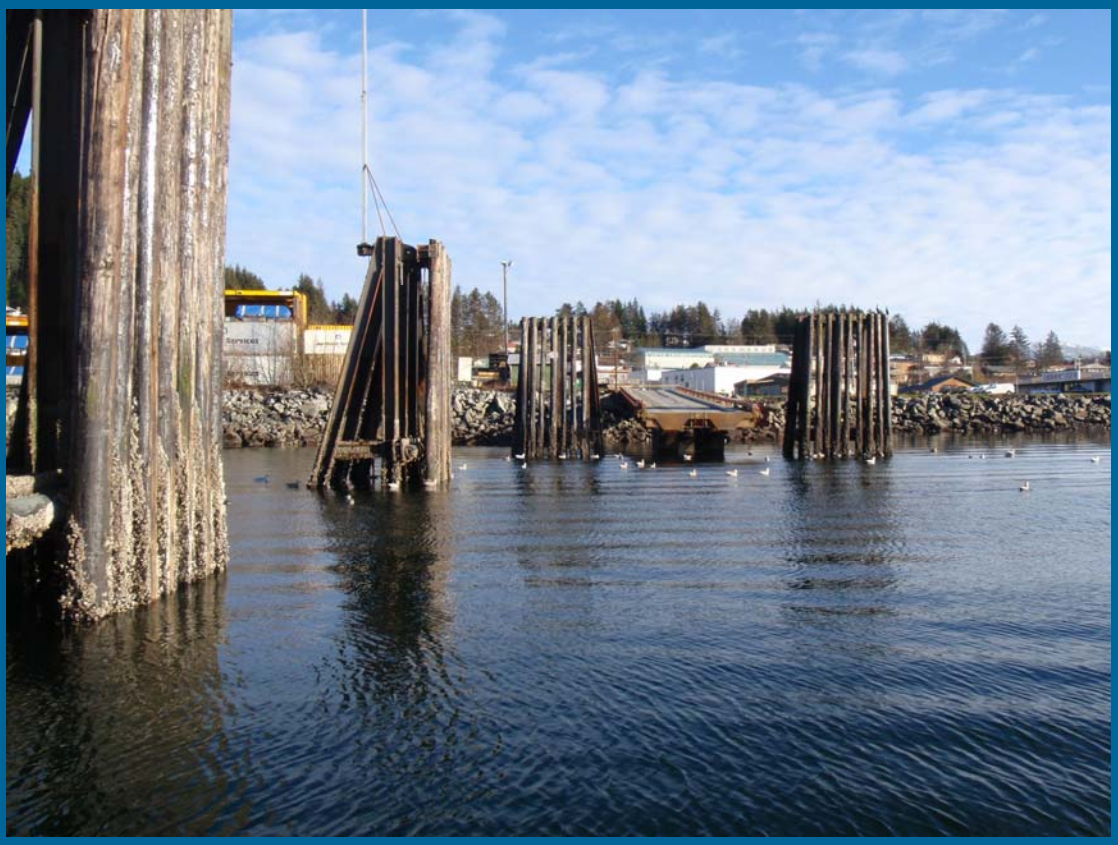
WRANGELL BARGE RAMP CONDITION ASSESSMENT



Prepared for:
City and Borough of Wrangell
Department of Public Works & Capital Projects
P.O. Box 531
Wrangell, Alaska 99929

Prepared by:

March 2011

WRANGELL BARGE RAMP CONDITION ASSESSMENT

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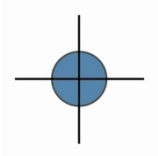


Section 1

Inspection Report

P | N | D

P | N | D
ENGINEERS, INC.

March 11, 2011 PND 102077.01

Ms. Amber Al-Haddad
Project Manager
City and Borough of Wrangell
P.O. Box 531
Wrangell, Alaska 99929

Re: Wrangell Barge Ramp Condition Assessment

Dear Ms. Haddad:

The following report is a summary of the recent condition assessment performed by PND Engineers, Inc. (PND) for the Wrangell Barge Ramp. PND was assisted by Echelon Engineering, who performed the underwater portion of the condition assessment, and by Tinnea and Associates, who performed a corrosion inspection of the facility. The purpose of this report is to provide the City and Borough of Wrangell (CBW) with a general overview of the current condition of the Barge Ramp facility, and to identify specific areas and components of the facility that need repair and/or replacement. The report provides recommendations to address the conditions noted, and includes discussions of the life-expectancy and cost feasibility associated with potential maintenance options.

OVERVIEW

The Wrangell Barge Ramp facility was originally constructed in the late 1970's and consisted of a 17-ft wide by 140-ft long steel transfer bridge with six, multi-pile breasting dolphins. The bridge was designed with a 9-ft diameter submerged steel tank supporting the bridge's seaward end. The design allows the seaward end of the bridge to be raised or lowered by adding or removing air, respectively, within the tank.

In the early 1980's, when major repair and expansion work was being done on the Wrangell City Dock, significant modifications were also completed on the barge ramp facility. All six original pipe-pile framed breasting dolphins were replaced with five, H-pile framed breasting dolphins and an earth-filled, circular sheet-pile mooring/breasting dolphin. The circular sheet-pile dolphin is positioned such that it is utilized both by barges at the barge ramp facility as well as vessels staged at the adjacent City Dock. The H-pile framed dolphins absorb vessel berthing energy through the use of a timber fender pile/rubber fender block system connected to the dolphin structure with stay chains. The circular sheet-pile dolphin absorbs energy through the use of multiple cylindrical rubber fenders suspended with chains on the exterior face of the steel sheet-piles. Though not shown on the 1981 *Barge Facility Modifications* drawings, it is assumed that this is also about the time frame in which a second, smaller submerged support tank, 7-ft in diameter, was installed shoreward and adjacent to the original support tank.

In the early 1990's, the steel transfer bridge coatings had deteriorated enough to warrant the City of Wrangell to hire a local contractor to repaint the bridge, in-place.

INSPECTION

Prior to field investigations, all available design documents and related construction records were collected and reviewed. A base map was then developed to identify specific elements of the facility (see Section 2 - Barge Facility Plan).

The condition assessment field work was carried out in two parts. The dive inspection was performed by PND's sub-consultant, Echelon Engineering, on October 22, 2010, while the corrosion and overall facility inspections were performed by Tinnea and Associates, and PND on November 10, 2010.

The dive inspection examined all 33 steel dolphin H-piles and both submerged cylindrical steel bridge support tanks. See Section 4 of this report for a complete description of the underwater portion of the condition assessment.

PND and its sub-consultant, Tinnea and Associates performed an above-water, "Level 1" (visual) inspection of all major structural components. Access beneath the transfer bridge and at each dolphin location was accomplished through the use of a boat. The facility was examined for obvious mechanical damage, corrosion and any other evidence of deterioration, with particular attention being given to the condition of the dolphin structure piles and the transfer bridge's protective coatings. Approximately 30% of the dolphin structure piles had a "Level 3" inspection performed (portions of the marine growth removed in the intertidal zone to facilitate examination), and ultrasonic thickness readings were taken, to assess the amount of original steel material remaining. See Section 5 of this report for Tinnea and Associates' corrosion assessment report.

Observations:

In general, the current overall condition of the facility is fair. None of the observations made presented any immediate structural concerns. However, the facility is over 30 years old and time, the elements, and the inherent nature of barge operations have all taken their toll. With the exception of steel components in the intertidal zone, the protective coating system for the facility's structural steel is fair in some instances, but mostly it is in poor condition. The dolphins exhibit evidence of being repeatedly hit hard by barges using the facility. Virtually all stay chains connecting the timber fender pile/rubber fender block system to the dolphin structure are broken and/or missing. Some timber fender piles are displaced, and in some instances, the entire dolphin structure itself has been permanently displaced.

The following specific conditions were observed:

Transfer Bridge:

- Abutment - The steel bridge bearing assemblies are still structurally adequate; however, the protective paint coating is in poor condition. The north bearing assembly has significant mechanical wear such that the bridge sets approximately an inch lower on the north side. Minor erosion exists along the base of the concrete abutment's front face.
- Transfer Bridge Superstructure - While the overall condition of the bridge is good, with no immediate structural concerns, the condition of the bridge's protective paint coating is poor, particularly on the underside of the main box-girders where a significant amount of surface corrosion exists.
- Support Tanks - Both support tanks are generally in good condition and have an estimated 75-90% of their protective epoxy coating remaining. The 48-inch diameter steel pipe struts which connect the support tanks to the bridge are structurally sound with minimal section loss due to corrosion, but the protective epoxy coating is in poor condition, with an estimated 50% remaining. The bolted connections with which the pipe struts are attached to the bridge are in poor condition. The

protective paint coatings have failed and a significant amount of corrosion exists on the bolts and the connection plates.

Breasting Dolphins:

- Structural Piles – All steel H-piles are structurally sound with minimal section loss due to corrosion, but the protective epoxy coating is deteriorating, particularly in the splash zone, where it is estimated that 50-75% remains. Coating from the intertidal zone to mudline is in fair condition, with an estimated 75-90% remaining.
- Dolphins B and C - Virtually all fender stay chains (and associated connection hardware) are broken and/or missing.
- Dolphin D - All timber fender piles are displaced and leaning shoreward. Virtually all fender stay chains (and associated connection hardware) are broken and/or missing.
- Dolphin F – South side of dolphin structure is displaced and leaning shoreward. Two timber fender piles and the timber chocks between them are broken. Virtually all fender stay chains (and associated connection hardware) are broken and/or missing.

Recommendations:

For marine facilities, a key factor in determining how long they will remain in service is the maintenance of protective coatings. Virtually all steel components for this facility have either reached or are close to reaching the end of their design life, and are no longer effectively performing their intended purpose. Without an intact, competent coating system, the chief concern is steel section loss due to corrosion. Section loss translates to reduced structural capacity, and eventually, structural failure. Fortunately, minimal or no section loss has occurred thus far, but the future of Wrangell's Barge Ramp Facility is at a critical juncture. On one hand, a decision to maintain the facility and extend its useful life would require prompt action and substantial funds to perform the repairs, coating restoration and cathodic protection necessary to preserve its structural integrity. On the other hand, the facility likely has another 10-15 years of useful life remaining before reaching a point where it will have degraded enough that it may no longer be considered safe to use.

If the decision is made that this facility needs to remain in its current location and be maintained as best as possible for future use, then the transfer bridge, the support tank struts and all dolphin structure piles (portions above the intertidal zone) would require field removal (over water and between tide cycles) of the existing, deteriorated coatings and installation of new protective coatings. The intertidal portion of the dolphin structure piles and the bridge support tanks would require the installation of sacrificial anodes to effectively slow down the rate of corrosion below water. In addition, the steel abutment bearing assemblies would need to be replaced with new, and the bolted connection assemblies between the bridge and the support tank struts would need to be repaired. Also, broken dolphin timber fender piles would need to be replaced, as well as all stay chains and associated connection hardware in order for the design to function as originally intended. It is PND's belief, however, that the existing dolphin fender system, as originally designed with stay chains resisting the lateral loads imposed by fully loaded cargo barges, is not adequate and will continue to be a maintenance problem. Design modifications to the existing fender system could be made to better resist lateral loads and hence, reduce future maintenance costs. It is estimated that the repair and restoration work recommended would effectively extend the useful life of this facility an estimated 15-20 years.

Another possible option might be to perform repair and/or replacement work in phases. For example, the transfer bridge could have new coatings applied as one task, and the dolphins could be systematically replaced over time. This might be more economically feasible, and would reduce the amount of time the facility would be out of service while repair/replacement work was being performed.

If the decision is made that it is not economically feasible or cost effective to perform the necessary repairs to a facility that is already over 30 years old, the facility still has an estimated 10-15 years of useful life remaining before the protective coatings deteriorate to the point were significant section loss could occur to the structural steel elements. Many variable factors would determine how quickly these events would transpire. Regular inspections should be conducted to monitor the rate of deterioration and evaluate the structural integrity of the facility.

CONCLUSION

The barge facility is crucial to the community of Wrangell. The current condition of the facility is such that major decisions need to be made as to when and how repairs and/or replacement of the facility components will be accomplished.

PND appreciates the opportunity we have had to assist you with this work, and we trust this information serves to provide the information necessary to decide a course of action for ensuring Wrangell has a safe, functional barge facility well into the future. Should you have any questions, please feel free to contact us.

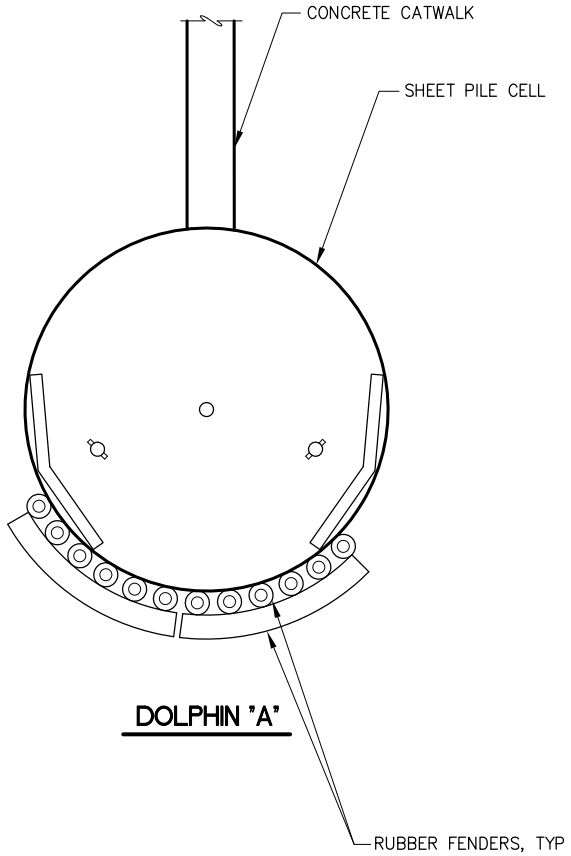
Sincerely,
PND Engineers, Inc. | Juneau Office

John L. DeMuth, P.E.
Senior Engineer

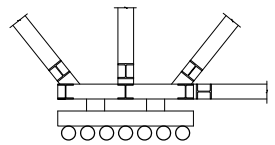
Attachments

Section 2

Barge Facility Plan



DOLPHIN "A"



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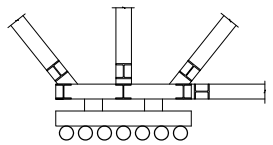

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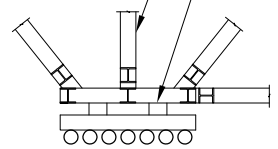

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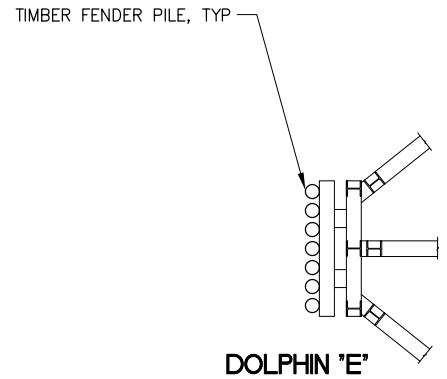

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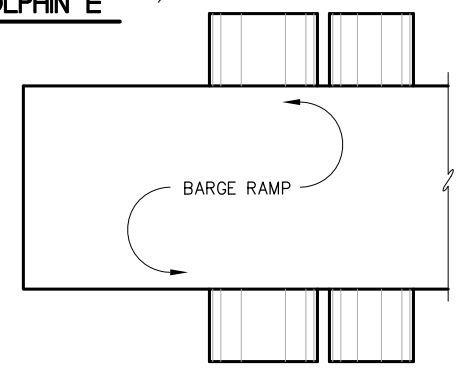
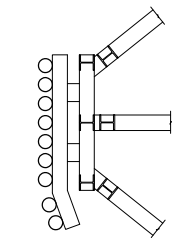




DOLPHIN "F"

BARGE RAMP AND DOLPHIN PLAN

REVISIONS

REV.	DATE	DESCRIPTION	DWN.	CKD.	APP.

P N D ENGINEERS, INC.
9360 Glacier Highway Suite 100
Juneau, Alaska 99801
Phone: 907-586-2093
Fax: 907-586-2099
www.pnd-anc.com

DESIGN: – CHECKED: –
DRAWN: PJD APPROVED: –

SCALE: SCALE IN FEET
0 8 16 FT.

DATE: MARCH 2011

CITY AND BOROUGH OF WRANGELL
WRANGELL CITY DOCK REHABILITATION

SHEET TITLE:
BARGE FACILITY PLAN

PN&D PROJECT NO.: 102070.01 DWG. FILE:

SHEET 1 OF 1

Section 3

Photographs

Overall view of barge ramp facility, looking east.

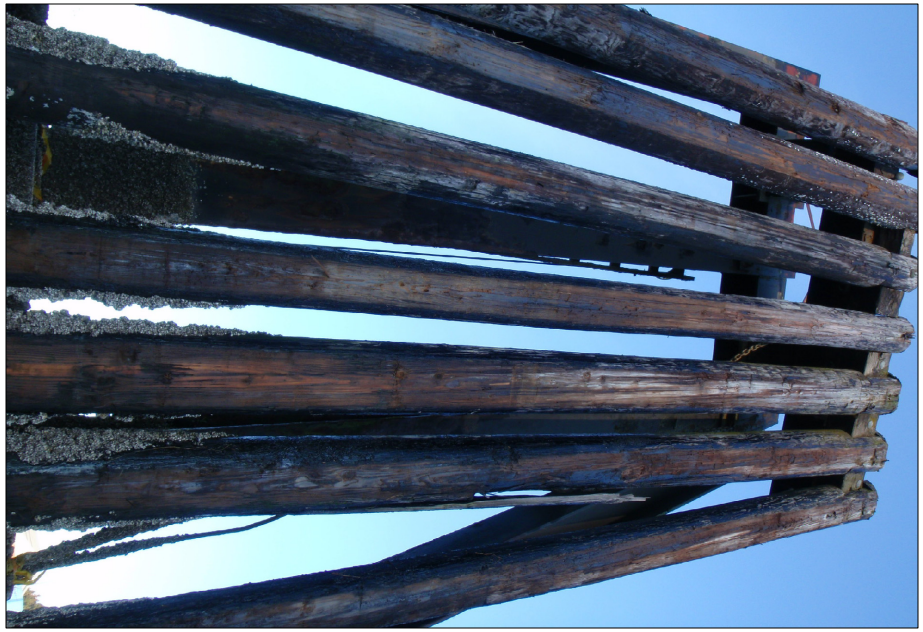
Barge ramp, looking north.

Barge ramp, looking east.

Overall barge ramp, looking north.

End of barge ramp, looking shoreward.

End of barge ramp, looking south.



Displaced fender piles at Dolphin "D".

Broken stay chains at Dolphin "D".

Displaced fender piles at Dolphin "D", looking north.

Broken stay chains at Dolphin "D".

Broken fender pile at Dolphin "F".

Profile of Dolphin "F", looking west.

Dolphin "F", looking east/shoreward.

Broken stay chains at Dolphin "F".

Original stay chain configuration at Dolphin "E".

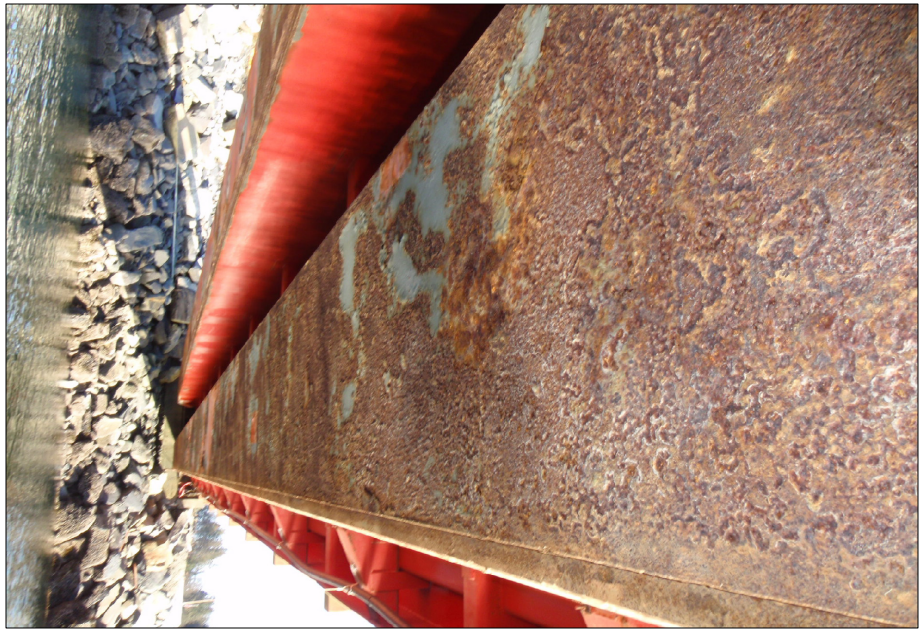
Broken stay chains at Dolphin "C".

Transition plate at barge ramp abutment.

North bearing assembly, debris and worn steel; coating failure on all steel components.

Top deck surface of barge ramp, looking shoreward.

South bearing assembly; coating failure on all steel components.



Ramp box-girder bottom flange corrosion.

Typical coating failure/corrosion of girder bottom flange.

Ramp box-girder bottom flanges; coating failure, minor corrosion, typical.

Ramp box-girder bottom flanges; coating failure, minor corrosion, typical.

Ramp/support tank connection assembly.

Typical minor corrosion of ramp girder bottom flange.

Ramp/support tank connection assembly.

Typical coating failing/minor corrosion of ramp tank support strut.

Coating failure/corrosion at ramp/support tank connection assemblies.

Coating failure/corrosion at ramp/support tank connection assemblies.

Coating failure/corrosion at ramp/support tank connection assemblies.

Coating failure/corrosion at ramp/support tank connection assemblies.

Section 4

Echelon Engineering, Inc.
Dive Inspection Report

ECHELON ENGINEERING, INC.

Civil/Marine Consulting Engineers

Inspection and Condition Assessment of Wrangell Barge Facility Wrangell, AK

Prepared For:

PND Engineers, Inc.
9360 Glacier Highway, Suite 100
Juneau, AK 99801

ATTN: Mr. Chris Gianotti, PE
Senior Engineer
Tel: 907 / 586.2093

Prepared By:

Echelon Engineering, Inc.
21027 61st Avenue West
Lynnwood, WA 98036

ATTN: Ms. Shelley Sommerfeld, PE
President
Tel: 425 / 672.8924

December 2010
10-2380

Echelon
Engineering

Civil / Marine
Consulting Engineers

December 3, 2010

PND Engineers, Inc.
9360 Glacier Highway, Suite 100
Juneau, AK 99801

ATTN: Chris Gianotti, P.E.
Senior Engineer

RE: Inspection and Condition Assessment of Wrangell Barge Facility, Wrangell, Alaska

Dear Mr. Gianotti:

This report documents the findings of our recent condition assessment of the five steel H-pile breasting dolphins and the associated transfer span floatation tanks that support the City /Borough of Wrangell's Barge Facility. The inspection was carried out as part of your structural evaluation and maintenance planning for the facility.

The project was authorized by Sub-consultant Agreement with PND Engineers, Inc. The scope of the project provided for a one day field effort to investigate the condition of the facility. Dolphin A, the cellular sheet pile dolphin which is shared with the City Dock was examined under a separate project, refer to Echelon Engineering Report 10-2379.

INTRODUCTION

The Barge Facility is located at the northern end of the City of Wrangell harbor, immediately south of and adjacent to the City Dock structure. The facility serves ocean going barges operated by Northland Navigation and Alaska Marine Lines. The facility consists of a steel transfer span which is supported by two submerged steel pipe floatation tanks, five multi-pile breasting dolphins and a circular steel cofferdam. The breasting dolphins are constructed with epoxy coated H-piles. The cellular sheet pile dolphin serves as both a turning and mooring dolphin and is located at the western end of the Barge Facility. This dolphin also serves as a mooring dolphin for the adjacent City Dock.

21027 61st Avenue West
Lynnwood, Washington 98036
Tel: 425 / 672.8924
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From a review of the record drawings provide we understand that the structure was originally constructed as a pipe pile supported facility in the mid to late 1970s. Modifications to the facility were apparently carried out in conjunction with expansion and repair of the City Dock in the 1980s. These modifications included the reconstruction of the pile supported breasting dolphins with H piles, the construction of the cellular sheet pile dolphin, and modifications to the transfer span floatation tank. Modification of the transfer span floatation tank appears to have included the addition of a supplemental, smaller 7 foot diameter tank installed alongside and shoreward of the original 9 foot diameter chamber. No design information or drawings of this conversion were available at the time of this investigation.

The identification of various dolphins is based on the original Barge Facility layout. The cellular sheet pile structure shared with the City Dock is identified as Dolphin A. The three breasting dolphins that define the northern edge of the barge slip are identified as Dolphins B – D from the west. Dolphins E and F serve the dual roles as the eastern breasting dolphins for the barge slip and act as guides to secure the offshore end of the transfer span.

Dolphins B – D are constructed with a total of seven H- piles configured with three vertical and four battered members. Dolphins E and F are similarly constructed but are configured using three vertical and three battered H-piles. The vertical piles within each dolphin are designated numerically 1 – 3. The batter piles are identified by the vertical member to which they are attached. In Dolphins B – D the extra batter piles are associated with the Row 1 verticals and the two batters are identified as the 1 E (east) and the 1 N (north) Batter.

The floatation tanks are designed to be adjustable by the addition or removal of air from within the main floatation chamber. Air is injected using an air port which is located off the south side of the transfer span on the top of the 9 ft. diameter tank. The original design called for a single 9 foot diameter steel chamber connected to the underside of the transfer span with large diameter steel pipe struts. Apparently at the time of the reconstruction of the Barge Facility, a smaller,7 ft. diameter floatation tank was installed on the eastern, shoreward side of the original chamber. This smaller tank is secured to the larger tank with two horizontal steel channels (~24x4) welded across the top of the two tanks and two welded across the bottom of the two tanks on a slight diagonal to accommodate the differing tank sizes. Two square steel tubes which also function as diagonal struts are secured to the east side of the smaller tank and to the transfer span.

The results of the investigation are discussed in the *Observed Inspected Conditions* section of this report. Photographs illustrating typical conditions encountered and items of note are presented in Appendix A. Appendix B provides a drawing showing the layout of the Barge Facility and the location and identification of the inspected floatation tanks and dolphin piles. Specific data on the damage and condition of the inspected members is presented in tabular format in Appendix C.

QUALIFICATIONS OF INSPECTORS

The investigation was conducted by a crew composed of professional and technical personnel capable and experienced in both the underwater and above water inspection and assessment of structural members. The personnel utilized on this project included the following Echelon Engineering staff:

S.D. Sommerfeld, P.E.	Project Manager/Engineer - Diver Licensed Professional Engineer, WA, Guam 26 Years Experience in Marine Structures Inspection & Design
E.B. Vegsund, B.Sc.	Marine Specialist/Biologist - Diver BS in Marine Biology - Emphasis on Marine Biological Studies 36 Years Experience in Marine Structures Inspection
R.C. Jenson	Inspection Technician – Diver 1 Year Experience in Marine Structures Inspection

INSPECTION METHODOLOGY AND RATING SYSTEM

The inspection was carried out under the three-tiered inspection protocol developed by the US Navy and endorsed by the American Society of Civil Engineers (ASCE). The scope of the investigation included Level I – III inspection techniques of representative piles throughout the structure. All of the piles were examined for their full accessible length. Level II cleaning and inspection was carried out on one pile in each of the dolphins (i.e. 5 piles total). For this investigation, Level II cleaning was carried out at the following three elevations: the intertidal zone, the mudline and an intermediate elevation between the two. Level III thickness readings were taken on 3 piles using either a caliper or an ultrasonic thickness gauge. On piles with intact epoxy coating the assessment was made that no corrosive section loss has occurred and therefore the thickness readings at these sites were noted as “OT” (i.e. original nominal thickness for that pile section).

Overall Condition Rating

Throughout the discussions the overall condition of the inspected piling is described as good, fair or poor in accordance with the following definitions:

- A member in **good condition** has not sustained any damage or has sustained only minor damage.
- A member in **fair condition** has sustained minor to moderate damage, but has no evidence of overstressing.
- A member in **poor condition** has sustained major to severe damage that affects the member’s load capacity. This damage may be evident as advanced deterioration, overstressing or breakage.

Pile Rating

The condition of the piles is based on the overall damage noted along the length of the member using Level I visual inspection and as augmented with detailed Level II and III inspection techniques. Areas of damage were recorded, including the location and quantification of specific deterioration encountered. A breakdown of the rating classifications is as follows:

Undamaged - Members identified as Undamaged were found to have an intact coating system and no visible deterioration or damage.

Minor Damage - Members identified with Minor damage were noted to have one or more of the following conditions:

- Deteriorated coating system
- Surface deterioration (rust) with no visible loss of thickness using Level I inspection techniques

Moderate Damage - Members identified with Moderate damage were noted to have one or more of the following conditions:

- Loss of wall thickness of up to 25% on at least 25% of the pile circumference for a pipe pile, or the perimeter of an H-pile
- Impact damage that causes deformation of the pile $\leq$ 2 inches
- Minor/moderate anodic loss of weldment in the heat-affected zone of pile splices

Major Damage - Members identified with Major damage were noted to have one or more of the following conditions:

- Loss of wall thickness of between 25 - 75% on at least 25% of the pile circumference for a pipe pile, or the perimeter of an H-pile
- Impact damage that causes deformation of the pile $>$ 2 inches
- Fatigue cracking
- Moderate/major anodic loss of weldment in the heat-affected zone of pile splices

Severe Damage - Members identified with Severe damage were noted to have one or more of the following conditions:

- Loss of wall thickness over 75% on at least 25% of the pile circumference for a pipe pile, or the perimeter of an H-pile
- Major anodic loss of weldment in the heat-affected zone of pile splices

OBSERVED INSPECTED CONDITIONS

The field investigation was carried out during the period of October 18 - 22, 2010, in conjunction with the inspection of the adjacent City Dock structure. Weather during the field investigation was seasonal with a mixture of rain and dry conditions. Winds were generally calm to moderate. The tidal level during the investigation fluctuated between a low of +1.4 feet and a high of +16.0 feet (MLLW). Underwater visibility was variable. On most days the visibility in the upper most five feet of the water column was less than 5 feet horizontally due to the suspended glacial silt. Below this elevation visibility increased to 15-20 feet. Currents were experienced during the inspection but these had no significant impact on the inspection activities. The inspection findings are as follows:

Epoxy Coated H-Piles

1. The overall condition of the inspected steel piles is good. A total of 33 vertical and batter piling were inspected within Dolphins B, C, D, E, and F. All of the piling are epoxy coated H-piles.

2. All of the inspected piling were found to have sustained localized failure of the protective coating and minor surface corrosion. As a result, all of the piling have been rated in the Minor rating category. No evidence of any significant damage or deterioration was identified on any of the inspected piling.

3. The overall condition of the protective epoxy coating is poor. As illustrated in the photos, evidence of coating deterioration and failure was found throughout the dolphins. The amount of coating remaining varies but generally, the coating near the pile top is in good condition; the coating in the splash zone is effectively destroyed; and the coating on the submerged portions of the piling is generally intact. Specifically from the pile top to through the splash zone, the overall condition of the coating has been estimated to range from 50% to 75% intact and the coating from the intertidal to mudline zones has been estimated to be 90% intact.

4. In spite of the deteriorated condition of the coating system the piles remain in good condition with regards to corrosive section loss. The piles have not sustained any significant loss of thickness. Ultrasonic readings taken on three of piles show the majority to be at or near their original thickness. Table 2 of Appendix C provides the results of the Level III ultrasonic testing that was carried out on representative piles.

Transfer Span Floatation Tanks

5. Inspection of the two steel floatation tanks which provide support for the offshore end of the transfer span, found them to be in generally good condition. No evidence of any significant impact, cracking, perforation or other significant damage or deterioration was identified. Level II spot cleaning of the two tanks and the associated framing struts found the coating system to be in generally fair / good condition below water with an estimated

75-90% remaining intact. Inspection of the members in the above water splash zone noted significant deterioration of the protective coating system with an estimated 50% of the coating noted to be intact. Refer to Photo No.s 4 – 10.

6. Level III thickness readings taken at several locations on the two tanks revealed the remaining thickness of the tank end plates to be ~0.750 inches and the thickness of both pipe tanks to be ~0.375 inches. Refer to Appendix C, Table 2 for specific locations and thickness readings.
7. Level II cleaning and investigation of several of the welds associated with the framing members found no evidence of any anodic weld loss or of any cracking along the welds.
8. Investigation of the inlet / exhaust system found it to be in good condition. No apparent damage or deterioration of the inlet was identified and the three exhaust ports (~3 ft' Ø) located on the bottom of the 9 ft. tank were found to be clear and free of significant marine fouling or obstruction. Refer to Photo No.s 7 and 8.
9. Inspection identified a bracket located on the northern end plate of the 9 ft. tank. This bracket appears to be an anode bracket, however, the anode has been completely consumed. Refer to Photo No. 6.

Miscellaneous Observations

10. The shoreward end of the transfer span is supported by a concrete foundation or sill. Cursory observation of this foundation found that it is undermined for the majority of its length.

CONCLUSIONS AND RECOMMENDATIONS

This inspection has found the overall structural condition of the dolphin piling and the floatation tanks associated with the transfer span at the Wrangell Barge Facility to be generally good. However, significant damage and failure of the protective coating system on the dolphin piles and on the transfer span floatation tanks has occurred.

Of the 33 vertical and batter piles inspected within Dolphins B - F, all have been rated in the minor rating category with no evidence of any significant impact, cracking or other significant structural damage. Investigation of the piles found that failure of the coating system has occurred primarily in the above water portion of the piling in the splash zone. No evidence of any significant corrosive section loss was found on any of the examined piling.

Investigation of the steel floatation tanks and the submerged framing members associated with the transfer span found them to be in good structural condition. However these members were also noted to have sustained deterioration of the protective coating system with an estimated 50% of the coating intact in the splash zone and 75-90% of their coating intact on the submerged surfaces. No evidence of any significant impact or other damage was noted to the members or to the welded connections. One apparent anode bracket was

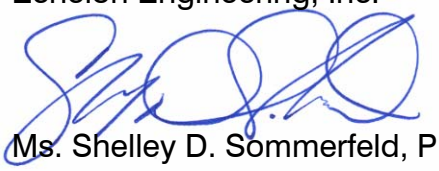
found on the northern end plate of the larger 9 ft. diameter tank, but no evidence of the anode was found. Investigation of the inlet / exhaust system used to raise and lower the span found no evidence of any damage or deterioration which might affect its use.

The shoreward end of the transfer span is supported by a concrete foundation or sill. Cursory observation of this foundation found that it is undermined for the majority of its length. We recommend that this condition be further investigated and evaluated for possible maintenance.

In summary, the overall condition of the piling and the floatation tanks associated with the barge facility is good. No structural maintenance repair of the piles appears warranted at this time. However, we recommend evaluation of the protective coating system and consideration of the application of new coating materials in the splash zone of the piling, along with design and installation of a cathodic protection system to protect the submerged portions of the piling as warranted. We also recommend that the City / Borough of Wrangell implement a periodic re-inspection program for the structure based on the ASCE Underwater Inspection of Marine Structure protocol. Under this regimen inspection and maintenance of the structure should be carried out on an approximate five year interval. These inspections will monitor the condition of the facility and will, as in the case of the current inspection, identify items that may require preventative or restorative maintenance. Such an approach will help to ensure the structural integrity and longevity of the barge facility, as well as the personal safety of those using the facility.

Once again, it has been a pleasure to have assisted you with this project. Should you have any questions concerning this report, or if we can assist you further, please do not hesitate to contact our office.

Yours Truly,
Echelon Engineering, Inc.



Ms. Shelley D. Sommerfeld, P.E.
President

SDS:jds
Enclosures

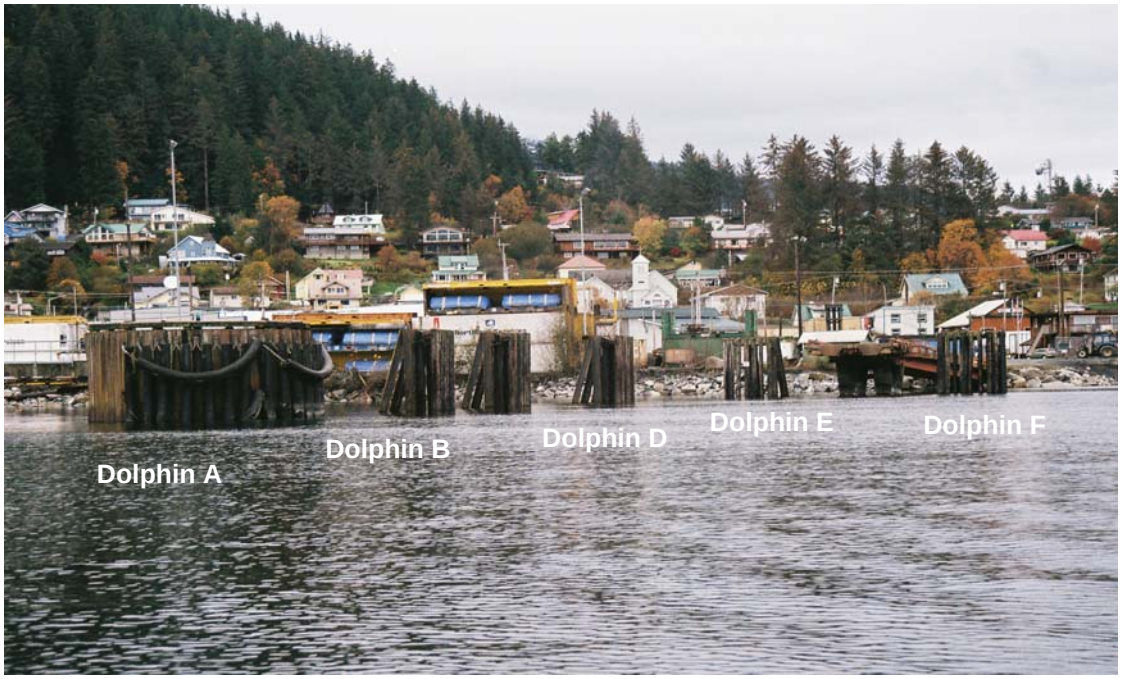


PHOTO No. 1: Wrangell Barge Facility Looking Northeast – Note the transfer span hinged off the shore. Also note the circular cofferdam, Dolphin A and the H-pile supported breasting Dolphins B – F.

PHOTO No. 2: Barge Facility Transfer Span – Note the large diameter pipe struts that connect to a nine foot diameter floatation tank located ~3 feet below the surface. The square tube struts shoreward of the pipe struts connect to a second smaller pontoon (7 foot diameter). Also note Dolphin F in the foreground.

PHOTO No. 3: Transfer Span Bridge Seat – Note the undermining of the concrete bridge seat. Also note the localized failure of the painted coating on the transfer span members.

PHOTO No. 4: Floatation Tank Pipe Struts – Note the deterioration and failure of the protective black epoxy coating on these members in the splash zone.

PHOTO No. 5: Southern Floatation Tank Pipe Strut – Note the coating failure and corrosive scale evident in the splash zone. Level III ultrasonic thickness measurements found the remaining thickness to be 0.357 inches.

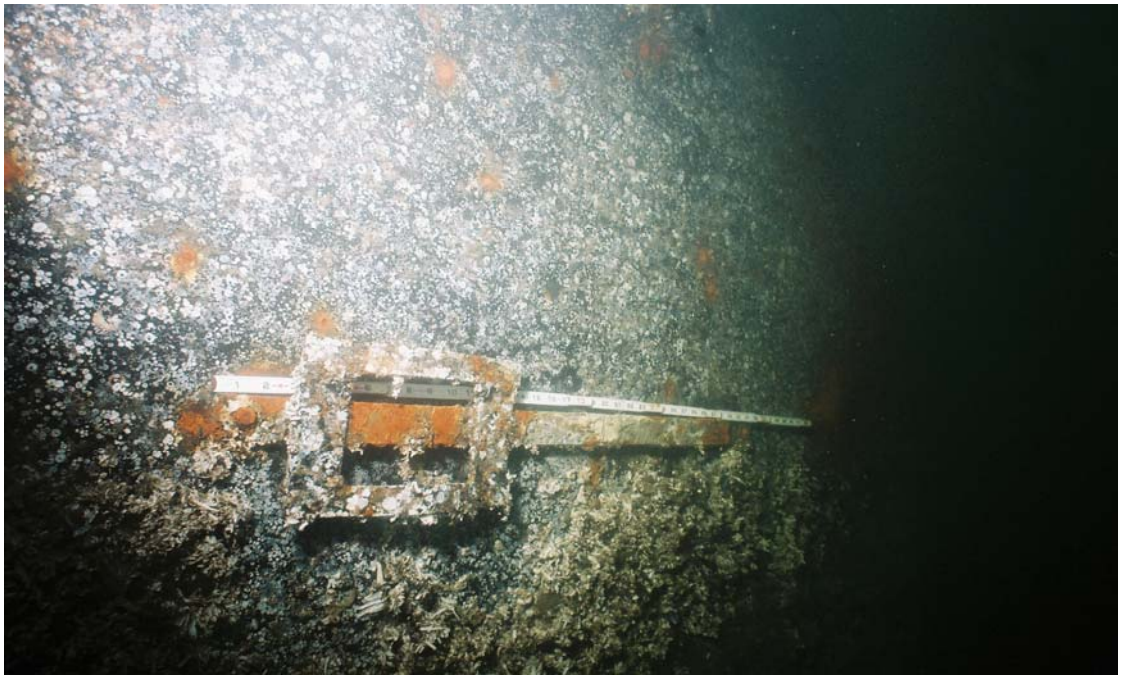


PHOTO No. 6: Floatation Pontoon Cathodic Protection Anode Bracket – Investigation of the Floatation Tanks noted this anode bracket on the north end of the larger 9 ft. diameter tank. Note the ruler lying along the top of the anode attachment bracket. The anode has been completely consumed.

PHOTO No. 7: Floatation Tank, Air Inlet Port – Note the good condition of the air inlet port located at the south end at the crown of the 9 ft. dia. tank. Also note the good condition of the coating on the two pipe struts and the minor coating deterioration in the vicinity of the inlet.

PHOTO No. 8: Floatation Tank Exhaust Port – Note the coating deterioration and minor surface corrosion on the bottom of one of the three exhaust ports located on the bottom of the 9 ft. diameter tank. Also note the good condition of the coating on the bottom of the tank.

PHOTO No. 9: Seven Foot Diameter Floatation Tank – Note the good condition of the welded connection between the square tubular strut and the floatation tank. Also not the good condition of the epoxy coating on the top of the pontoon and the localized coating failure on the strut.

PHOTO No. 10: Seven Foot Diameter Floatation Tank – Note the good condition of the welded connection between the square tubular strut and the eastern side of the floatation tank. Also not the general good condition of the epoxy coating.

PHOTO No. 11: Breasting Dolphin F – Note the good condition of the epoxy coating at the tops of the piles and the localized coating deterioration in the splash zone. Overall these piles have been estimated to retain 75% of their coating in the combined top and splash zone.

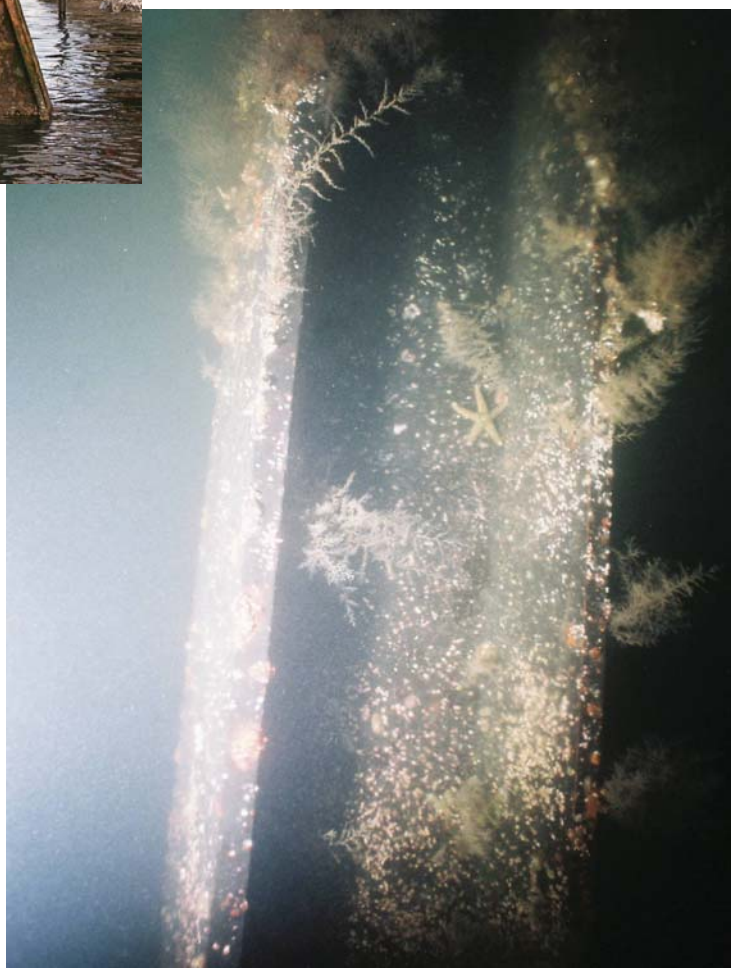


PHOTO No. 12: Breasting Dolphin C, Pile 3 Batter – Note the general good condition of the epoxy coating in the upper portion of the submerged zone. The coating at this elevation has been estimated to be 90% remaining overall.

PHOTO No. 13: Breasting Dolphin C, Pile 3 Batter – Note the yellow caliper on the flange at this Level II cleaned site and the good condition of the epoxy coating in the submerged zone.

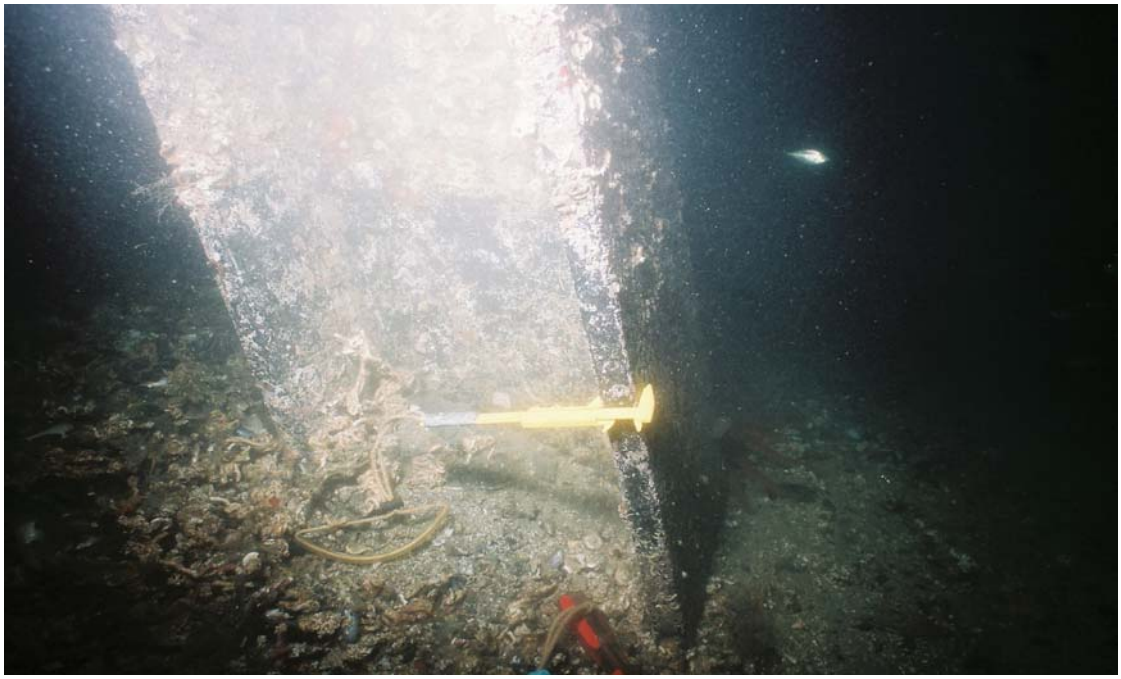
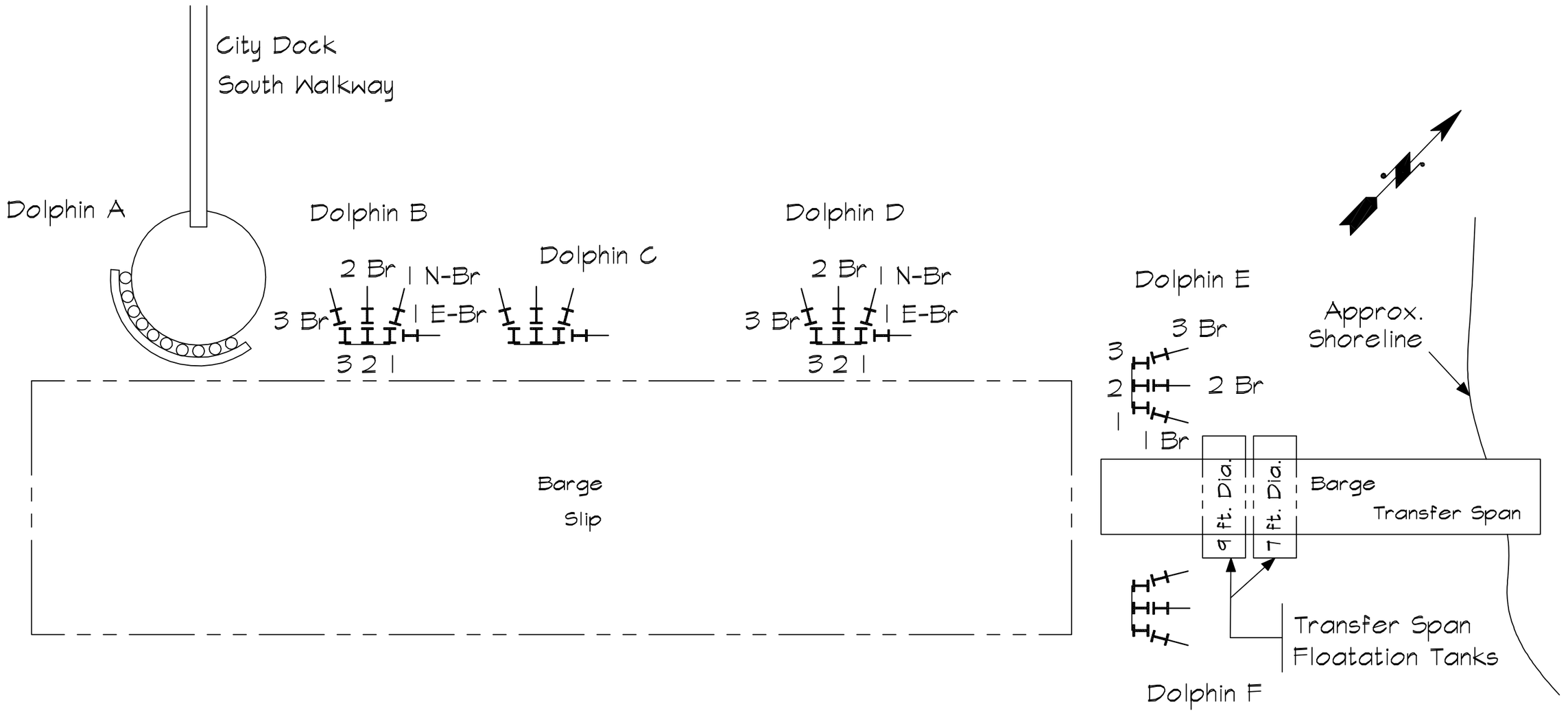


PHOTO No. 14: Breasting Dolphin C, Pile 3 Batter – Level II cleaning of this pile at the mudline found it to be in good condition with an estimated 90% of the epoxy coating intact at the mudline.



PLAN

LEGEND

X Pile ID

Steel H-Pile - Vertical

Steel H-Pile - Batter

SCALE: Not To Scale

PND Engineers, Inc.	
PILE PLAN	
City / Borough of Wrangell Barge Facility	
DATE: Dec 2010	ECHELON ENGINEERING, INC. Civil/Marine Consulting Engineers Lynnwood, Washington Tel: (425) 672-8424
PROJECT: 10-2380	
SHEET: 1 of 1	
DRAWN: SDS / JDS	

TABLE 1
PILE INSPECTION DATA

PILE LOCATION		CONDITION RATING	CONDITION / DAMAGE	
Bent	Row		Elevation (Chart Datum)	Details / Remarks
Dolphin B	1	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 N-Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 E-Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
Dolphin C	1	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 N-Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 E-Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2 Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3 Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
Dolphin D	1	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 N-Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 E-Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact

TABLE 1
PILE INSPECTION DATA

PILE LOCATION		CONDITION RATING	CONDITION / DAMAGE	
Bent	Row		Elevation (Chart Datum)	Details / Remarks
Dolphin E	1	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3 Br	Minor	Top / SPL	75% Coating Intact
			ITZ / MDL	90% Coating Intact
Dolphin F	1	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	1 Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	2 Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact
	3 Br	Minor	Top / SPL	50-75% Coating Intact
			ITZ / MDL	90% Coating Intact

TABLE 2
PILE THICKNESS READINGS

PILE ID		AVERAGE THICKNESS READING (inches)				
Dolphin	Pile No.	Elevation	Flange	Web	Pipe Wall	Remarks
B	2	SPL	1.130	0.722		
		ITZ	1.155	0.712		
		SUB	OT	OT		90% Coating Intact
		MDL	OT	OT		90% Coating Intact
D	3	SPL	1.110	0.728		
		ITZ	1.130	0.718		
		SUB	OT	OT		90% Coating Intact
		MDL	OT	OT		90% Coating Intact
F	1	SPL	1.100	0.743		
		ITZ	1.105	0.745		
		SUB	OT	OT		90% Coating Intact
		MDL	OT	OT		90% Coating Intact
Transfer	9 ft. dia.	SUB			0.740	North End Plate
Span	Main Tank	SUB			0.380	Top of Tank, North End
Floatation	7 ft. dia.	SUB			0.740	North End Plate
Tanks	Supplemental	SUB			0.365	Top of Tank, North End
	Tank	SUB			0.373	Top of Tank, Near N. Strut

Section 5

Tinnea and Associates, LLC.
Corrosion Inspection Report

Port of Wrangell Barge Ramp Inspection

December 9, 2010

Prepared for:

City Borough of Wrangell, Alaska
Wrangell Harbor Department
Post Office Box 531
Wrangell, Alaska 99929

Prepared by:
Ryan Tinnea
Engineer

Tinnea & Associates, LLC
2018 East Union Street
Seattle, Washington 98122-2836

Wrangell, Alaska

Tinnea & Associates, LLC

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Introduction

On November 10, Tinnea & Associates staff inspected the City/Borough of Wrangell's (CBW) Barge Ramp and associated breasting dolphins as corrosion consultants working with PND Engineers, Inc. The purpose of this inspection was to determine the current health of the structures and to identify what measures need to be taken in order to mitigate future corrosion to acceptable levels.

Inspection

This inspection focused on the floating barge ramp and the H-pile supports to its five breasting dolphins. The breasting dolphin H-piles are all type W14x159 oriented in both vertical and battered orientations.

The inspection consisted of a visual examination of all piles and the barge ramp structural members including photographs. In addition to the visual examination, ultrasonic thickness (UT) readings were taken on one pile of each breasting dolphin at varying elevations. UT readings were also taken on selected places on the barge ramp. These tests help paint a picture of the structures' overall health.

Inspection Results

In general among all piles, the worst corrosion was seen in the few feet above high tide, referred to as the splash zone. A schematic drawing of the several tidal zones and the associated corrosion rates appears in the Figure 1. The splash zone receives frequent exposure to salt spray from the ocean. Seawater contains chloride ions, which are a corrosion accelerator for steel structures. As this area is directly exposed to the air, there is plenty of oxygen from the air, which combined with the chloride ion exposure makes this a highly corrosive environment.

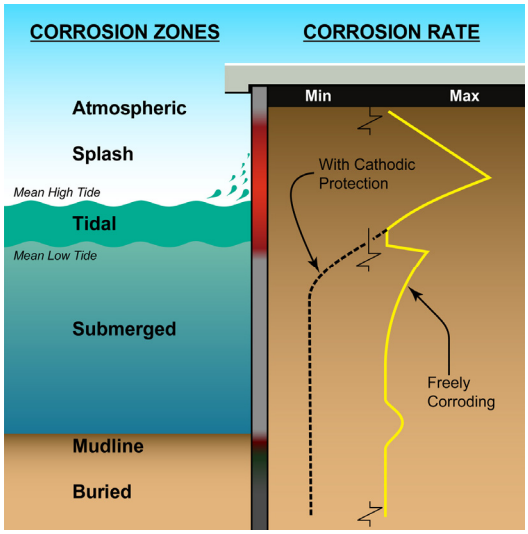

Figure 1 – corrosion rates versus exposure

Note that the corrosion rate diminishes as you move down into the tidal zone. The reason for the decline in corrosion rate is reduced oxygen availability. In the tidal zone, the piles are submerged for part of each day. Although seawater contains oxygen, it does not provide it to the steel surface for corrosion as readily as atmospheric exposure. Also at about mean tide level, marine growth becomes prevalent. Marine growth, such as barnacles, mussels, algae, and other microbes are oxygen consumers, so at the level of the steel the amount of available oxygen is markedly reduced from much higher levels available in the open ocean. This reduction in oxygen reduces the corrosion rate of the piles.

H-Piles

The H-piles on the breasting dolphins are found in both vertical and battered orientations and are all type W14x159. Nominal thicknesses of W14x159 piles are 1.190" for the flanges and 0.745" in the web. The H-piles still had tightly adhering coating throughout much of the lower tidal zone with failure of the coating in the upper tidal and splash zones (see Figure 2).

Figure 2 - coating failure in the splash zone

The geometry of H-piles allows for both sides to corrode as opposed to closed-shape pile types, such as pipe piles, which are only exposed to open seawater on one side. With closed-shape piling, microbial activity and initial corrosion quickly consume all the available oxygen and the corrosion rate for carbon steel in anaerobic conditions is so small as to not have engineering significance. This two-face exposure causes the effective corrosion rate of the H-piles to be double that of pipe piles. Overall, the web of the H-piles was in better condition with an average thickness loss of approximately 0.01" and a maximum loss of 0.04". However, the flanges are in worse condition. Average thickness loss on the flanges is 0.08" with a maximum loss of 0.14". This difference in corrosion rates is frequently observed in marine H-piles and is the result of the outer face of the flange having greater exposure to mechanical damage from flotsam or vessels.

Barge Ramp

The barge ramp is a floating structure located to the south of the main city dock used for unloading shipping vessels. Buoyancy is adjusted on the ramp using two underwater pneumatic tanks. Overall, the coating system on the barge ramp is in good condition with the exception of the bottom of the two supporting girders that run the length of the ramp.

Figure 3 - coating failure along the barge ramp girder soffits

Since it is a floating structure, much of the length of the two box girder flanges constantly sit in or near the splash zone, causing accelerated corrosion on these areas. The coating has largely deteriorated in this area (see Figure 3). The nominal thickness of the box girder flange is 0.75" in most areas with a small reinforced

area that is nominally 1.50". The actual measured thickness at each of these areas is 0.64" (0.11" section loss) and 1.27" (0.23" section loss) respectively.

Conclusions

Barge Ramp

The barge ramp is experiencing significant section loss on the girder soffits. As stated above, this is likely due to their position constantly in the splash zone. In order to increase the life of this structure, the corrosion rate needs to be reduced. Due to low time of wetness, a cathodic protection system would not be affective in this location. Instead, the coating should be replaced.

Recommendations

Petrolatum Jackets

In order to reduce the corrosion rate of the H-piles in the upper tidal and splash zones, a petrolatum jacketing system should be installed on all H-piles and pipe piles on the breasting dolphins. Petrolatum jackets function similarly to a coating system in that they act as a barrier between the piles and the corrosive seawater. The benefit of these systems is that they require less extensive surface preparation than typical coating systems, are more durable, and can be installed in wet conditions. The jackets themselves are made of fiberglass reinforced plastic (FRP) which has been molded to fit the shape of the pile it will be installed on. There is a small annulus between the FRP jacket and the pile which is filled with petrolatum. The petrolatum serves as the barrier between chloride ions in the seawater and the piles while the FRP jacket protects the system from mechanical damage. This system should be installed within the next 2 years simultaneously with the city dock jacket system to reduce the amount of future corrosion damage.

- The jackets should be installed from the pile caps to -5' MLLW in order to protect the piles from the areas of highest corrosion. Extending the jackets to five feet below MLLW avoids mechanical damage that likely will occur were the jackets terminated at a higher elevation where flotsam could catch under the lower edge of the jackets.
- Prior to installation, the piles should be cleaned of any loose corrosion product through water blasting or power tool cleaning.

Continued Corrosion Assessment

Even with corrosion mitigation strategies in place, it is important to continue with regular corrosion inspections of the dock. Coatings and jackets have finite lives, and even when employed correctly, corrosion can still occur. Corrosion assessments of the barge and dolphins should be performed alongside future corrosion investigations of the city dock at an interval of not more than 5 years between inspections.

Tinnea & Associates, LLC

City / Borough of Wrangell
Barge Ramp Pile Data
Barge Ramp and Breasting Dolphins

H-Piles						
Pile Location				Thickness	Nominal	Elevation (MLLW)
Bent	Row	Pile	Location			
Dolphin B		Center Batter	N Flange	1.050 in	1.190 in	20.00 ft
Dolphin B		Center Batter	S Flange	1.084 in	1.190 in	20.00 ft
Dolphin B		Center Batter	S Flange	1.129 in	1.190 in	7.25 ft
Dolphin B		Center Batter	N Flange	1.144 in	1.190 in	7.25 ft
Dolphin C		NE Batter	S Flange	1.119 in	1.190 in	20.00 ft
Dolphin C		NE Batter	N Flange	1.124 in	1.190 in	20.00 ft
Dolphin C		NE Batter	S Flange	1.126 in	1.190 in	7.25 ft
Dolphin C		NE Batter	N Flange	1.127 in	1.190 in	7.25 ft
Dolphin D		West Batter	S Flange	1.087 in	1.190 in	20.00 ft
Dolphin D		West Batter	N Flange	1.097 in	1.190 in	7.25 ft
Dolphin D		West Batter	N Flange	1.098 in	1.190 in	20.00 ft
Dolphin D		West Batter	S Flange	1.111 in	1.190 in	7.25 ft
Dolphin E		North Vertical	W Flange	1.070 in	1.190 in	20.00 ft
Dolphin E		North Vertical	E Flange	1.107 in	1.190 in	7.25 ft
Dolphin E		North Vertical	W Flange	1.109 in	1.190 in	7.25 ft
Dolphin E		North Vertical	E Flange	1.139 in	1.190 in	20.00 ft
Dolphin F		North Batter	W Flange	1.088 in	1.190 in	7.25 ft
Dolphin F		North Batter	W Flange	1.097 in	1.190 in	20.00 ft
Dolphin F		North Batter	E Flange	1.120 in	1.190 in	7.25 ft
Dolphin F		North Batter	E Flange	1.149 in	1.190 in	20.00 ft
Dolphin B		Center Batter	Web	0.733 in	0.745 in	20.00 ft
Dolphin B		Center Batter	Web	0.745 in	0.745 in	7.25 ft
Dolphin C		NE Batter	Web	0.720 in	0.745 in	20.00 ft
Dolphin C		NE Batter	Web	0.734 in	0.745 in	7.25 ft
Dolphin D		West Batter	Web	0.709 in	0.745 in	20.00 ft
Dolphin D		West Batter	Web	0.745 in	0.745 in	7.25 ft
Dolphin E		North Vertical	Web	0.740 in	0.745 in	20.00 ft
Dolphin E		North Vertical	Web	0.760 in	0.745 in	7.25 ft
Dolphin F		North Batter	Web	0.714 in	0.745 in	7.25 ft
Dolphin F		North Batter	Web	0.746 in	0.745 in	20.00 ft

Barge Ramp						
Pile Location				Thickness	Nominal	Elevation (MLLW)
Bent	Row	Pile	Location			
Barge Ramp		Girder Bottom	Normal	0.639 in	0.750 in	N/A
Barge Ramp		Girder Bottom	Reinforced	1.270 in	1.500 in	N/A
Barge Ramp		Girder Bottom	Tank Support	0.399 in	--	N/A