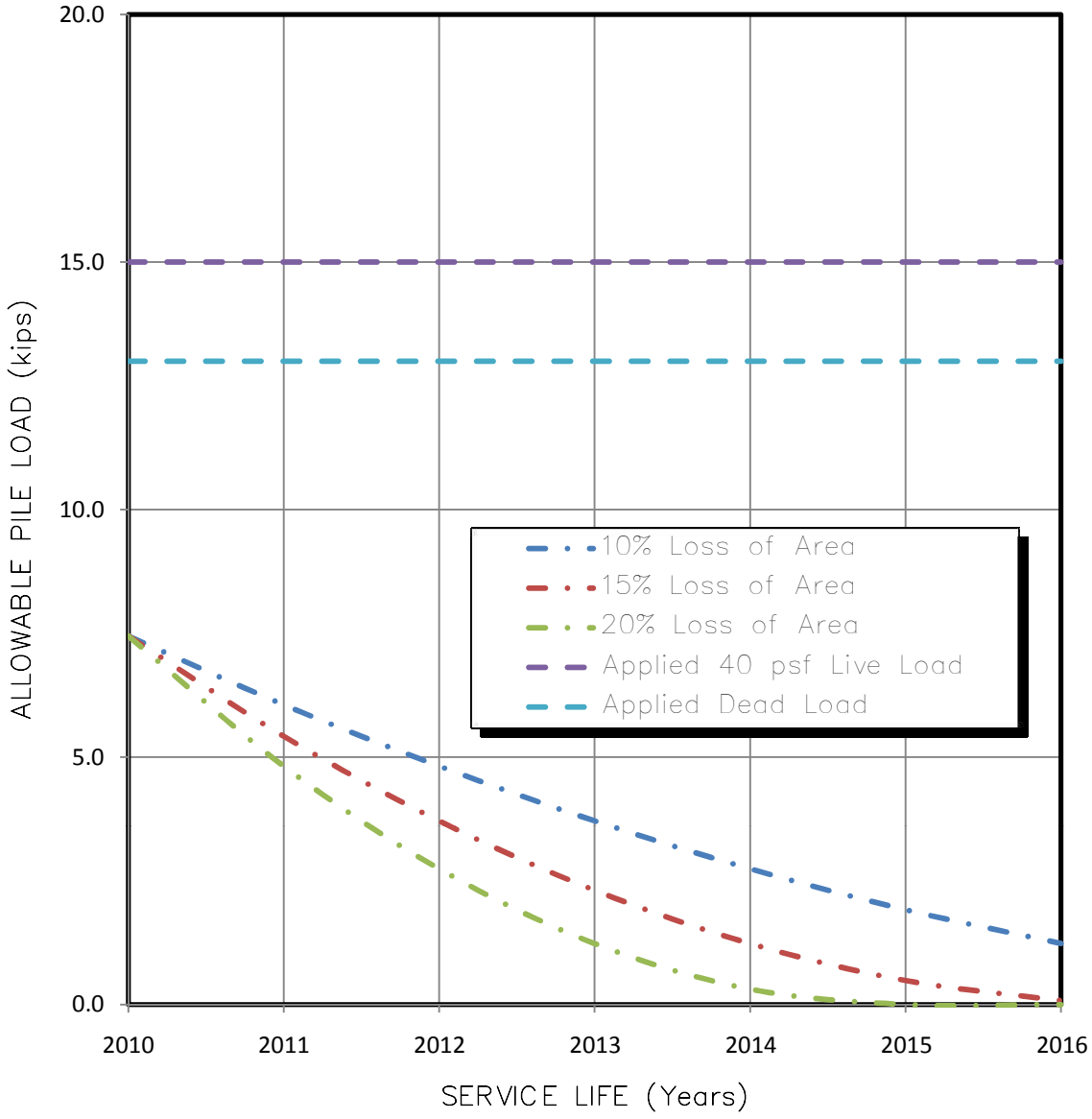
# DIMINISHING PILE CAPACITY DUE TO MARINE BORER ACTIVITY - NEW MARKET BUILDING

| Input | | | |
|---|---|---|---|
| Avg. Pile Diameter | *in* | 7.3 | |
| Standard Deviation | *in* | 2.10 | |
| Distance to Mudline | *ft* | 12.7 | |
| Depth to Fixity | *ft* | 10 | |

| Output | | | |
|---|---|---|---|
| Pile Diameter (84% Ex) | *in.* | 5.2 | Design Diameter |
| Area of Design Pile | $in^2$ | 21.23 | |
| Effective Pile Length | *in* | 217.9 | |

| | | 10% Loss of Area | | | | | 15% Loss of Area | | | | | 20% Loss of Area | | | | | Live Load | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Time** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **40 psf** | **0 psf** |
| | yrs | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | kips | kips |
| 2010 | 0 | 5.20 | 21.2 | 369.8 | 7.4 | 12.4 | 5.20 | 21.2 | 369.8 | 7.4 | 12.4 | 5.20 | 21.2 | 369.8 | 7.4 | 12.4 | 15 | 13 |
| 2011 | 1 | 4.93 | 19.1 | 332.0 | 6.1 | 10.1 | 4.79 | 18.0 | 313.6 | 5.4 | 9.0 | 4.65 | 17.0 | 295.1 | 4.8 | 8.0 | 15 | 13 |
| 2012 | 2 | 4.65 | 17.0 | 295.1 | 4.8 | 8.0 | 4.35 | 14.9 | 258.3 | 3.7 | 6.2 | 4.02 | 12.7 | 221.4 | 2.7 | 4.5 | 15 | 13 |
| 2013 | 3 | 4.35 | 14.9 | 258.3 | 3.7 | 6.2 | 3.85 | 11.7 | 202.9 | 2.3 | 3.8 | 3.29 | 8.5 | 147.6 | 1.2 | 2.0 | 15 | 13 |
| 2014 | 4 | 4.02 | 12.7 | 221.4 | 2.7 | 4.5 | 3.29 | 8.5 | 147.6 | 1.2 | 2.0 | 2.32 | 4.2 | 73.8 | 0.3 | 0.5 | 15 | 13 |
| 2015 | 5 | 3.67 | 10.6 | 184.5 | 1.9 | 3.2 | 2.60 | 5.3 | 92.2 | 0.5 | 0.8 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 15 | 13 |
| 2016 | 6 | 3.29 | 8.5 | 147.6 | 1.2 | 2.0 | 1.64 | 2.1 | 36.9 | 0.1 | 0.1 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 15 | 13 |

| Design Values | | | |
|---|---|---|---|
| *l* | ft | 22.70 | |
| $K_{ce}$ | | 0.3 | |
| *c* | | 0.85 | |
| $K_e$ | | 0.8 | |
| $I_e$ | in | 217.9 | |
| *E* | psi | 1500000 | Southern Pine (Table 6A) |
| *Emin* | psi | 790000 | |
| $F_{ce}$ | psi | 369.8 | Changes w/ Diameters |
| $F_c$* | psi | 1320 | |
| $C_p$ | | 0.266 | Changes w/ Diameters |
| $F'_c$ | psi | 351 | Changes w/ Diameters |


20.0
15.0
10.0
5.0
0.0
ALLOWABLE PILE LOAD (kips)
2010
2011
2012
2013
2014
2015
2016
SERVICE LIFE (Years)
10% Loss of Area
15% Loss of Area
20% Loss of Area
Applied 40 psf Live Load
Applied Dead Load

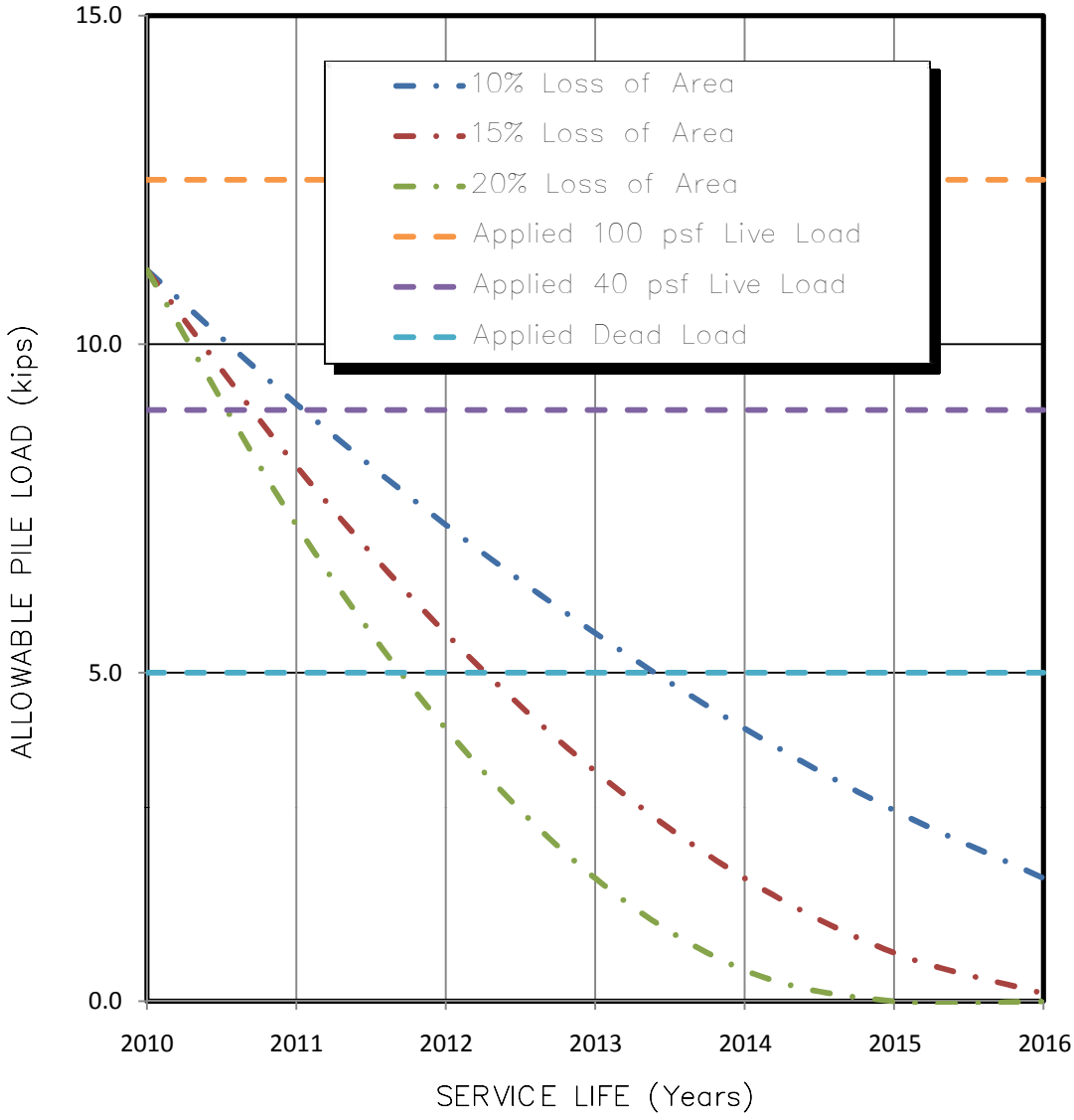
# DIMINISHING PILE CAPACITY DUE TO MARINE BORER ACTIVITY - WEST APRON

| Input | | | |
|---|---|---|---|
| Avg. Pile Diameter | *in* | 8.8 | |
| Standard Deviation | *in* | 1.90 | |
| Distance to Mudline | *ft* | 10.5 | |
| Depth to Fixity | *ft* | 10 | |

| Output | | | |
|---|---|---|---|
| Pile Diameter (84% Ex) | *in.* | 5.5 | Design Diameter |
| Area of Design Pile | $in^2$ | 23.75 | |
| Effective Pile Length | *in* | 196.8 | |

| | | 10% Loss of Area | | | | | 15% Loss of Area | | | | | 20% Loss of Area | | | | | Live Load | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Time** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **100 psf** | **40 psf** | **0 psf** |
| | yrs | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | kips | kips | kips |
| 2010 | 0 | 5.50 | 23.7 | 507.2 | 11.1 | 18.5 | 5.50 | 23.7 | 507.2 | 11.1 | 18.5 | 5.50 | 23.7 | 507.2 | 11.1 | 18.5 | 12.5 | 9 | 5 |
| 2011 | 1 | 5.21 | 21.4 | 455.5 | 9.1 | 15.1 | 5.07 | 20.2 | 430.2 | 8.1 | 13.5 | 4.91 | 19.0 | 404.9 | 7.2 | 12.0 | 12.5 | 9 | 5 |
| 2012 | 2 | 4.91 | 19.0 | 404.9 | 7.2 | 12.0 | 4.60 | 16.6 | 354.2 | 5.6 | 9.3 | 4.26 | 14.2 | 303.6 | 4.1 | 6.9 | 12.5 | 9 | 5 |
| 2013 | 3 | 4.60 | 16.6 | 354.2 | 5.6 | 9.3 | 4.07 | 13.1 | 278.3 | 3.5 | 5.8 | 3.47 | 9.5 | 202.4 | 1.9 | 3.1 | 12.5 | 9 | 5 |
| 2014 | 4 | 4.26 | 14.2 | 303.6 | 4.1 | 6.9 | 3.47 | 9.5 | 202.4 | 1.9 | 3.1 | 2.46 | 4.7 | 101.2 | 0.5 | 0.8 | 12.5 | 9 | 5 |
| 2015 | 5 | 3.88 | 11.9 | 253.0 | 2.9 | 4.8 | 2.75 | 5.9 | 126.5 | 0.7 | 1.2 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 12.5 | 9 | 5 |
| 2016 | 6 | 3.47 | 9.5 | 202.4 | 1.9 | 3.1 | 1.74 | 2.4 | 50.6 | 0.1 | 0.2 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 12.5 | 9 | 5 |

| Design Values | | | |
|---|---|---|---|
| *l* | ft | 20.50 | |
| $K_{ce}$ | | 0.3 | |
| *c* | | 0.85 | |
| $K_e$ | | 0.8 | |
| $I_e$ | in | 196.8 | |
| *E* | psi | 1500000 | Southern Pine (Table 6A) |
| *Emin* | psi | 790000 | |
| $F_{ce}$ | psi | 507.2 | Changes w/ Diameters |
| $F_c$* | psi | 1320 | |
| $C_p$ | | 0.355 | Changes w/ Diameters |
| $F'_c$ | psi | 469 | Changes w/ Diameters |


15.0
10.0
5.0
0.0
ALLOWABLE PILE LOAD (kips)
10% Loss of Area
15% Loss of Area
20% Loss of Area
Applied 100 psf Live Load
Applied 40 psf Live Load
Applied Dead Load
2010
2011
2012
2013
2014
2015
2016
SERVICE LIFE (Years)

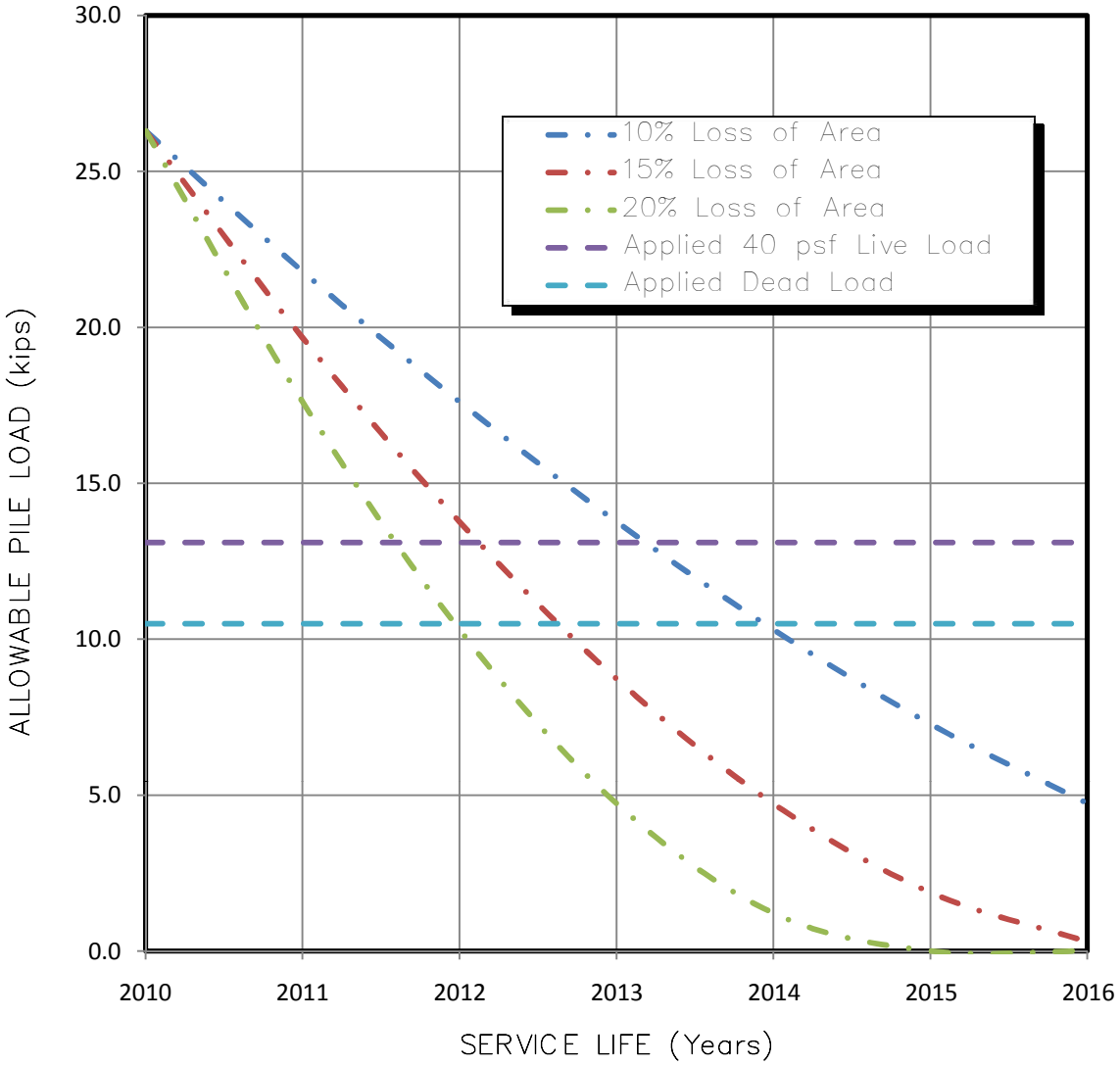
# DIMINISHING PILE CAPACITY DUE TO MARINE BORER ACTIVITY - TIN BUILDING

| Input | | | |
|---|---|---|---|
| Avg. Pile Diameter | *in* | 11.7 | D+3 only |
| Standard Deviation | *in* | 0.48 | |
| Distance to Mudline | *ft* | 30.4 | |
| Depth to Fixity | *ft* | 10 | |

| Output | | | |
|---|---|---|---|
| Pile Diameter (84% Ex) | *in.* | 6.8 | Design Diameter |
| Area of Design Pile | $in^2$ | 36.30 | |
| Effective Pile Length | *in* | 187.2 | |

| | | 10% Loss of Area | | | | | 15% Loss of Area | | | | | 20% Loss of Area | | | | | Live Load | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Time** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **Diameter** | **Area** | **$F_{ce}$** | **P** | **$P_{crit}$** | **40 psf** | **0** |
| | yrs | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | in | $in^2$ | psi | kips | kips | kips | kips |
| 2010 | 0 | 6.80 | 36.3 | 856.9 | 26.3 | 43.7 | 6.80 | 36.3 | 856.9 | 26.3 | 43.7 | 6.80 | 36.3 | 856.9 | 26.3 | 43.7 | 13.1 | 10.5 |
| 2011 | 1 | 6.44 | 32.7 | 769.5 | 21.8 | 36.2 | 6.26 | 30.9 | 726.7 | 19.7 | 32.6 | 6.08 | 29.0 | 684.0 | 17.6 | 29.2 | 13.1 | 10.5 |
| 2012 | 2 | 6.08 | 29.0 | 684.0 | 17.6 | 29.2 | 5.68 | 25.4 | 598.5 | 13.8 | 22.9 | 5.26 | 21.8 | 513.0 | 10.3 | 17.1 | 13.1 | 10.5 |
| 2013 | 3 | 5.68 | 25.4 | 598.5 | 13.8 | 22.9 | 5.04 | 20.0 | 470.2 | 8.7 | 14.5 | 4.30 | 14.5 | 342.0 | 4.7 | 7.9 | 13.1 | 10.5 |
| 2014 | 4 | 5.26 | 21.8 | 513.0 | 10.3 | 17.1 | 4.30 | 14.5 | 342.0 | 4.7 | 7.9 | 3.04 | 7.3 | 171.0 | 1.2 | 2.0 | 13.1 | 10.5 |
| 2015 | 5 | 4.80 | 18.1 | 427.5 | 7.3 | 12.1 | 3.40 | 9.1 | 213.7 | 1.9 | 3.1 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 13.1 | 10.5 |
| 2016 | 6 | 4.30 | 14.5 | 342.0 | 4.7 | 7.9 | 2.15 | 3.6 | 85.5 | 0.3 | 0.5 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 13.1 | 10.5 |

| Design Values | | | |
|---|---|---|---|
| *l* | ft | 19.50 | |
| $K_{ce}$ | | 0.3 | |
| *c* | | 0.85 | |
| $K_e$ | | 0.8 | |
| $I_e$ | in | 187.2 | |
| *E* | psi | 1500000 | Southern Pine (Table 6A) |
| *Emin* | psi | 790000 | |
| $F_{ce}$ | psi | 856.9 | Changes w/ Diameters |
| $F_c$* | psi | 1320 | |
| $C_p$ | | 0.549 | Changes w/ Diameters |
| $F'_c$ | psi | 725 | Changes w/ Diameters |


30.0
25.0
20.0
15.0
10.0
5.0
0.0
ALLOWABLE PILE LOAD (kips)
2010
2011
2012
2013
2014
2015
2016
SERVICE LIFE (Years)
10% Loss of Area
15% Loss of Area
20% Loss of Area
Applied 40 psf Live Load
Applied Dead Load

# Calculation of Minimum Diameters and Allowable Loads at the Fulton Fish Market

References :

National Design Specificaion for Wood Construction, 2005 Edition. (NDS)

Definitions:

$kips \equiv 1000 \cdot lbf$

Design values for treated round timber piles (Southern Yellow Pine).

$F_c := 1200 \cdot psi$ — Tabulated value of allowable compressive stress (Parallel to grain.) NDS Table 6A

$E := 1.5 \cdot 10^6 \cdot psi$ — Modulus of elasticity of timber (NDS Table 6A)

$E_{min} := 790000 \cdot psi$ — NDS Table 6A

$C_t := 1.0$ — Temperature Factor (NDS, Table 2.3.3)

$C_u := 1.0$ — Untreated Factor (NDS, Table 6.3.5)

$C_{sp} := 1.0$ — Single Pile Factor (NDS, Table 6.3.11)

$C_{cs} := 1.10$ — Critical Section Factor (NDS, Eq. 6.3-1)

$\phi_c := 0.90$ — Resistance Factor (NDS, Appendix Table N2)

$K_F := \frac{2.16}{\phi_c}$ $K_F = 2.4$ — Format Conversion Factor (NDS, Appendix Table N1)

$\lambda := 0.6$ — Time Effect Factor (NDS, Appendix Table N3)

$Fstar_c := F_c \cdot C_t \cdot C_u \cdot C_{sp} \cdot C_{cs} \cdot K_F \cdot \phi_c \cdot \lambda$

$Fstar_c = 1.711 \times 10^3\ psi$ $F_c^* = 1320$ psi

**Tabular compression design value multiplied by all applicable adjustment factors except $C_p$ (psi).**

## New Market Building

### Buckling Failure

$l := 22.7 \cdot ft$ — Average length of pile to an assumed point of fixity.

$D := 5.1 in$ — Design pile diameter with 84% Excedence. (average less 1 standard deviation)

$c := 0.85$ — For round timber piles. (NDS, p. 19)

$K_e := 0.8$ — Effective buckling length factor for hinged-fixed pile. (NDS, Appendix Table G1)

$l_e := K_e \cdot l$ $\quad l_e = 217.92\,in \quad l_e = 18.16\,ft$ — Effective pile length.

$E'_{min} := E_{min} \cdot C_t$ $\quad E'_{min} = 7.900 \times 10^5\,psi$ — Modulus of elasticity associated with the axis of column buckling.

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D}\right)^2} \qquad F_{ce} = 355.67\,psi$$ (NDS 3.7.1)

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$ — Column Stability Factor (NDS Eq. 3.7-1)

$C_p = 0.2$

$F'_c := Fstar_c \cdot C_p$ $\quad F'_c = 343\,psi$ — Allowable compressive stress in a pile

$P_b := F'_c \cdot \frac{\pi \cdot D^2}{4}$ $\quad \boxed{P_b = 7\,kips}$ — Allowable load for resistance to buckling.

### Compressive Failure

$Fstar_c = 1710.72\,psi$ — Compressive Design Stress

$A := \frac{\pi}{4} \cdot D^2 \qquad A = 20.43\,in^2$ — Cross Sectional Area of Design Pile

$P := Fstar_c \cdot A$ $\quad P = 34.95\,kips$ — Allowable load for resistance to compressive failure

By inspection, the allowable load with respect to buckling failure will govern over compressive failure.

## Loading

Determine the loading conditions applied applied to the typical piles assuming the building will remain vacant (no live load). Also assumed that the weight of the building structure is entirely supported by the encased concrete pedestal clusters.

$A_{trib} := 6ft \cdot 10ft$ $\quad A_{trib} = 60\ ft^2$

Maximum tributary area for piles beneath the New Market Building. Maximum area yields a larger load and therefore is most conservative.

$D_{conc} := A_{trib} \cdot 1ft \cdot 150 \frac{lb}{ft^3}$ $\quad D_{conc} = 9000\ lb$

Dead load of concrete deck. Assumed to be 12 inches thick with weight of 150 pcf.

$D_{cap} := 1ft^2 \cdot 10ft \cdot 35 \frac{lb}{ft^3}$ $\quad D_{cap} = 350\ lb$

Dead load of 12x12 timber pile cap. Assumed to be 35 pcf.

Load Scenario 1 (No Live Load)

$P_u := 1.4\left(D_{conc} + D_{cap}\right)$ $\quad P_u = 13090\ lb$

With no live load, the design pile does not have sufficient capacity to resist buckling failure.

Load Scenario 2 (40 psf Live Load)

$$P_u := 1.2\left(D_{conc} + D_{cap}\right) + 1.6\left(A_{trib} \cdot 40 \frac{lb}{ft^2}\right)$$

$P_u = 15060\ lb$

With a 100 psf live load, the pile does not have sufficient capacity to resist buckling failure.

## Minimum Current Requirements

Determine the minimum current pile diameter required for sufficient capacity against buckling. Because both $A_{req}$ and $C_p$ vary with diameter, you must solve by iteration.

$P_0 := 13.1kip$

Load applied to typical pile with 0 live load

$P_{40} := 15.0kip$

Load applied to typical pile with 40 psf live load

Dead Load Only

$C_p := 0.271$

Assumed value to start

$$A_{req} := \frac{P_0}{C_p \cdot Fstar_c} \qquad A_{req} = 28.26\ in^2$$

$$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}} \qquad D_{min} = 6\ in$$

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2} \qquad F_{ce} = 491.97\,psi$$

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$

$C_p = 0.272$

Value converges when $D_{min}$ is equal to 6 inches

$D_{min} = 6\,in$

Use 6.0 inches as minimum diameter

40 psf Live Load

$C_p := 0.290$

Assumed value to start

$$A_{req} := \frac{P_{40}}{C_p \cdot Fstar_c} \qquad A_{req} = 30.24\,in^2$$

$$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}} \qquad D_{min} = 6.2\,in$$

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2} \qquad F_{ce} = 526.42\,psi$$

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$

$C_p = 0.29$

$D_{min} = 6.2\,in$

Value converges when $D_{min}$ is equal to 6.2 inches

Piles with diameters equal to or greater than 6.0 inches provide sufficient capacity against buckling. Any pile with diameter less than 6.0 inches is unsafe for a 13.1 kip loading.

## Future Section Loss

Determine the minimum current pile diameter necessary to maintain sufficient capacity against buckling after 3 years of deterioration under dead load only. Use annual deterioration rates of 10%, 15%, and 20% of cross sectional area.

$D_{design} := 6in$

Design diameter represents the minimum allowable diameter to resist buckling under dead load conditions

$A_{design} := \frac{\pi}{4} \cdot D_{design}^{2}$ $A_{design} = 28.27\ in^2$

$P_0 := 13.1kip$

Load applied to pile with 0 live load

Rate of 10% Loss Per Year

$Rate := 10 \frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 36.76\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 6.84\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$Rate := 15 \frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 41\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.22\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$Rate := 20 \frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 45.24\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.59\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

Determine minimum current pile diameters to support 40 psf live load in 3 years time.

$D_{design} := 6.2in$ Design diameter represents the minimum required diameter

$A_{design} := \frac{\pi}{4} \cdot D_{design}^{2}$ $A_{design} = 30.19\ in^2$

$P_{40} = 15\ kip$ Load applied to pile with 40 psf live load

Rate of 10% Loss Per Year

$Rate := 10\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 39.25\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.07\ in$ Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$Rate := 15\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 43.78\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.47\ in$ Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$Rate := 20\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 48.31\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.84\ in$ Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

Determine minimum current pile diameters to support 40 psf live load in 6 years time.

$D_{design} := 6.2in$

Design diameter represents the minimum required diameter

$A_{design} := \frac{\pi}{4} \cdot D_{design}^{2}$ $A_{design} = 30.19\ in^2$

$P_{40} = 15\ kip$

Load applied to pile with 40 psf live load

Rate of 10% Loss Per Year

$Rate := 10\frac{\%}{yr}$ $T := 6yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 48.31\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.84\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$Rate := 15\frac{\%}{yr}$ $T := 6yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 57.36\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 8.55\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$Rate := 20\frac{\%}{yr}$ $T := 6yr$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 66.42\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 9.2\ in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

# West Apron

## Buckling Failure

$l := 20.5 \cdot ft$ — Average length of pile to an assumed point of fixity.

$D := 5.5in$ — Design pile diameter (with 84% Excedence)

$c := 0.85$ — For round timber piles. (NDS, p. 19)

$K_e := 0.8$ — Effective buckling length factor for hinged-fixed pile. (NDS, Appendix Table G1)

$l_e := K_e \cdot l$ $\quad l_e = 16.4\ ft$ — Effective pile length.

$E'_{min} := E_{min} \cdot C_t$ $\quad E'_{min} = 7.900 \times 10^5\ psi$ — Modulus of elasticity associated with the axis of column buckling.

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D}\right)^2} \qquad F_{ce} = 507.19\ psi$$ (NDS 3.7.1)

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$ — Column Stability Factor (NDS Eq. 3.7-1)

$C_p = 0.28$

$F'_c := Fstar_c \cdot C_p$ $\quad F'_c = 479.22\ psi$ — Allowable compressive stress in a pile

$P := F'_c \cdot \frac{\pi \cdot D^2}{4}$ $\quad P = 11.39\ kip$ — Allowable load for resistance to buckling.

## Loading

Determine the loading conditions applied applied to the typical piles. Assumed that the weight of the building structure is entirely supported by the encased concrete pedestal clusters.

$A_{trib} := 6ft \cdot 6ft$ $\quad A_{trib} = 36\ ft^2$ — Maximum tributary area for piles beneath the West Apron. Maximum area yields a larger load and therefore is most conservative.

$D_{conc} := A_{trib} \cdot 1ft \cdot 150 \frac{lb}{ft^3}$ $\quad D_{conc} = 5400\ lb$ — Dead load of concrete deck. Assumed to be 12 inches thick with weight of 150 pcf.

$D_{cap} := 1ft^2 \cdot 6ft \cdot 35 \frac{lb}{ft^3}$ $D_{cap} = 210\ lb$

Dead load of 12x12 timber pile cap. Assumed to be 35 pcf.

Load Scenario 1 (40 psf Live Load)

$P_u := 1.2\left(D_{conc} + D_{cap}\right) + 1.6\left(A_{trib} \cdot 40 \frac{lb}{ft^2}\right)$

$D := D_{conc} + D_{cap}$ $D = 5610\ lb$

$P_u = 9036\ lb$

With a 40 psf live load, the pile has sufficient capacity to resist buckling failure.

Load Scenario 2 (100 psf Live Load)

$P_u := 1.2\left(D_{conc} + D_{cap}\right) + 1.6\left(A_{trib} \cdot 100 \frac{lb}{ft^2}\right)$

$P_u = 12492\ lb$

With a 100 psf live load, the pile does not have sufficient capacity to resist buckling failure.

## Minimum Current Requirements

Determine the minimum current pile diameter required for sufficient capacity against buckling. Because both $A_{req}$ and $C_p$ vary with diameter, you must solve by iteration.

40 psf Live Load

$P_{40} := 9.0kip$

Load applied to typical pile

$C_p := 0.25$

Assumed value to start

$A_{req} := \frac{P_{40}}{C_p \cdot Fstar_c}$ $A_{req} = 21.04\ in^2$

$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}}$ $D_{min} = 5.18\ in$

$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2}$ $F_{ce} = 449.24\ psi$

$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$

$C_p = 0.25$

Value converges when $D_{min}$ is equal to 5.18 inches

$D_{min} = 5.18\,in$

Use 5.18 inches as minimum diameter

100 psf Live Load

$P_{100} := 12.5kip$

Load applied to typical pile

$C_p := 0.293$

Assumed value to start

$A_{req} := \frac{P_{100}}{C_p \cdot Fstar_c}$ $A_{req} = 24.94\,in^2$

$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}}$ $D_{min} = 5.63\,in$

$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2}$ $F_{ce} = 532.38\,psi$

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$

$C_p = 0.293$

Value converges when $D_{min}$ is equal to 5.63 inches

$D_{min} = 5.63\,in$

Use 5.63 inches as minimum diameter

## Future Section Loss

Determine the minimum current pile diameter necessary to maintain sufficient capacity against buckling after 3 years of deterioration. Use annual deterioration rates of 10%, 15%, and 20% of cross sectional area.

$D_{design} := 6in$

Design diameter represents the minimum required pile diameter to resist buckling.

$A_{design} := \frac{\pi}{4} \cdot D_{design}^2$ $A_{design} = 28.27\,in^2$

$P_{100} := 12.5kip$

Load applied to pile under 100 psf uniform live load

3 Year Time Period

Rate of 10% Loss Per Year

$\text{Rate} := 10\frac{\%}{\text{yr}}$ $\quad T := 3\text{yr}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 36.76\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 6.84\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$\text{Rate} := 15\frac{\%}{\text{yr}}$ $\quad T := 3\text{yr}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 41\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 7.22\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$\text{Rate} := 20\frac{\%}{\text{yr}}$ $\quad T := 3\text{yr}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 45.24\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 7.59\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

6 year Time Period

Rate of 10% Loss Per Year

$\text{Rate} := 10\frac{\%}{\text{yr}}$ $\quad T := 6\text{yr}$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 45.24\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 7.59\ in$

Current diameter required to maintain sufficient capacity against buckling after 6 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$Rate := 15 \frac{\%}{yr}$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 53.72\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 8.27\ in$

Current diameter required to maintain sufficient capacity against buckling after 6 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$Rate := 20 \frac{\%}{yr}$

$A_{req} := Rate \cdot (A_{design}) \cdot T + A_{design}$

$A_{req} = 62.2\ in^2$

$D_{req} := \sqrt{\frac{4}{\pi} \cdot A_{req}}$ $D_{req} = 8.9\ in$

Current diameter required to maintain sufficient capacity against buckling after 6 years of marine borer infestation at 20% loss/year.

# Tin Building - Pile Capacity

## Buckling Failure

$l := 19.5 \cdot ft$ — Average length of pile to an assumed point of fixity.

$D := 6.8in$ — Design pile diameter (with 84% Excedence)

$c := 0.85$ — For round timber piles. (NDS, p. 19)

$K_e := 0.8$ — Effective buckling length factor for hinged-fixed pile. (NDS, Appendix Table G1)

$l_e := K_e \cdot l$ $\quad l_e = 15.6\ ft$ — Effective pile length.

$E'_{min} := E_{min} \cdot C_t$ $\quad E'_{min} = 7.900 \times 10^5\ psi$ — Modulus of elasticity associated with the axis of column buckling.

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D}\right)^2} \qquad F_{ce} = 856.85\ psi$$ (NDS 3.7.1)

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$ Column Stability Factor (NDS Eq. 3.7-1)

$C_p = 0.45$

$F'_c := Fstar_c \cdot C_p$ $\quad F'_c = 764.28\ psi$ — Allowable compressive stress in a pile

$P := F'_c \cdot \frac{\pi \cdot D^2}{4}$ $\quad P = 27.76\ kip$ — Allowable load for resistance to buckling.

## Loading

Determine the loading conditions applied applied to the typical piles assuming the building will remain vacant (no live load). Also assumed that the weight of the building structure is entirely supported by the encased concrete pedestal clusters.

$A_{trib} := 6ft \cdot 10.5ft$ $\quad A_{trib} = 63\ ft^2$ — Maximum tributary area for piles beneath the West Apron. Maximum area yields a larger load and therefore is most conservative.

$D_{conc} := A_{trib} \cdot 8in \cdot 150 \frac{lb}{ft^3}$ $\quad D_{conc} = 6300\ lb$ — Dead load of concrete deck. Assumed to be 12 inches thick with weight of 150 pcf.

$D_{cap} := 1ft^2 \cdot 6ft \cdot 35 \frac{lb}{ft^3}$ $D_{cap} = 210\ lb$ Dead load of 12x12 timber pile cap. Assumed to be 35 pcf.

$D_{stringer} := 10ft \cdot 3\left(1ft^2\right) \cdot 35 \frac{lb}{ft^3}$ $D_{stringer} = 1050\ lb$ Dead load for three sets of 2-6x12 stringers.

Load Scenario 1 (No Live Load)

$P_u := 1.4\left(D_{conc} + D_{cap} + D_{stringer}\right)$ $P_u = 10584\ lb$ With no live load, the pile has sufficient capacity to resist buckling failure.

Load Scenario 2 (40 psf Live Load)

$P_u := 1.2\left(D_{conc} + D_{cap} + D_{stringer}\right) + 1.6\left(A_{trib} \cdot 40 \frac{lb}{ft^2}\right)$

$P_u = 13104\ lb$ With a 40 psf live load, the pile has sufficient capacity to resist buckling failure.

## Minimum Current Requirements

Determine the minimum current pile diameter required for sufficient capacity against buckling. Because both $A_{req}$ and $C_p$ vary with diameter, you must solve by iteration.

Dead Load Only

$P := 10.6kip$ Load applied to typical pile

$C_p := 0.284$ Assumed value to start

$A_{req} := \frac{P}{C_p \cdot Fstar_c}$ $A_{req} = 21.82\ in^2$

$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}}$ $D_{min} = 5.27\ in$

$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2}$ $F_{ce} = 514.76\ psi$

$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$

$C_p = 0.284$

Value converges when $D_{min}$ is equal to 5.27 inches

$D_{min} = 5.27\,in$

Use 5.27 inches as minimum diameter

40 psf Live Load

$P := 13.1kip$

Load applied to typical pile

$C_p := 0.315$

Assumed value to start

$$A_{req} := \frac{P}{C_p \cdot Fstar_c} \qquad A_{req} = 24.31\,in^2$$

$$D_{min} := \sqrt{\frac{4 \cdot A_{req}}{\pi}} \qquad D_{min} = 5.56\,in$$

$$F_{ce} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_e}{D_{min}}\right)^2} \qquad F_{ce} = 573.56\,psi$$

$$C_p := \frac{1 + \left(\frac{F_{ce}}{Fstar_c}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{ce}}{Fstar_c}}{2 \cdot c}\right)^2 - \frac{\frac{F_{ce}}{Fstar_c}}{c}}$$

$C_p = 0.314$

Value converges when $D_{min}$ is equal to 5.56 inches

$D_{min} = 5.56\,in$

Use 5.56 inches as minimum diameter

## Future Section Loss

Determine the minimum current pile diameter necessary to maintain sufficient capacity against buckling after 3 years of deterioration. Use annual deterioration rates of 10%, 15%, and 20% of cross sectional area.

Dead Load Only

$D_{design} := 6in$

Design diameter represents the minimum required pile diameter to resist buckling.

$$A_{design} := \frac{\pi}{4} \cdot D_{design}^2 \qquad A_{design} = 28.27\,in^2$$

$P := 10.6kip$

Load applied to typical pile under 0 live load

Rate of 10% Loss Per Year

$Rate := 10\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 36.76\,in^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $D_{req} = 6.84\,in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$Rate := 15\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 41\,in^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $D_{req} = 7.22\,in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$Rate := 20\frac{\%}{yr}$ $T := 3yr$

$A_{req} := Rate\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 45.24\,in^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $D_{req} = 7.59\,in$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

40 psf Live Load

$D_{design} := 6in$

Design diameter represents the minimum required pile diameter to resist buckling.

$A_{design} := \frac{\pi}{4}\cdot D_{design}^{\,2}$ $A_{design} = 28.27\,in^2$

$P := 13.1kip$

Load applied to typical pile under 40 psf uniform live load

Rate of 10% Loss Per Year

$\text{Rate} := 10\frac{\%}{\text{yr}}$ $\quad T := 3\text{yr}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 36.76\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 6.84\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 10% loss/year.

Rate of 15% Loss Per Year

$\text{Rate} := 15\frac{\%}{\text{yr}}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 41\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 7.22\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 15% loss/year.

Rate of 20% Loss Per Year

$\text{Rate} := 20\frac{\%}{\text{yr}}$

$A_{req} := \text{Rate}\cdot\left(A_{design}\right)\cdot T + A_{design}$

$A_{req} = 45.24\ \text{in}^2$

$D_{req} := \sqrt{\frac{4}{\pi}\cdot A_{req}}$ $\quad D_{req} = 7.59\ \text{in}$

Current diameter required to maintain sufficient capacity against buckling after 3 years of marine borer infestation at 20% loss/year.

# Tin Building - Pile Cap Analysis

Design values for treated round timber piles (Southern Yellow Pine).

All design values assume Southern Yellow Pine, No. 2 Timber (NDS, Table 4D)

$F_b := 850psi$

$F_v := 165psi$

$E := 1200000psi$

$E_{min} := 440000psi$

$C_M := 1.0$ Wet Service Factor (NDS, Table 4D)

$C_t := 1.0$ Temperature Factor (NDS, Appendix C)

$C_i := 1.0$ Incising Factor (NDS Section 4.3.8)

$C_T := 1.0$ Buckling Stability Factor (NDS 4.3.11)

$C_F := 1.0$ Size Factor (NDS Table 4D)

$C_{fu} := 1.0$ Flat Use Factor

$C_r := 1.0$ Repetitive Use Factor

$\phi_b := 0.85$ Load Resistance Factors (NDS Table N2)

$\phi_s := 0.85$

$\phi_v := 0.75$

$\lambda := 0.6$ Time Effect Factor (NDS Table N3)

$K_{Fb} := \frac{2.16}{\phi_b}$ $K_{Fb} = 2.54$ Format Conversion Factors (NDS Table N1)

$K_{Fv} := \frac{2.16}{\phi_v}$ $K_{Fv} = 2.88$

$K_{Fs} := \frac{1.5}{\phi_s}$ $K_{Fs} = 1.76$

$F'_v := F_v \cdot C_M \cdot C_t \cdot C_i \cdot K_{Fv} \cdot \phi_v \cdot \lambda$ $F'_v = 213.84\,psi$

$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T \cdot K_{Fs} \cdot \phi_s$ $E'_{min} = 660000\,psi$

$Fstar_b := F_b \cdot C_M \cdot C_t \cdot C_F \cdot C_i \cdot C_r \cdot K_{Fb} \cdot \phi_b \cdot \lambda$ $Fstar_b = 1101.6\,psi$

Timber Pile Caps consist of 2- 6x12's witha 6x12 filler between piles

$b := 5.5in$ $d := 11.5in$ Base and depth dimensions of standard 6x12

$A := 3 \cdot b \cdot d$ $A = 189.75\ in^2$ Cross sectional area of pile cap

$S_x := \frac{3 \cdot b \cdot d^2}{6}$ $S_x = 363.69\ in^3$ Section modulus of pile cap

$l_u := 6ft$ Pile spacing

$l_e := 1.84 \cdot l_u$ $l_e = 11.04\ ft$ Effective pile spacing length

$R_B := \sqrt{\frac{l_e \cdot d}{b^2}}$ $R_B = 7.1$ Pile cap slenderness ratio

$F_{bE} := \frac{1.20 \cdot E'_{min}}{R_B^2}$ $F_{bE} = 15725.43\ psi$

$C_L := \frac{1 + \frac{F_{bE}}{Fstar_b}}{1.9} - \sqrt{\left(\frac{1 + \frac{F_{bE}}{Fstar_b}}{1.9}\right)^2 - \frac{\frac{F_{bE}}{Fstar_b}}{0.95}}$ $C_L = 1$

$F'_b := F_b \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r \cdot K_F \cdot \phi_b \cdot \lambda$

$F'_b = 1036.51\ psi$ Adjusted bending stress

Check Failure Against Bending

$M_n := F'_b \cdot S_x$ $M_n = 31.41\ kip \cdot ft$ Allowable maximum moment

Determine maximum applied moment

$l := 6ft$ Maximum pile spacing and length of timber cap

$D_{conc} := 10.5ft \cdot 8in \cdot 150 \frac{lb}{ft^3}$ $D_{conc} = 1050 \frac{lb}{ft}$

$D_{stringer} := 10.5ft \cdot 3ft^2 \cdot 35 \frac{lb}{ft^3} \cdot \frac{1}{l}$ $D_{stringer} = 183.75 \frac{lb}{ft}$ Dead load of three sets of 2-6x12s assumed to be distributed evenly over pile cap

$D_{deck} := 10.5ft \cdot 3.5in \cdot 35 \frac{lb}{ft^3}$ $D_{deck} = 107.19 \frac{lb}{ft}$ Dead load of 4x12 timber decking

$D_{cap} := A \cdot 35 \frac{lb}{ft^3}$ $D_{cap} = 46.12 \frac{lb}{ft}$ Dead load of pile cap

$D := D_{conc} + D_{stringer} + D_{deck} + D_{cap}$

$D = 1387.06 \frac{lb}{ft}$ Total unfactored dead load

Dead Load Only

$\omega_u := 1.4D$ $\omega_u = 1941.88 \frac{lb}{ft}$ Total factored load

$M_u := \frac{\omega_u \cdot l^2}{8}$ $M_u = 8738.46\ lb \cdot ft$ Maximum applied moment, assuming pile caps are simply supported single span members.

40 psf Live Load

$L := 10.5ft \cdot 40 \frac{lb}{ft^2}$ $L = 420 \frac{lb}{ft}$

$\omega_{u40} := 1.2D + 1.6L$ $\omega_{u40} = 2336.47 \frac{lb}{ft}$ Total factored uniform load

$M_u := \frac{\omega_{u40} \cdot l^2}{8}$ $M_u = 10514.11\ lb \cdot ft$ Maximum applied moment, assuming pile caps are simply supported single span members.

Under original construction conditions, the pile cap has sufficient capacity against flexural failure. Determine maximum allowable loss of cross sectional area to still maintain sufficient capacity against flexural failure.

Allowable Section Loss under Bending Failure

Dead Load Only

$S_x := \frac{M_u}{F'_b}$ $S_x := 159.3 in^3$ Required Section modulus to support 10.5 kip-ft moment

$bdd := S_x \cdot 6$ $bdd = 955.8\ in^3$ Assume ratio from b:d stays consistent at 1.4:1

$b := \sqrt[3]{\frac{bdd}{4}}$ $b = 6.21\ in$

$d := \frac{b}{1.4}$ $d = 4.43\ in$

$A_{req} := d \cdot b$ $A_{req} = 27.5\ in^2$

$\%lost := \frac{A - A_{req}}{A}$ $\%lost = 85.5\ \%$ Maximum allowable section loss to resist dead only

40 psf Live Load

$S_x := \frac{M_u}{F'_b}$ $S_x := 121.6 in^3$ Required Section modulus to support 29.2 kip-ft moment

| | | |
|---|---|---|
| $bdd := S_x \cdot 6$ | $bdd = 729.6\ in^3$ | Assume ratio from b:d stays consistent at 1.4:1 |
| $b := \sqrt[3]{\frac{bdd}{4}}$ | $b = 5.67\ in$ | |
| $d := \frac{b}{1.4}$ | $d = 4.05\ in$ | |
| $A_{req} := d \cdot b$ | $A_{req} = 22.97\ in^2$ | |
| $\%lost := \frac{A - A_{req}}{A}$ | $\%lost = 87.89\ \%$ | Maximum allowable section loss to resist 250 psf live load. |

Check Failure Against Shear

| | | |
|---|---|---|
| $V_n := F'_v \cdot A$ | $V_n = 40.58\ kip$ | Allowable maximum shear force |

Determine maximum applied shear

Dead Load Only

| | | |
|---|---|---|
| $V_u := \frac{\omega_u \cdot l}{2}$ | $V_u = 5825.64\ lb$ | The maximum applied shear force is less than the allowable shear forece. |
| $A_{req} := \frac{V_u}{F'_v}$ | $A_{req} := 31.25 in^2$ | |
| $\%lost := \frac{A - A_{req}}{A}$ | $\%lost = 83.53\ \%$ | Maximum allowable section loss to resist dead load only |

40 psf Live Load

| | | |
|---|---|---|
| $V_u := \frac{\omega_{u40} \cdot l}{2}$ | $V_u = 7009.41\ lb$ | |
| $A_{req} := \frac{V_u}{F'_v}$ | $A_{req} := 32.9 in^2$ | |
| $\%lost := \frac{A - A_{req}}{A}$ | $\%lost = 82.66\ \%$ | Maximum allowable section loss to resist 250 psf Live Load |

# Tin Building - Stringer Analysis

See above section for all design values. Stringers consist of 2- 6x12 timber members.

$b := 5.5in$ $d := 11.5in$

$A := 2 \cdot b \cdot d$ $A = 126.5\ in^2$

$S_x := \frac{2 \cdot b \cdot d^2}{6}$ $S_x = 242.46\ in^3$ Section Modulus

Check Failure Against Bending

$l := 10.5ft$ $s := 3ft$ length and spacing of stringers

$M_n := F'_b \cdot S_x$ $M_n = 20.94\ kip \cdot ft$ Maximum allowable moment

$D_{conc} := 3ft \cdot 12in \cdot 150 \frac{lb}{ft^3}$ $D_{conc} = 450\ \frac{lb}{ft}$

$D_{deck} := 3ft \cdot 3.5in \cdot 35 \frac{lb}{ft^3}$ $D_{deck} = 30.63\ \frac{lb}{ft}$

$D_{stringer} := 1ft^2 \cdot 35 \frac{lb}{ft^3}$ $D_{stringer} = 35\ \frac{lb}{ft}$

$D := D_{conc} + D_{deck} + D_{stringer}$ $D = 515.63\ \frac{lb}{ft}$ Total unfactored dead load

Dead Load Only

$\omega_u := 1.4D$ $\omega_u = 721.88\ \frac{lb}{ft}$ Total factored load

$M_u := \frac{\omega_u \cdot l^2}{8}$ $M_u = 9948.34\ lb \cdot ft$ Maximum applied moment

$S_x := \frac{M_u}{F'_b}$ $S_x := 131.5in^3$

$bdd := S_x \cdot 6$ $bdd = 789\ in^3$ Assume ratio from b:d stays consistent at 1:1

$b := \sqrt[3]{bdd}$ $b = 9.24\ in$

$d := b$ $d = 9.24\ in$

$A_{req} := d \cdot b$ $A_{req} = 85.39\ in^2$

$\%lost := \frac{A - A_{req}}{A}$ $\%lost = 32.5\,\%$

40 psf Live Load

$L := 3ft \cdot 40 \frac{lb}{ft^2}$ $L = 120 \frac{lb}{ft}$

$\omega_{u40} := 1.2 \cdot D + 1.6L$ $\omega_{u40} = 810.75 \frac{lb}{ft}$ Total factored uniform load

$M_u := \frac{\omega_{u40} \cdot l^2}{8}$ $M_u = 11173.15\ lb \cdot ft$ Maximum applied moment

$S_x := \frac{M_u}{F'_b}$ $S_x := 100.7 in^3$

$bdd := S_x \cdot 6$ $bdd = 604.2\ in^3$ Assume ratio from b:d stays consistent at 1:1

$b := \sqrt[3]{bdd}$ $b = 8.45\ in$

$d := b$ $d = 8.45\ in$

$A_{req} := d \cdot b$ $A_{req} = 71.47\ in^2$

$\%lost := \frac{A - A_{req}}{A}$ $\%lost = 43.5\,\%$

# APPENDIX C - BACKUP DATA FOR COST ESTIMATES

# OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS

**OCC PROJECT NO:** 209093
**OCC PROJECT NAME:** Fulton Fish Market

**CLIENT:** TURNER
**SITE LOCATION:** MANHATTAN, NY

**PREPARED BY:** MATE
**DATE:** 07/07/10
**CHECKED BY:**
**DATE:**

**THE FOLLOWING APPLY FOR DEMOLITION & CONSTRUCTION:**

**TOTAL OPINION OF PROBABLE COST INCLUDE A CONTINGENCY OF:** **25%**
**TOTAL OPC INCLUDE GENERAL CONDITIONS OF:** **5%**
**TOTAL OPINION OF PROBABLE COST INCLUDE A OVERHEAD OF:** **10%**
**TOTAL OPINION OF PROBABLE COST INCLUDE A PROFIT OF:** **10%**

| DESCRIPTION | DEMOLITION AND CONSTRUCTION | CONTINGENCY | OPC TOTAL |
|---|---|---|---|
| **MOBILIZATION AND DEMOBILIZATION** | | | |
| OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $210,000 | $0 | **$210,000** |
| | | | |
| **TIN BUILDING - MAIN BUILDING** | | | |
| OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $1,059,375 | $265,000 | **$1,325,000** |
| | | | |
| **WEST APRON** | | | |
| OPINION OF PROBABLE COSTS - PRIORITY | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $523,500 | $131,000 | **$655,000** |
| | | | |
| **NEW MARKET BUILDING** | | | |
| OPINION OF PROBABLE COSTS - PRIORITY | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $2,154,375 | $539,000 | **$2,694,000** |
| | | | |
| **TOTALS** | **$1,269,375** | **$265,000** | **$4,884,000** |

**MOBILIZATION AND DEMOBILIZATION**
**OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS**

**OPINION OF PROBABLE COSTS**

| MATERIALS | | | | | | |
|---|---|---|---|---|---|---|
| **MATERIALS** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| S&E CONTROLS | 1.00 | LS | $5,000.00 | $5,000.00 | | |
| MISC MATERIALS | 1.00 | LS | $1,000.00 | $1,000.00 | | |
| **SUBTOTAL** | | | | | **$6,000.00** | |

| LABOR & EQUIPMENT | | | | | | |
|---|---|---|---|---|---|---|
| **LABOR & EQUIPMENT** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| OFFSITE PREPARATION | 2.50 | SHIFT | $10,941.08 | $27,352.71 | | CREW 2 |
| MOBILIZATION | 2.00 | SHIFT | $7,782.64 | $15,565.27 | | CREW 2 |
| SITE PREPARATION | 2.50 | SHIFT | $7,782.64 | $19,456.59 | | CREW 2 |
| S&E CONTROLS | 3.00 | SHIFT | $7,782.64 | $23,347.91 | | CREW 2 |
| PUNCH-LIST | 3.00 | SHIFT | $7,782.64 | $23,347.91 | | CREW 2 |
| FINAL CLEAN-UP | 2.00 | SHIFT | $3,684.68 | $7,369.36 | | CREW 4 |
| DEMOBILIZATION | 2.00 | SHIFT | $7,782.64 | $15,565.27 | | CREW 2 |
| OFFSITE BREAKDOWN | 2.00 | SHIFT | $7,782.64 | $15,565.27 | | CREW 2 |
| PROJECT MANAGER | 38.00 | HOUR | $100.00 | $3,800.00 | | 25% OF CONST. TIME |
| **SUBTOTAL** | | | | | **$151,370.30** | |

| SUBCONTRACTORS | | | | | | |
|---|---|---|---|---|---|---|
| **SUBCONTRACTORS** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| NONE | | | | | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0.00 | |

| GENERAL CONDITIONS, OVERHEAD & PROFIT | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $157,370.30 | |
| GENERAL CONDITIONS | | 10.00% | PERCENT | | $15,737.03 | |
| OVERHEAD | | 10.00% | PERCENT | | $17,310.73 | |
| PROFIT | | 10.00% | PERCENT | | $19,041.81 | |
| SALES TAX | | 0.00% | PERCENT | | $0.00 | |
| INFLATION | | 0.00% | PERCENT | | $0.00 | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$209,460.00** | |

**TIN BUILDING - MAIN BUILDING**
**OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS**

**OPINION OF PROBABLE COSTS**

| REPAIR | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 862.50 | LF | $750 | $646,875 | | 69 TOTAL, 12.5' AVG |
| STRINGER REPAIR | 1500.00 | LF | $275 | $412,500 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $1,059,375 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $1,059,375 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$1,059,375** | |

**WEST APRON**
**OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS**

**OPINION OF PROBABLE COSTS**

| MATERIALS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 650.00 | LF | $750 | $487,500 | | 52 TOTAL 12.5' AVG |
| SHOTCRETE REPAIR | 100.00 | SF | $350 | $35,000 | | |
| PILE CAP REPAIR | 10.00 | LF | $100 | $1,000 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $523,500 | |

| LABOR & EQUIPMENT | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | SHIFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | SHFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | | | | | |
| PROJECT MANAGER | 0.00 | HOUR | $100 | $0 | | 25% OF CONST. TIME |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| SUBCONTRACTORS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $523,500 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$523,500** | |

**NEW MARKET BUILDING**
**OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS**

**OPINION OF PROBABLE COSTS**

| MATERIALS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 1362.50 | LF | $750 | $1,021,875 | | 109 TOTAL, 12.5' AVG |
| SHOTCRETE REPAIR | 100.00 | SF | $350 | $35,000 | | |
| PEDESTAL REPAIRS | 26.00 | EA | $42,000 | $1,092,000 | | ($12k MAT'L, 2.5 DAYS EA.) |
| PILE CAP REPAIR | 55.00 | LF | $100 | $5,500 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $2,154,375 | |

| LABOR & EQUIPMENT | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | SHIFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | SHFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | | | | | |
| PROJECT MANAGER | 0.00 | HOUR | $100 | $0 | | 25% OF CONST. TIME |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| SUBCONTRACTORS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $2,154,375 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$2,154,375** | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**
OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS
**CREW 1 - TOPSIDE DEMOLITION CREW**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | SUPERINTENDENT | 139.88 | 54.51 | 38.06 | 92.57 |
| | DOCKBUILDER FOREMAN | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| | OILER | 69.60 | 28.94 | 15.55 | 44.49 |
| **EQUIPMENT** | | | | | |
| | FORKLIFT | 50.00 | | | |
| | COMPRESSOR | 25.00 | | | |
| | WORK FLOATS | 15.00 | | | |
| | FORKLIFT | 50.00 | | | |
| | SAWCUTTER | 40.00 | | | |
| | WELD & TORCH | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | 25.00 | | | |
| TOTAL HOURLY RATE | | 1177.77 | | | |
| **TOTAL SHIFT RATE** | | 9422.20 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**

OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS

**CREW 2 - Marine Construction w/o Pile Driving**

| | | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|---|
| **LABOR** | | | | | | |
| | DOCKBUILDER FOREMAN | | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | | 119.51 | 43.61 | 38.06 | 81.67 |
| | OPERATOR | | 129.10 | 55.25 | 25.90 | 81.15 |
| | OILER | | 69.60 | 28.94 | 15.55 | 44.49 |
| **EQUIPMENT** | | | | | | |
| | CRANE BARGE | - | | | | |
| | SCOW / MATERIAL BARGE | - | | | | |
| | TUG | - | | | | |
| | WORK FLOATS | | 5.00 | | | |
| | WELD & TORCH | | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | | 25.00 | | | |
| TOTAL HOURLY RATE | | | 972.83 | | | |
| **TOTAL SHIFT RATE** | | | 7782.64 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**
OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS
**CREW 3 - UNDERWATER WORK**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | SUPERINTENDENT | 165.61 | 68.29 | 38.06 | 106.35 |
| | DOCKBUILDER FOREMAN | 160.51 | 65.56 | 38.06 | 103.62 |
| | DIVER | 140.10 | 54.63 | 38.06 | 92.69 |
| | DIVER | 140.10 | 54.63 | 38.06 | 92.69 |
| | TENDER | 111.24 | 39.18 | 38.06 | 77.24 |
| | TENDER | 111.24 | 39.18 | 38.06 | 77.24 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| **EQUIPMENT** | | | | | |
| | SCOW / MATERIAL BARGE | 25.00 | | | |
| | SCOW / MATERIAL BARGE | 25.00 | | | |
| | COMPRESSOR | 17.75 | | | |
| | WELD & TORCH | 10.75 | | | |
| | DIVE STATION | 31.25 | | | |
| | CRANE BARGE | 200.00 | | | |
| | EXCAVATOR/ HOE RAM | 75.00 | | | |
| | MISC TOOLS & HOSES | 25.00 | | | |
| TOTAL HOURLY RATE | | 1367.64 | | | |
| **TOTAL SHIFT RATE** | | 10941.08 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**
OPINION OF PROBABLE COSTS - PRIORITY RECOMMENDATIONS
**CREW 4 - MAINTENANCE CREW**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | DOCKBUILDER FOREMAN | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| **EQUIPMENT** | | | | | |
| | WORK BOAT | 50.00 | | | |
| | WELD & TORCH | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | 25.00 | | | |
| TOTAL HOURLY RATE | | 460.59 | | | |
| **TOTAL SHIFT RATE** | | 3684.68 | BASED ON EIGHT (8) HOUR SHIFT | | |

# OPINION OF PROBABLE COSTS - ROUTINE RECOMMENDATIONS

**OCC PROJECT NO:** 209093
**OCC PROJECT NAME:** Fulton Fish Market

**CLIENT:** TURNER
**SITE LOCATION:** MANHATTAN, NY

**PREPARED BY:** MATE
**DATE:** 07/07/10
**CHECKED BY:**
**DATE:**

**THE FOLLOWING APPLY FOR DEMOLITION & CONSTRUCTION:**

**TOTAL OPINION OF PROBABLE COST INCLUDE A CONTINGENCY OF:** **25%**
**TOTAL OPC INCLUDE GENERAL CONDITIONS OF:** **5%**
**TOTAL OPINION OF PROBABLE COST INCLUDE A OVERHEAD OF:** **10%**
**TOTAL OPINION OF PROBABLE COST INCLUDE A PROFIT OF:** **10%**

| DESCRIPTION | DEMOLITION AND CONSTRUCTION | CONTINGENCY | OPC TOTAL |
|---|---|---|---|
| **MOBILIZATION AND DEMOBILIZATION** | | | |
| OFFSITE PREPARATION, MOBILIZATION, SITE SET-UP, S&E CONTROLS, FINAL CLEAN-UP & DEMOBILIZATION | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $250,000 | $0 | **$250,000** |
| | | | |
| **TIN BUILDING - MAIN BUILDING** | | | |
| DEMOLISH CONCRETE DECK, INSTALL CONCRETE ENCASEMENTS AND ENCASEMENT EXTENSIONS | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $3,226,500 | $807,000 | **$4,034,000** |
| | | | |
| **WEST APRON** | | | |
| CONCRETE ENCASEMENTS AND ENCASEMENT | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $568,500 | $143,000 | **$712,000** |
| | | | |
| **NEW MARKET BUILDING** | | | |
| CONCRETE ENCASEMENTS, ENCASEMENT | | | |
| CONSTRUCTION - DEMOLITION, MATERIAL, EQUIPMENT, & LABOR | $792,750 | $199,000 | **$992,000** |
| | | | |
| **TOTALS** | **$3,476,500** | **$807,000** | **$5,988,000** |

**MOBILIZATION AND DEMOBILIZATION**
**OFFSITE PREPARATION, MOBILIZATION, SITE SET-UP, S&E CONTROLS, FINAL CLEAN-UP & DEMOBILIZATION**

**OPINION OF PROBABLE COSTS**

| MATERIALS | | | | | | |
|---|---|---|---|---|---|---|
| **MATERIALS** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| S&E CONTROLS | 1.00 | LS | $5,000.00 | $5,000.00 | | |
| MISC MATERIALS | 1.00 | LS | $1,000.00 | $1,000.00 | | |
| **SUBTOTAL** | | | | | **$6,000.00** | |

| LABOR & EQUIPMENT | | | | | | |
|---|---|---|---|---|---|---|
| **LABOR & EQUIPMENT** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| OFFSITE PREPARATION | 2.50 | SHIFT | $10,941.08 | $27,352.71 | | CREW 2 |
| MOBILIZATION | 2.00 | SHIFT | $9,862.64 | $19,725.27 | | CREW 2 |
| SITE PREPARATION | 2.50 | SHIFT | $9,862.64 | $24,656.59 | | CREW 2 |
| S&E CONTROLS | 3.00 | SHIFT | $9,862.64 | $29,587.91 | | CREW 2 |
| PUNCH-LIST | 3.00 | SHIFT | $9,862.64 | $29,587.91 | | CREW 2 |
| FINAL CLEAN-UP | 2.00 | SHIFT | $3,684.68 | $7,369.36 | | CREW 4 |
| DEMOBILIZATION | 2.00 | SHIFT | $9,862.64 | $19,725.27 | | CREW 2 |
| OFFSITE BREAKDOWN | 2.00 | SHIFT | $9,862.64 | $19,725.27 | | CREW 2 |
| PROJECT MANAGER | 38.00 | HOUR | $100.00 | $3,800.00 | | 25% OF CONST. TIME |
| **SUBTOTAL** | | | | | **$181,530.30** | |

| SUBCONTRACTORS | | | | | | |
|---|---|---|---|---|---|---|
| **SUBCONTRACTORS** | **QUANTITY** | **UNITS** | **UNIT $** | **EXTENDED $** | | **COMMENTS** |
| NONE | | | | | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0.00 | |

| GENERAL CONDITIONS, OVERHEAD & PROFIT | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $187,530.30 | |
| GENERAL CONDITIONS | | 10.00% | PERCENT | | $18,753.03 | |
| OVERHEAD | | 10.00% | PERCENT | | $20,628.33 | |
| PROFIT | | 10.00% | PERCENT | | $22,691.17 | |
| SALES TAX | | 0.00% | PERCENT | | $0.00 | |
| INFLATION | | 0.00% | PERCENT | | $0.00 | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$249,603.00** | |

**TIN BUILDING - MAIN BUILDING**
**DEMOLISH CONCRETE DECK, INSTALL CONCRETE ENCASEMENTS AND ENCASEMENT EXTENSIONS**

**OPINION OF PROBABLE COSTS**

| REPAIR | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 2775.00 | LF | $600 | $1,665,000 | | 222 TOTAL, 12.5' AVG |
| SCOUR ENCASEMENT | 27.00 | EA | $4,500 | $121,500 | | |
| DECK DEMOLITION | 18000.00 | SF | $30 | $540,000 | | 500 SF/DAY, $14K/DAY CREW |
| NEW 2-WAY DECK | 18000.00 | SF | $50 | $900,000 | | (PIER 35 USED $44/SF) |
| | | | | | | |
| **SUBTOTAL** | | | | | $3,226,500 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $3,226,500 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$3,226,500** | |

**WEST APRON**
**CONCRETE ENCASEMENTS AND ENCASEMENT EXTENSIONS**

**OPINION OF PROBABLE COSTS**

| MATERIALS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 650.00 | LF | $750 | $487,500 | | 52 TOTAL. 12.5' AVG |
| SCOUR ENCASEMENTS | 18.00 | EA | $4,500 | $81,000 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $568,500 | |

| LABOR & EQUIPMENT | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | SHIFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | SHFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | | | | | |
| PROJECT MANAGER | 0.00 | HOUR | $100 | $0 | | 25% OF CONST. TIME |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| SUBCONTRACTORS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $568,500 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$568,500** | |

**NEW MARKET BUILDING**
**CONCRETE ENCASEMENTS, ENCASEMENT EXTENSIONS**

**OPINION OF PROBABLE COSTS**

| MATERIALS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| CONCRETE ENCASEMENT | 800.00 | LF | $750 | $600,000 | | 64 TOTAL, 12.5' AVG |
| SCOUR ENCASEMENTS | 2.00 | EA | $4,500 | $9,000 | | 2 TOTAL, 3' AVG |
| FIREWALL REPLACEMENT | 525.00 | LF | $350 | $183,750 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $792,750 | |

| LABOR & EQUIPMENT | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | SHIFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | SHFT | | $0 | | |
| | | SHIFT | | $0 | | |
| | | | | | | |
| PROJECT MANAGER | 0.00 | HOUR | $100 | $0 | | 25% OF CONST. TIME |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| SUBCONTRACTORS | QUANTITY | UNITS | UNIT $ | EXTENDED $ | | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | $0 | | |
| | | | | | | |
| **SUBTOTAL** | | | | | $0 | |

| GENERAL CONDITIONS, OVERHEAD AND PROFIT, TOTAL OPC | | | | | | |
|---|---|---|---|---|---|---|
| SUBTOTAL PROJECT | | | | | $792,750 | |
| GENERAL CONDITIONS | | 0.00% | PERCENT | | $0 | |
| OVERHEAD | | 0.00% | PERCENT | | $0 | |
| PROFIT | | 0.00% | PERCENT | | $0 | |
| SALES TAX | | 0.00% | PERCENT | | $0 | |
| INFLATION | | 0.00% | PERCENT | | $0 | |
| | | | | | | |
| | | | | | | |
| **TOTAL OPC** | | | | | **$792,750** | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**

**CREW 1 - TOPSIDE DEMOLITION CREW**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | SUPERINTENDENT | 139.88 | 54.51 | 38.06 | 92.57 |
| | DOCKBUILDER FOREMAN | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| | OILER | 69.60 | 28.94 | 15.55 | 44.49 |
| **EQUIPMENT** | | | | | |
| | FORKLIFT | 50.00 | | | |
| | COMPRESSOR | 25.00 | | | |
| | WORK FLOATS | 15.00 | | | |
| | FORKLIFT | 50.00 | | | |
| | SAWCUTTER | 40.00 | | | |
| | WELD & TORCH | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | 25.00 | | | |
| TOTAL HOURLY RATE | | 1177.77 | | | |
| **TOTAL SHIFT RATE** | | 9422.20 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**

**CREW 2 - Marine Construction w/o Pile Driving**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | DOCKBUILDER FOREMAN | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| | OILER | 69.60 | 28.94 | 15.55 | 44.49 |
| **EQUIPMENT** | | | | | |
| | CRANE BARGE | 200.00 | | | |
| | SCOW / MATERIAL BARGE | 25.00 | | | |
| | TUG | 35.00 | | | |
| | WORK FLOATS | 5.00 | | | |
| | WELD & TORCH | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | 25.00 | | | |
| TOTAL HOURLY RATE | | 1232.83 | | | |
| **TOTAL SHIFT RATE** | | 9862.64 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**

**CREW 3 - UNDERWATER WORK**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | SUPERINTENDENT | 165.61 | 68.29 | 38.06 | 106.35 |
| | DOCKBUILDER FOREMAN | 160.51 | 65.56 | 38.06 | 103.62 |
| | DIVER | 140.10 | 54.63 | 38.06 | 92.69 |
| | DIVER | 140.10 | 54.63 | 38.06 | 92.69 |
| | TENDER | 111.24 | 39.18 | 38.06 | 77.24 |
| | TENDER | 111.24 | 39.18 | 38.06 | 77.24 |
| | OPERATOR | 129.10 | 55.25 | 25.90 | 81.15 |
| **EQUIPMENT** | | | | | |
| | SCOW / MATERIAL BARGE | 25.00 | | | |
| | SCOW / MATERIAL BARGE | 25.00 | | | |
| | COMPRESSOR | 17.75 | | | |
| | WELD & TORCH | 10.75 | | | |
| | DIVE STATION | 31.25 | | | |
| | CRANE BARGE | 200.00 | | | |
| | EXCAVATOR/ HOE RAM | 75.00 | | | |
| | MISC TOOLS & HOSES | 25.00 | | | |
| TOTAL HOURLY RATE | | 1367.64 | | | |
| **TOTAL SHIFT RATE** | | 10941.08 | BASED ON EIGHT (8) HOUR SHIFT | | |

**LABOR AND EQUIPMENT RATE BREAKDOWN**

**CREW 4 - MAINTENANCE CREW**

| | | FULL COST W / BURDEN | A DIRECT WAGES* | B FRINGES | A+B |
|---|---|---|---|---|---|
| **LABOR** | | | | | |
| | DOCKBUILDER FOREMAN | 135.81 | 52.33 | 38.06 | 90.39 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| | DOCKBUILDER | 119.51 | 43.61 | 38.06 | 81.67 |
| **EQUIPMENT** | | | | | |
| | WORK BOAT | 50.00 | | | |
| | WELD & TORCH | 10.75 | | | |
| | MISC MATERIALS & EQUIPMENT | 25.00 | | | |
| TOTAL HOURLY RATE | | 460.59 | | | |
| **TOTAL SHIFT RATE** | | 3684.68 | BASED ON EIGHT (8) HOUR SHIFT | | |

# APPENDIX D - REFERENCES

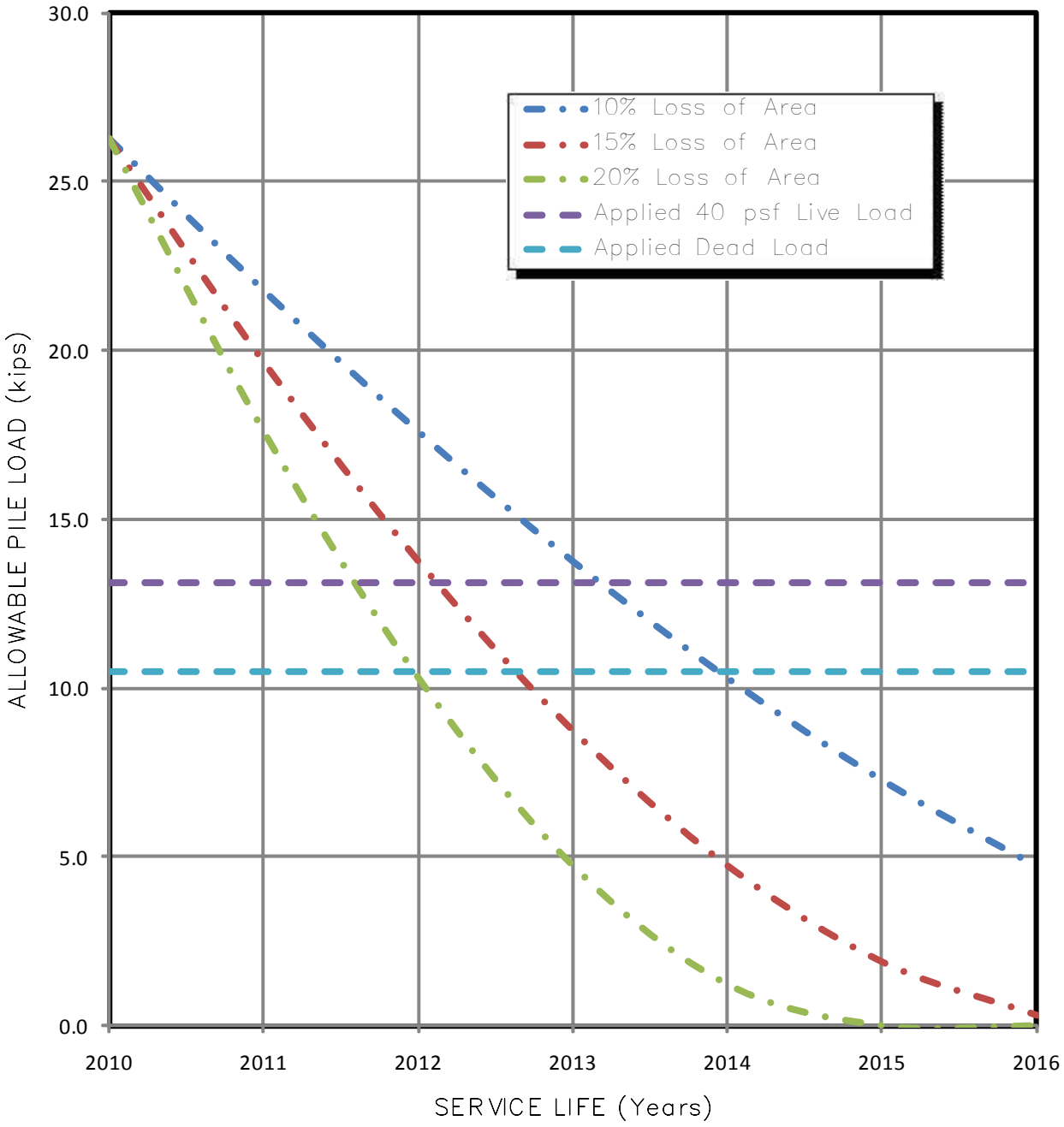
Waterfront Facilities Maintenance Management System, Inspection Guidelines Manual, Han- Padron Associates, October 1999.

Fulton Fish Market, Routine Inspection, Ocean and Coastal Consultants Engineering P.C., February 2007 (Inspection Report and Notes).

Fulton Fish Market, Routine Inspection, M.G. McLaren, P.C., February 2002 (Inspection Report and Notes).

Fulton Fish Market, New York, New York, Substructure Repairs – Phase One, M.G. McLaren, P.C., June 6, 2003 (100% Submission Drawings).

# APPENDIX E - FIELD NOTES




NEW YORK CITY
ECONOMIC DEVELOPMENT CORPORATION
FULTON FISH MARKET, MANHATTAN, NY

TIN BUILDING
PILE CAPACITY GRAPH



FIG. 3–8

P:\2009\OCC_209093.0\3_Project_Files\CAD\Task2C – Fulton Fish Market\3_8.dwg Figure 3–8 Rey T. Buzeta Thu, 19 Aug 2010 – 3:37pm