Marine Services Center Bulkhead Condition Assessment

Prepared for:
The City & Borough of Sitka
Department of Public Works
100 Lincoln Street
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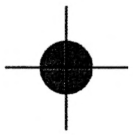
October 2011 Update

MARINE SERVICES CENTER BULKHEAD CONDITION ASSESSMENT

TABLE OF CONTENTS

P | N | D



Section 1

Inspection Report and Recommendations

P | N | D

P | N | D

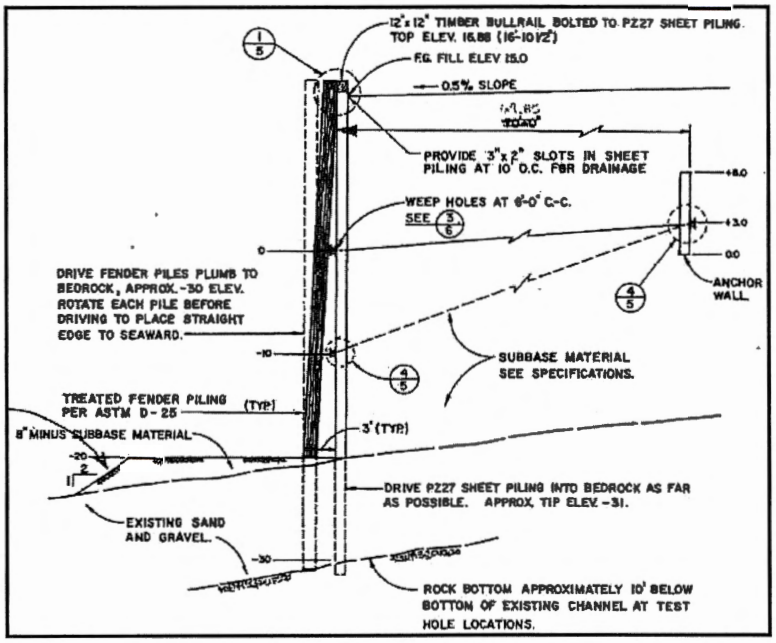
ENGINEERS, INC.

INTRODUCTION

The following report is a summary of the inspection and condition assessment performed in April, 2011, by PND Engineers, Inc. (PND) and Echelon Engineering, Inc. (EEI), for the Sitka Marine Services Center Bulkhead Dock. EEI performed the underwater portion of the inspection and condition assessment. The purpose of this report is to provide the City and Borough of Sitka (CBS) with a general overview of the current condition of the facility, and to identify specific areas and components of the facility that need repair and/or replacement in order to maintain a safe, structurally competent facility. The report includes a discussion of the findings, along with recommendations. However, specific designs for repair and/or replacement are not included.

BACKGROUND

The Marine Services Center sheet pile bulkhead dock was originally constructed in 1976. The tie-back wall structure is approximately 36-ft high (from mudline) by 356-ft long along the face, with approximately 10-ft long end/return walls at each end of the bulkhead. The PZ27 sheet piles are driven approximately 10-ft to underlying bedrock, and are laterally restrained by exterior, MC8x22.8 walers located at elevations 0.0 ft (MLLW) and -10.0 ft. Each waler is connected via tie-rods to a sheet pile anchor wall approximately 70-ft behind the bulkhead face. The steel, round bar tie-rods are 2 ½-inch diameter, with ends upset to 3 ¼-inch diameter. They are spaced at 6-ft on-center, with the upper tie-rods being offset from the lower tie-rods by 3-ft. The walers and tie-rods are of ASTM A36 chemistry while the sheet piles are of ASTM A690 material. Creosote-treated timber fender piles protect the face of the bulkhead and a 12x12 timber bullrail caps the top of the wall. Steel pipe bollards and access ladders are positioned at varied spacing along the dock face.



(Figure 1 – Typical bulkhead wall section)

In 1990, the CBS contracted for the design and construction of a 140-ft wide by 150-ft long cold storage building that is positioned approximately 30-ft behind the face of the bulkhead.

In 1993, the CBS contracted with WS Construction Inc. to install 22 anodes along the face of the bulkhead and perform associated electrical bonding work.

In November of 1999, the CBS engaged Tryck Nyman Hayes, Inc. (TNH) to perform an inspection and condition assessment of the facility which did not include an underwater inspection. Shortly thereafter, in April of 2000, Foreshore Technologies, Inc. (FTI) performed a dive inspection. Potential readings were taken during the underwater inspection which indicated that the structure was actively corroding. Both the TNH and FTI reports noted significant corrosion existed throughout the bulkhead face sheet piles as well as at the walers and tie-rod ends.

In 2002, in response to the TNH and FTI inspections, the CBS again contracted with WS Construction Inc. to install an additional 36 anodes along the face of the bulkhead, and in 2003, the CBS retained the local

engineering company, Structural Solutions to design a complete cathodic protection system for the facility. The designed CP system was installed in 2004. Included in the construction documents were the requirements to provide electrical bonding and continuity between all steel bulkhead face elements. All tie-rod locations were required to be videotaped, and continuity was to be verified at each tie-rod location using a reference electrode.

INSPECTION

Prior to field investigations, all available design documents and previous inspection reports were collected and reviewed. For inspection purposes, a base map was developed, using the timber fender piles as a reference to locations along the face of the bulkhead. (See Appendix B of the Echelon Engineering, Inc. Dive Inspection Report).

The inspection and condition assessment field work was carried out in two parts. The dive inspection was performed by EEI during the period of April 18th – 21st, 2011, while the top-side dock and subsurface anchor wall inspections were performed by PND, with the assistance of CBS personnel and equipment, on April 18th and 19th, 2011.

The dive inspection consisted of a three day field effort to effectively examine the bulkhead sheet piles, walers, tie-rods and timber fender system. Observations made during the initial portion of the dive inspection served to identify specific areas to target for the remainder of the inspection effort - areas that had advanced deterioration/damage or exhibited a trend. Section 3 provides a complete description of the underwater portion of the condition assessment.

PND performed an above-water, "Level 1" (visual) inspection of representative dock elements and bulkhead structural components. Access along the face of the bulkhead was accomplished through the use of a CBS harbor department skiff. The facility was examined for obvious physical damage, corrosion and any other evidence of deterioration, with particular attention being given to the condition of the walers and tie-rods. In addition, CBS retained a local contractor to excavate the area adjacent to and seaward of the sheet pile anchor wall at two different locations. The anchor wall waler and a tie-rod end were also exposed at one of the locations. PND inspected exposed portions of the anchor wall, waler and tie-rods.

Observations:

In general, the current overall condition of the sheet pile bulkhead dock is fair to poor. No observations were made that presented any immediate structural concerns. However, the facility is approximately 35 years old and very near the end of its useful design life. Time and the elements have taken their toll, and the current condition of key structural components represents the chief concern with regard to the overall integrity of the bulkhead. The following conditions were observed:

Fender System and Miscellaneous:

- Timber Fender Piles and Chocking – With a few exceptions, the overall condition of the timber fender system is good. The 1999 TNH Report identified several rotten fender piles and many instances of broken or otherwise damaged chocking between the fender piles. Since that time, the majority of the fender system appears to have been repaired and/or replaced. Most of the fender piles are very dark in color indicating a high amount of creosote treatment still exists, and several of the fender piles have had galvanized sheet metal caps installed to protect the pile tops from deterioration. The last four fender piles at the "south end" (adjacent to the SPC Dock) look to be of earlier origin, exhibiting substantial deterioration, including marine borer damage, and should be replaced.

- Miscellaneous – The overall condition of the timber bullrail is good with only minor abrasions and normal wear and tear observed. The steel pipe bollards are in good condition and structurally sound. Two of the six access ladders (near SPC Dock) are damaged significantly with the handrails having been bent over as the result of vessel impact. All other access ladders were observed to have minor to moderate corrosion and minor physical damage.

Sheet Pile Bulkhead:

- Sheet Piles – The overall condition of the steel sheet piles is fair to poor, with particularly significant deterioration in the splash zone. The steel thickness is this region was measured to be as low as 0.17 inches as compared to the original thickness of 0.375 inches. The low thickness measurements in the splash zone are consistent along the full length of the bulkhead.

- Walers and Tie-Rods – The overall condition of the walers and tie-rods is generally poor. Corrosive section loss exists primarily along the channel flanges of both the upper and lower walers and at virtually all tie-rod ends. The corners and edges of all tie-rod nuts, washer plates and bearing plates are rounded and in many instances, the plate edges have a scalloped shape due to the severity of corrosion and loss of steel material. The tie-rod ends that extend beyond the nut are conical shaped, with essentially no visible threads remaining. At the tie-rod/nut interface, there is evidence that some threads remain engaged with the nut, but visible crevice corrosion observed at the majority of tie-rod/nut locations suggests these critical connections are quickly approaching the point of no longer being adequate to resist the loads they were designed for.

- Cathodic Protection – Potential readings obtained indicate the cathodic protection system installed in 2004 is working to protect the bulkhead; however, the readings are at or near the minimum required to be effective and likely not high enough to successfully prevent the crevice corrosion observed. Also, as discussed in the dive inspection report, although the potential readings suggest the anodes are working to protect the bulkhead, calcium carbonate deposits indicative of effective cathodic protection were not observed. Remaining anode material was observed to be between 75 and 90% of the original volume.

- Anchor Wall – The overall condition of those portions of anchor wall sheet piles exposed during the inspection appears to be fair. Though buried, the anchor wall is exposed to seawater during high tide. Sheet pile thickness measurements were not taken, however the corrosion observed appeared to be limited to minor pitting. Significant pitting of the tie-rod nut and bearing washer plate was observed. The waler channel flanges were observed to be scalloped-shaped, similar to the exterior bulkhead face walers, but the material loss due to corrosion was not as extensive as observed on the exterior walers. The portion of tie-rod exposed exhibited only minor pitting.

DISCUSSION AND RECOMMENDATIONS

The Marine Services Center is approximately 35 years old and is quickly approaching the end of its useful design life. As discussed in previous inspection reports, although sacrificial anodes were installed on different occasions, the number of anodes installed was never adequate to provide enough protection to the bulkhead and it continued to freely corrode. A complete and adequate cathodic protection system was never designed and installed until 2004; twenty-eight years after original construction. By then, substantial damage due to corrosion had already occurred. In fact, in the time between the 1999 TNH inspection and 2004, when the condition of all tie-rods was documented on videotape, the amount of corrosion and steel material loss, particularly the loss of tie-rod threads, was considerably noticeable. While the installation in 2004 of a cathodic protection system appears to have significantly slowed the rate of corrosion, the extent of damage that currently exists is significant enough to question whether or not the bulkhead is capable of withstanding a seismic event or the 600 psf uniform live load surcharge it was originally design to resist.

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Conservatively, it is estimated that the existing structure has a remaining life of 5 years. While it is conceivable that the cathodic protection system could contribute to extending the remaining life, the anodes have been in service for 7 years and will provide a decreasing level of protection as the anode material is consumed. In addition, the anodes only provide protection in the submerged portion of the bulkhead and do not address the section loss of the sheet piles in the splash zone.

Therefore, it is recommended that the CBS begin now the process to examine replacement options and the associated costs in an effort to secure adequate funds for design and construction before the tie-rod connections are no longer capable of resisting the existing soil pressures and structural failure of the bulkhead occurs.

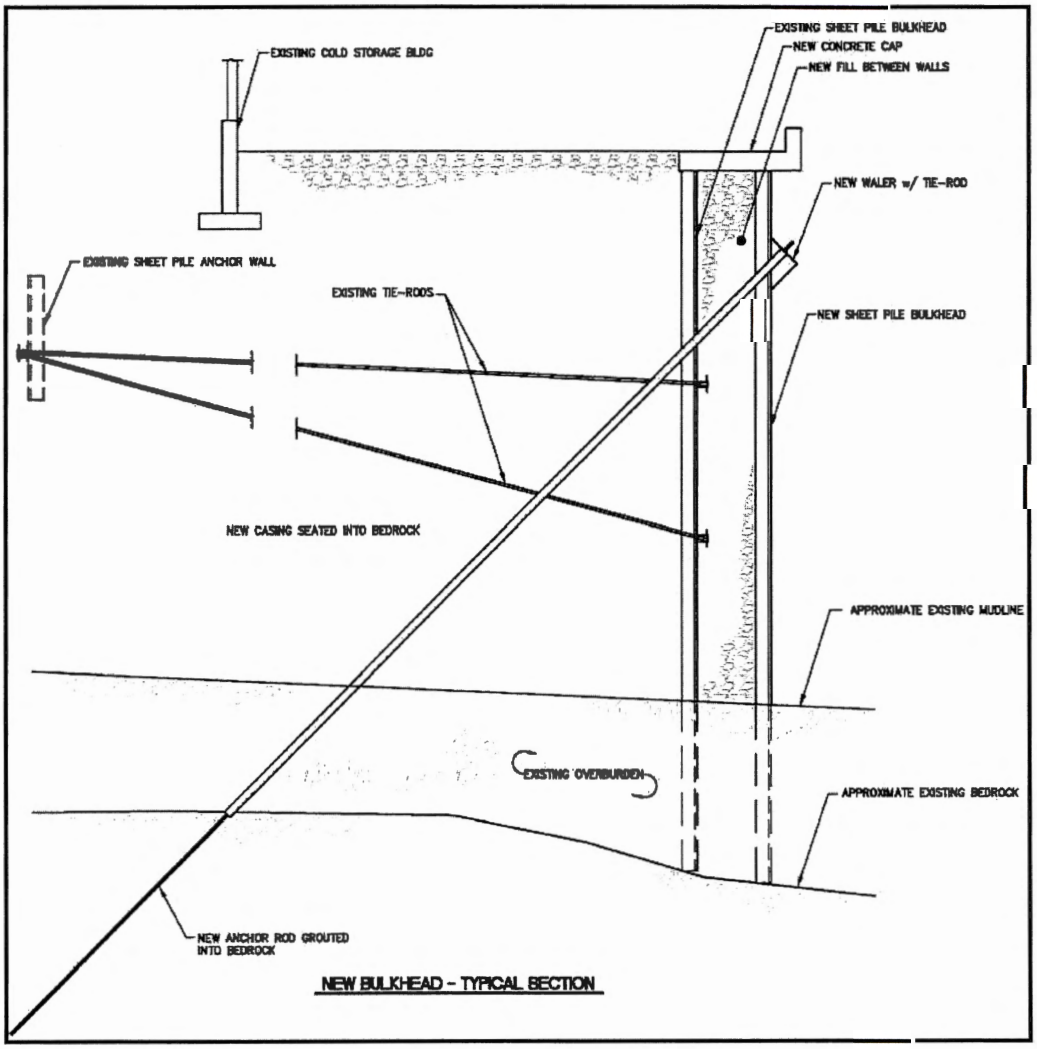
Replacement Options:

Replacement options to consider will depend on the long-range plans CBS might have for the site. Due to the proximity of the existing CBS Cold Storage Building, demolition and an in-kind replacement of the existing bulkhead is not feasible.

- If a dock face is no longer deemed necessary, then placement of an armor-rocked fill slope in front of the existing bulkhead might be a cost-effective option. If, on the other hand, maintaining a dock is regarded as essential for the site, then a pile supported dock or another similar designed sheet pile bulkhead could be constructed along with the armor-rocked fill slope. Given the existing site conditions and geometry, however, the toe of a fill slope would extend a minimum of 50 feet seaward of the existing bulkhead, and would also extend a significant distance perpendicular to the face of the bulkhead, and under the adjacent, private dock. In addition, the toe of the fill slope would also be very near the edge of the established navigational channel. A pile supported dock or sheet pile bulkhead built off a fill slope would extend well beyond the existing pier head alignment of adjacent facilities, and would likely encroach upon the navigational channel. The degree of discontinuity created by the new layout and alignment would have an adverse effect on vessel traffic in the channel and at the adjacent docks. Consequently, these options would likely be problematic and may not be considered practicable solutions.

- Alternatively, a viable option would be to construct a new, similar bulkhead design located slightly seaward of the existing bulkhead, utilizing grouted anchor rods drilled through the existing fill material and into the underlying bedrock (See Figure 2 below). Though relatively small, the revised pier head alignment would require coordination with adjacent property owners to resolve any potential navigational issues. Two rough-order-magnitude cost estimates for this option are attached. One estimate provides costs for basic facility improvements to replace the facility with similar

materials and the other provides costs for an upgraded facility with superior materials and improved cathodic protection systems.



(Figure 2 – Typical replacement bulkhead wall section)

SITKA MARINE SERVICES CENTER BULKHEAD REPLACEMENT

ROM Cost Estimate - Basic Improvements

Prepared By: PND Engineers, Inc., July 2011

Item	Item Description	Units	Quantity	Unit Cost	Amount
1	Mobilization	LS	All Reqd	$374,800	$374,800
2	Demolition and Disposal	LS	All Reqd	$200,000	$200,000
3	New Sheet Pile Face Wall	LF	360	$3,000	$1,080,000
4	New Sheet Pile End Walls	LF	40	$3,200	$128,000
5	New Drilled, Grouted Tie-Rod Anchors	EA	45	$30,000	$1,350,000
6	New Waler Assembly	LF	400	$500	$200,000
7	Shot Rock Fill	EA	5000	$50	$250,000
8	New C.I.P. Concrete Bulkhead Cap	LF	400	$600	$240,000
9	New CP System (Anodes)	LS	All Reqd	$100,000	$100,000
10	New Timber Fender System	LS	All Reqd	$400,000	$400,000
	ESTIMATED CONSTRUCTION BID PRICE				**$4,322,800**
	CONTINGENCY (20%)				**$864,560**
	ENVIRONMENTAL PERMITTING, FINAL DESIGN, CONTRACT ADMINISTRATION, CONSTRUCTION INSPECTION & OTHER INDIRECT COSTS (20%)				**$864,560**
	5 YEAR INFLATION (15%)				**$648,420**
	TOTAL RECOMMENDED PROJECT BUDGET				**$6,700,340**

SITKA MARINE SERVICES CENTER BULKHEAD REPLACEMENT

ROM Budget Estimate - Upgraded Facility with Improved Cathodic Protection

Prepared By: PND Engineers, Inc., September 19, 2011

Item	Item Description	Units	Quantity	Unit Cost	Amount
1	Mobilization	LS	All Reqd	$515,500	$515,500
2	Demolition and Disposal	LS	All Reqd	$200,000	$200,000
3	Sheet Pile Face Wall, Galvanized	LF	360	$3,300	$1,188,000
4	Sheet Pile End Walls, Galvanized	LF	40	$3,500	$140,000
5	Drilled & Grouted Tie-Rod Anchors	EA	45	$40,000	$1,800,000
6	Steel Waler Assembly, Galvanized	LF	400	$600	$240,000
7	Shot Rock Fill, Vibrocompacted	CY	5,000	$60	$300,000
8	Drainage Improvements	LS	All Reqd	$75,000	$75,000
9	C.I.P. Concrete Bulkhead Cap	LF	400	$1,000	$400,000
10	Cathodic Protection System (Anodes)	LS	All Reqd	$100,000	$100,000
11	Energy Absorbing Fender System	LF	360	$1,700	$612,000
12	Area Lighting	LS	All Reqd	$100,000	$100,000
	ESTIMATED CONSTRUCTION BID PRICE				**$5,670,500**
	CONTINGENCY (20%)				**$1,134,100**
	ENVIRONMENTAL PERMITTING, FINAL DESIGN, CONTRACT ADMINISTRATION, CONSTRUCTION INSPECTION & OTHER INDIRECT COSTS (20%)				**$1,134,100**
	2 YEAR INFLATION (6%)				**$340,230**
	TOTAL RECOMMENDED PROJECT BUDGET				**$8,278,930**