PIER 5
PRELIMINARY STUDY

Prepared for:
Pier 5 Association

Prepared by:
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1. History

Pier 5 is one of many remaining piers that used to comprise the Charlestown Navy Yard, which has undergone many transformations both during its operational period and on to present day. According to historical records a wooden pier, designated Pier 4A originally built prior to the 1920's, used to occupy the site. As part of the Navy Yard's first wartime improvement in the early 1940's, the existing pier was replaced to accommodate considerable shipbuilding work. The rebuilt Pier 5 was enlarged to accommodate two high portal cranes to service ships on both sides of the pier and was constructed with steel H-piles and a concrete deck.

Figure 1- Original Pier 4A During Construction

Due to the lack of original drawings and the inability to directly observe the pier, the following description is taken from the BRA's (now BPDA) evaluation dated May 9, 2000:

> *"The pier is approximately 655' long by 125' wide and consists of a concrete superstructure supported on concrete encased steel H-piles. The superstructure is comprised of an 8" thick concrete deck slab supported on integral stringers varying in depth from 24 to 48 inches. The concrete pile caps are 48 inches deep and the pile bent spacings vary from 6 feet below the railroad and crane tracks to 12 feet elsewhere."*

Figure 2- Pier 5 during construction

The pier seems to have remained operational until 1974 upon the Navy Yard's closure.

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2. Current Condition

It appears that the pier remained abandoned after the Yard's closure until the first of several periodic inspections by Childs Engineering Corporation in 1987. That report noted substantial deterioration of the protective concrete pile encasement and of the welds around the exposed pile splices. Corrosion of the steel piles was also noted, while the concrete deck and pile caps were generally noted to be in good condition.

Predictably, the lack of maintenance through the years led to progressively worse deterioration in all pier elements as noted in subsequent reports from 2000 prepared by Fay, Spofford and Thorndike, and from 2004 and 2017, performed by Childs Engineering Corporation. The most recent report notes that the full loss of weld at pile splices and severe metal loss at portions of the piles have greatly reduced, if not fully reduced, the capacity of some piles. Furthermore, it has been noted that corrosion of the reinforcing steel within the concrete deck and pile caps has begun to accelerate causing substantial concrete spalling on the underside of the pier.

Figure 3-Corrosion and Spalling at Underside of Pier (Courtesy of Childs Report)

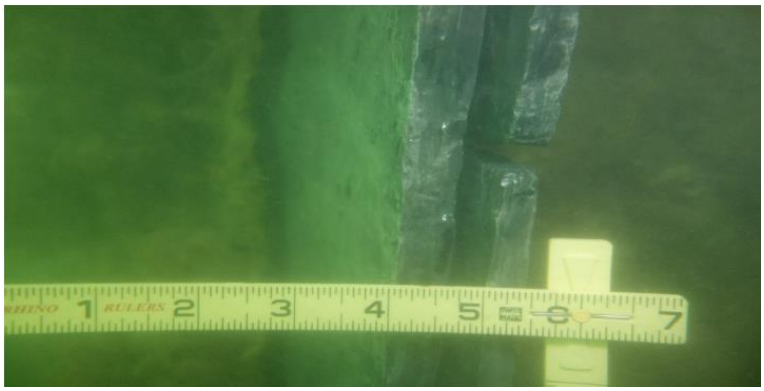

Figure 4-Deterioration at Pile Splice (Courtesy of Childs Report)

Without access to conduct a thorough investigation of the current conditions, it is assumed that conditions have only worsened. Continued deterioration of the piles would likely reduce their expected capacity to almost nothing. Continued corrosion of the pier reinforcing will cause

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further degradation of the concrete, and while there may have been some reserve capacity due to the original design loading for the pier, some level of remediation would likely be required to replace or repair the deck and to mitigate further degradation.

3. Original Structural Capacity Assessment

Without the original design drawings for the pier, some assumptions regarding the original design capacity will need to be made. The following information has been collected from various sources made available:

Original Pile Size and Capacity:	HP14x102 – 60 Ton Capacity
Original deck capacity:	~350 to 400 psf live load
Portal Crane:	28 Ton Crane weighing approx. 60 tons
Pile Caps:	48" Deep x 36" (assumed) Wide
Slab Thickness:	8" Deep

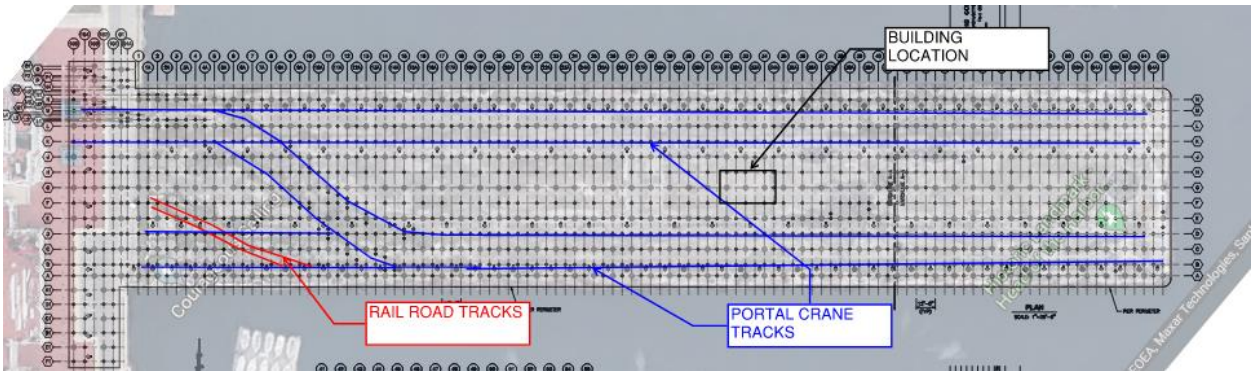

Figure 5-Pier Diagram (Layout taken from Child's Report)

Based on the information listed above, we have calculated the self-weight of the pier structure (slab and pile caps) to be approximately 255 pounds per square foot. Given the assumed original live load and the indicated pile spacing, the estimated original design loading on each pile was approximately 40 Tons, which is validated by the pile capacity indicated above. These capacities are further validated by considering the additional weight of the portal cranes in comparison to the more closely spaced piles supporting the existing tracks.

4. Planning Considerations

While the current state of the pier renders it unsafe for any activity without further investigation/verification, the potential reuse of the pier should be evaluated relative to the proposed use and loading. Anticipated loads from a public occupancy such as a park would certainly be within the original design capacities of the pier elements and would offer flexibility on the scope/extent of remediation required as opposed to other uses which would require the pier to be restored to its previous full design capacity. Based on our experience, loads for various elements of a landscaped park are as follows:

Live Load:

Public Occupancy:	100 psf (Requirements for emergency vehicle access if any should be verified with code consultant)

Superimposed Dead Load

Topping Slab for Drainage:	75 psf (3" at Low Point, 9" at High Point assumed)
Pavers:	50 psf
Soil for grass/light plantings:	175 psf (18" of 115 pcf plating soil)
Tree planters:	600 psf (36" of planting soil with trees)
Support Spaces:	100 psf (assume 1 story light framed construction)

5. Possible Remediation Strategies

In order to safely repurpose the existing pier structure, the concrete deck and the piles both need to be addressed. Potential strategies for both are as follows:

Concrete Deck
Per previous reports, various asphalt patches and steel cover plates have been used as patchwork surface remediations throughout the years. All coverings would need to be removed down to the original concrete which would need to be inspected for any significant corrosion or spalling that would reduce the load carrying capacity. Locations of sever degradation would require removal of existing concrete to sound substrate, prepping and/or replacing corroded reinforcing and patching the area.

It is assumed that the underside of the deck has seen substantially more corrosion and thus may require substantially more repairs to the point that full depth replacement may be a more viable and cost-effective solution. An elevated walkway that is independently supported by the pile caps currently spaced at 6' to 12' o/c would provide an alternate solution to repairing the deck.

The pile caps would need to be similarly inspected for degradation. Depending on the final design loading, the full capacity may not be required, and repairs may be limited to maintaining the remaining integrity as opposed to restoring the full design capacity.

Piles
As discussed earlier, it is assumed that the capacity of the existing piles is approaching a level that cannot safely support additional load. Piles needing to be replaced will need to have the splices re-welded and any sections with significant section loss will need to be repaired. After the steel pile is adequately repaired, the pile should be encased in concrete for future protection. Similar to the pile caps, it may be feasible to only have to repair every other pile in a given area depending on the final design loading. For example, at the typical areas of the pier (not at the existing tracks) it is likely feasible to only repair every other pile along the transverse sections. Likewise heavier loads such as planters could likely be accommodated where the tracks were located by only having to repair every other pile. Necessary investigations would need to verify the ability of the pile caps to span the additional distance between supporting piles as a result.

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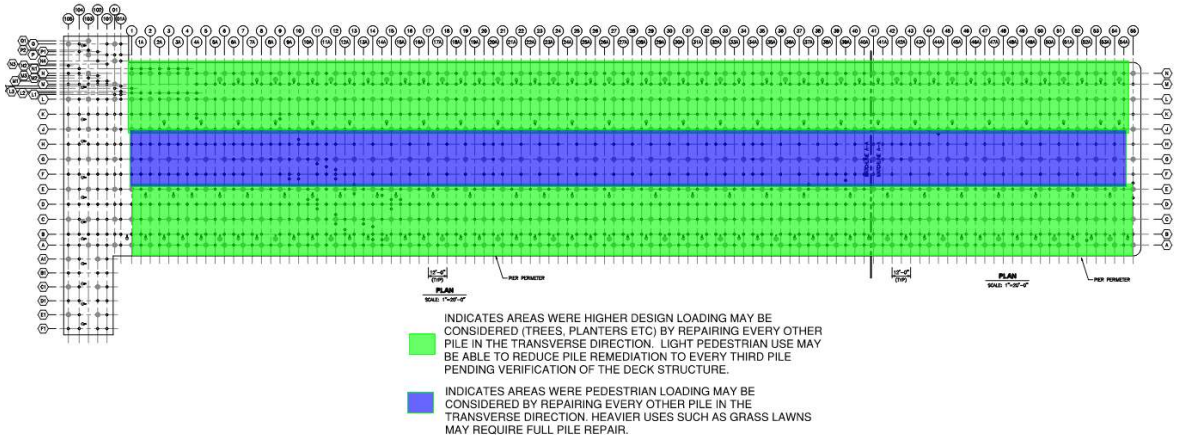

Figure 6-Representative Pile Repair Diagram (Pier Layout taken from Childs Report)