May 27, 2021

Mr. Christopher Moore, PE
Project Engineer
Jon Guerry Taylor & Associates, Inc.
PO Box 1082
Mt. Pleasant, South Carolina 29465
(843) 884-6415
www.jgtinc.com

Re: Morgan Creek Harbor Corrosion Assessment Report
Isle of Palms, South Carolina

Dear Mr. Moore,

In accordance Jon Guerry, Taylor and Associates (JGT) written authorization dated December 22, 2020 and our proposed scope of work dated November 11, 2020, Southern Cathodic Protection Company (SCPC) personnel conducted a condition assessment of approximately 6,000 feet of steel sheet pile installed[1] at the subject harbor at Isle of Palms, South Carolina. The project objective was to identify deterioration processes affecting structure life. The assessment was therefore focused on the pile coating system effectiveness, electrochemical activity due to environmental exposure and stray current sources, and strength of the steel pile material.

The following sections and attachments detail the inspection findings. The Figure 01 below shows the project site and key elements referenced frequently in the subsequent text and attachments. The report is outlined below.

Tests and Measurements
Results and Analysis
Conclusions
Recommendations
Exhibit 1: Metal Samples Destructive Testing
Exhibit 2: Ultrasonic Metal & Coating Thickness Measurements
Exhibit 3: Stray Current Test Results: Data Logger & Spot Measurements
Exhibit 4: Electrochemical Potential Measurements – Vertical Profiles
Exhibit 5: Steel Pile Electrical Continuity Testing
Exhibit 6: Electrochemical Properties of Soil & Water Samples
Exhibit 7: Microbiologically-Influenced Corrosion (MIC) Testing Results
Exhibit 8: Environmental Corrosivity Analysis

[1] Station numbering marked on the piles includes a 100-foot gap. The east end of the south wall is marked 27+00 and the west end of the north wall starts at 26+00. Southern wall starting location should have been marked 26+00 also, not 27+00.

Figure 01: Morgan Creek Harbor showing start and end point station numbers as marked on the wall pile cap. The wall is comprised of 2 segments.

BACKGROUND

The steel sheet pile was reportedly constructed circa 1997 and was comprised of AZ13 and AZ18 steel sheet pile[2] of grade 50 and 60 strengths in varying lengths. The sheets were capped with a continuously-welded and concrete-filled steel channel. The wall replaced an existing wooden sea wall and was not originally installed with a tie-back system. The anchors were installed several years later following observation of wall displacements.

The wall is divided in two segments – one on each side of the Morgan Creek Harbor, as shown in Figure 01 above. Numerous housing units (single family and multi-story condominiums) and marine docks are located along the wall.

According to record drawings and field observations, the sheets were originally coated only on the water side with coal tar epoxy. Numerous subsequent coatings were evidently applied in the course of maintaining the structure. Figure 02 below shows the typical coating system observed.

[2] The material thickness used for the analysis herein was found in the ArcelorMittal "Piling Handbook," 8th Edition, 2008. The stated value is 9.5 millimeters or 374 mils.

Figure 02: Illustration of typical coatings applied over time. The grinding process revealed the coating history. The middle surface was polished to bare metal.

TESTS & MEASUREMENTS

The following summarizes tests conducted to evaluate the wall condition.

Visual Inspection: Upon arrival and throughout the field examination, a visual inspection was conducted to identify evidence of deterioration. In particular, the inspection was performed to identify locations where the wall was visibly corroded through. This portion of the work was conducted from a small watercraft to access otherwise inaccessible segments of the wall.

Mechanical Properties of the Steel: Six steel coupons were collected from sites identified during the corrosion evaluation and furnished to a metals testing laboratory, Applied Technical Services, Inc of Marietta, Georgia, for destructive testing. The tests performed include yield strength, tensile strength and chemical properties. The results may be used to conduct a structural integrity assessment of the wall.

Structure Potential: Using a Fluke 87V high-input impedance digital multimeter and copper-copper sulfate reference electrode, measures of structure potential were recorded. The measurements are commonly stated in Volts and millivolts. This technique is utilized to evaluate the overall corrosion condition of the structure, identify personnel threats due to AC voltages and detect DC interference usually associated with aggressive corrosion. An M. C. Miller model Gx data logger was similarly employed to record structure potential measurements at a single location for a period of approximately 8 hours per site. Three locations were selected and the data recorded at 1-second intervals.

Electrical Continuity Testing: The aforementioned digital multimeter and appropriate test reels were used to evaluate electrical continuity of the sheet pile structure. The test required firm, temporary electrical connection of the test meter positive (+) lead to the steel structure, while the negative lead was connected to adjacent sheets with an awl designed to penetrate to coating to bare metal beneath. The meter is set to measure millivolts DC, and the potential difference between the sheets and pile cap is recorded. A zero potential difference indicates electrical continuity. Two 100-foot sample segments were selected for evaluation and each pile pair was tested.

Ultrasonic Thickness Measurements: a DeFelsko PosiTector UTG was utilized to measure thickness of the steel sheets. A similar instrument, the DeFelsko PosiTector 6000, was used to measure coating thickness. These instruments collected 10 measurements at each test site for statistical evaluation of the data quality. The measurements were used to determine corrosion loss rates and evaluate coating system functionality. Measurements were recorded at six selected locations on approximately 8-inch centers along the pile wall.

Properties of the Electrolytes: Water, channel bottom silt and land-side soil samples were collected for determination of electrochemical properties of the materials. Measures of pH, resistivity and chlorides were conducted. These properties are key attributes of corrosivity for naturally-occurring bulk materials.

Microbiologically Influenced Corrosion (MIC) Testing: Bacteria are commonly associated with aggressive corrosion of steel in a variety of environments. The key class of organism responsible for the phenomena are called sulfate-reducing bacteria. A Biosan Laboratories, Inc. model Sani-Check SRB test kit was utilized to sample and culture the bacterial colonies where present.

RESULTS AND ANALYSIS

The following sections summarize the evaluation findings. Data records and detailed analyses are attached as Exhibits 1 through 5.

- Visual inspection of the structures found a significantly deteriorated coating system in the tidal and splash zones, particularly along the north wall segment. Large corrosion product scaling was observed with widespread inter-layer disbondment of the corroded metal. No through-wall penetrations were found; although, the wall was found leaking behind a jacking plate at Station 58+80 and a missing tie rod end was observed at Station 35+80. Figure 03 below illustrates typical coating and corrosion conditions observed.

Figure 03: Coating system failure with significant corrosion product scaling in the splash and tidal zones. Location was found on the north wall at Station 17+30.

- The sheet pile metal samples were collected from sites where electrochemical testing indicated corrosion activity and wall loss were likely. Key findings include approximately 69% wall loss at Station 17+30 and a yield strength measurement below the steel grade specification for the indicated product utilized in the original installation. A wall structural analysis utilizing these data is scheduled to be performed by others. Figure 04 shows at the coupon collected at Station 17+30. The third-party examination results are included in Exhibit 1 below.

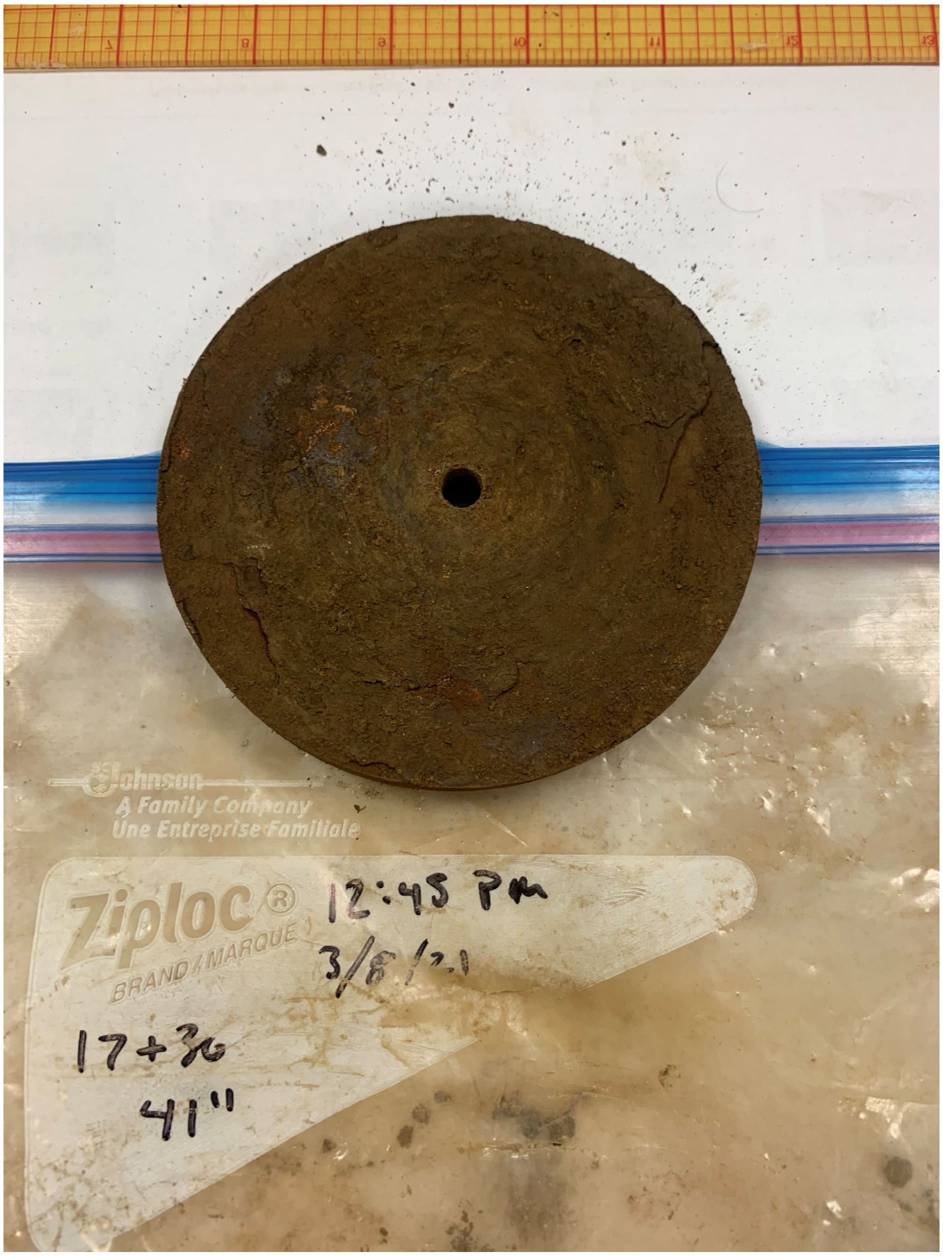


Figure 04: One of six coupons taken from the pile walls. Note the heavy corrosion product scale. The soil side of the coupon is shown. The water-side appearance was very similar.

- Structure potential measurements along each side of the walls were largely consistent and typical for bare, unprotected steel in the respective electrolytes; however, a significant difference existed between the water and soil sides – approximately 250mV on average. This difference causes a small corrosion current to flow from the more active water side to the more noble soil side, accelerating corrosion of the water-immersed sheets. The cause of the potential difference is likely differential aeration conditions and difference of electrolytes. The data were recorded in Exhibit 4.

- Stray current testing found both structures free of stray or dynamic DC or AC voltages at the time of evaluation. All AC potentials were zero and all DC potentials were stable. The time series data recorded along each wall were largely flat. Minor fluctuation was observed in the range of a few millivolts, likely due to changing tide conditions. The data and time series plots are attached in Exhibit 3.

- In the segments evaluated, the structure was found electrically continuous. All measurements of potential difference in the test areas were zero, indicating continuity. Inspection of the pile cap bottom side found numerous welds, likely placed during the original construction, thereby creating an electrical pathway. Continuity is important for functionality of a corrosion control system, should such measures be implemented.

- Measurement of metal and coating thickness indicated significant corrosion activity and inadequate coating. Metal loss was most common in the splash zone and where the coating system was found most deteriorated. This result indicated the majority of corrosion has occurred on the water side. However, thickness losses observed in the top portions of the wall, most notably Station 44+80, occurred on the soil side. The pile coating systems were found in satisfactory condition on the visible water side at these elevations. Exhibit 2 contains the detailed analyses. Additional, Figure 05 below provides a visual reference of the corrosion losses.

- Samples were collected from four sites and tested for sulfate-reducing bacteria activity. During the low-tide inspection, corrosion tubercles were observed largely at the tie-back jacking plates among significant biofouling (oyster colonies). These bacterial formations were sampled and cultured. The test results are shown in Table 1 below. All four sites tested positive for active colonies.

Table 1: MIC Testing for SRB

Station No.	Date of Collection	Time	Distance BTP	Result
05+65	1/28/2021	16:25	60”	Positive
30+10	1/28/2021	15:34	62”	Positive
59+35	1/28/2021	14:15	89”	Positive
61+00	1/28/2021	11:30	60”	Positive

- The corrosion rate analysis was performed considering environmental conditions and actual wall losses measured in situ. A statistical corrosion probability analysis was conducted based upon the environment samples. The model estimated approximately 33 years until probable corrosion failure of the wall. Similarly, if the largest average corrosion rate detected is used for a linear prediction[3], 32 years is found. Figure 05 below shows the loss analysis graphically. Exhibit 5 contains the environmental sample test results.

	Station Number					
BTP	**0+60**	**17+30**	**23+00**	**35+89**	**44+80**	**60+90**
	Sheet Pile Shape					
	AZ13	AZ18	AZ13	AZ18	AZ18	AZ13
9	1.2	2.2	-0.3	-0.2	8.5	
17	2.4	1.2	0.0	0.1	3.4	7.6
25	4.7	1.8	-0.3	-0.1	0.8	1.7
33	5.7	4.9	0.2	1.2	3.2	6.1
41	5.6	5.9	0.3	3.4	2.2	5.2
49	6.5	4.2	0.5	5.5	1.3	2.8
57	4.7	3.4	0.1	11.7	1.5	3.2
65	2.1	2.2	0.3	1.9	0.9	4.3
73	1.7	0.6	0.3	0.5	0.9	0.3
81				0.3		0.4
89						0.2

Original Thickness, Nom.: 374 mils (9.5mm)
Present Year: 2021
Installation Year: 1997

Figure 05: Visual metal loss analysis from UT measurements. Thickness losses are due to corrosion on both sides of sheets. Elevations adjusted as necessary to account for differences in measurement elevations site to site.

[3] Using 11.7 mils lost per year as found at Station 35+89 Elevation 57” BTP and at nominal original wall thickness of 374 mils (9.5mm), through wall penetration will occur in 374mils/11.7mpy = 32 Years

CONCLUSIONS

Based on the results of testing, the following conclusion was drawn.

- Metal loss detected on the sheet pile surfaces were not likely related to interference currents. While it is possible interference currents may have existed in the past or could occur in the future, estimate of the free corrosion rate (in absence of outside forces) compared favorably with field results.

- Deterioration of the sheet pile structure was an interaction of deferred water-side coating maintenance, no soil-side coating, a highly corrosive environment, and no electrochemical corrosion control system installed.

RECOMMENDATIONS

Based upon the tests conducted, the following recommendations are submitted.

- Following a detailed structural condition analysis confirming sufficient remaining strength of the wall, the coating system must be restored and a cathodic protection system designed and installed promptly. Should a structural investigation find the wall strength inadequate, the new wall should be installed with a complete coating system on both water and soil sides; and a robust cathodic protection system designed, installed and properly maintained for the wall life.

Should you have any questions regarding our report or require additional information, please contact us at your earliest convenience. We appreciate the opportunity to be of service and look forward to future correspondence.

Sincerely,

Christopher R. McKinley, P.E.
Chief Operating Officer
Southern Cathodic Protection Company

EXHIBIT 1

Metal Samples Destructive Testing

Morgan Creek Harbor Corrosion Assessment Report
Jon Guerry Taylor & Associates, Inc.
May 26, 2021

APPLIED TECHNICAL SERVICES

www.atslab.com
1049 Triad Court • Marietta, GA 30062 • 770-423-1400

TENSILE TEST REPORT

Ref. 353667 **Date** April 20, 2021

Customer: Southern Cathodic Protection, 780 Johnson Ferry Road NE, Suite 225, Atlanta, GA 30342

Attention: Chris McKinley

Purchase Order #: 1824-CRM Part #/Name: Sheet Pile Samples, See Below

Material Designation: Steel Specimen Type: Flat Reduced Section

Tensile Test Equipment: Tinius Olsen ATS #: 6266 Cal. Due: 10/28/21

Extensometer: Tinius Olsen ATS #: 2320 Cal. Due: 12/28/21

Lab Comment: Tested per ASTM A370-20.

Test Results

Specimen Identification	Thickness, in.	Diameter or Width in.	Area, in.^{2}	Ultimate Load, lbs.	0.2% Offset Load, lbs.	Tensile Strength, psi	Yield Strength, psi	Elong. % in 1 in.	Red. in Area, %
00+60, 33", 2:05pm, 3-8-21	0.1990	0.251	0.0500	3,940	2,895	79,000	58,000	32	—
21+18, 36", 12:10pm, 3-8-21	0.2554	0.251	0.0641	5,250	3,869	82,000	60,500	32	—
35+89, 57", 1:27pm, 3-8-21	0.1241	0.250	0.0310	2,329	1,469	75,000	47,300	32	—
34+00, 41", 7:45pm, 3-9-21	0.1951	0.250	0.0488	4,241	3,166	87,000	65,000	30	—
17+30, 41", 12:45pm, 3-8-21	0.1151	0.251	0.0289	2,484	1,843	86,000	64,000	25	—
44+44, 12", 8:24am, 39-21	0.2447	0.251	0.0615	4,891	3,825	79,500	62,000	32	—

ISO 9001

Prepared by: A. Anderson
Materials Testing

Reviewed by: W. R. Allen
Materials Testing

CHEMICAL TEST REPORT

Ref. 353667 **Date** April 20, 2021 **Page** 2 **of** 3

Customer: Southern Cathodic Protection, 780 Johnson Ferry Road, Suite 225, Atlanta, GA 30342

Attention: Christopher McKinley

Purchase Order #: 1824-CRM Part #/Name: See below

Material Designation: 5L Carbon Steel Pipe, PSL 1, Steel Grade B

Special Requirement: N/A

Lab Comment: Analyzed using ASTM E415-17 as a guide.

Test Results

Composition: Weight %

Identification	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V
Alloy or Spec. Req. (1)	0.28 max	1.20 max	0.030 max	0.030 max	—	—	—	—	—	—
00+60, 33", 2:05pm, 3-8-21	0.18	0.82	0.023	0.011	0.06	0.09	0.06	0.05	0.01	<0.01
21+18, 36", 12:10pm, 3-8-21	0.14	0.97	0.026	0.015	0.05	0.09	0.07	0.08	0.01	<0.01
35+89, 57", 1:27pm, 3-8-21	0.22	0.68	0.019	0.025	0.08	0.10	0.08	0.05	0.01	<0.01
34+00, 41", 7:45pm, 3-9-21	0.18	1.18	0.030	0.013	0.05	0.08	0.06	0.07	0.01	<0.01
17+30, 41", 12:45pm, 3-8-21	0.17	1.23 (2)	0.021	0.017	0.04	0.07	0.05	0.04	0.01	<0.01
44+44, 12", 8:24am, 39-21	0.16	0.91	0.022	0.020	0.06	0.10	0.05	0.05	0.01	<0.01

Sample meets chemical requirements.

Sample will also meet other Steel Grade chemical requirements.

(1) API Specification 5L/ISO 3183, 44th edition, Oct. 1, 2007, PSL 1 pipe, Steel Grade B

(2) For each reduction of 0,01 % below the specified maximum concentration for carbon, an increase of 0,05 % above the specified maximum concentration for manganese is permissible, up to a maximum of 1,65 %.

ISO 9001

Prepared by: K. Banyas
Chemist

Approved by: D. M. McKay
Supervisor

non-standard test method, ATS does not assume responsibility for validation of the method. Measurement uncertainty available upon request where applicable.

CHEMICAL TEST REPORT

Ref. 353667 **Date** April 20, 2021

Customer: Southern Cathodic Protection, 780 Johnson Ferry Road, Suite 225, Atlanta, GA 30342

Attention: Christopher McKinley

Purchase Order #: 1824-CRM Part #/Name: See below

Material Designation: 5L Carbon Steel Pipe, PSL 1, Steel Grade B

Special Requirement: N/A

Lab Comment: Analyzed using ASTM E415-17 as a guide.

Test Results

Composition: Weight %

Identification	Nb	Ti	(2)	(3)						
Alloy or Spec. Req. (1)	—	—	0.06 max	0.15 max	—					
00+60, 33", 2:05pm, 3-8-21	0.03	<0.01	<0.06	<0.15						
21+18, 36", 12:10pm, 3-8-21	0.02	<0.01	<0.06	<0.15						
35+89, 57", 1:27pm, 3-8-21	<0.01	<0.01	<0.06	<0.15						
34+00, 41", 7:45pm, 3-9-21	0.04	<0.01	<0.06	<0.15						
17+30, 41", 12:45pm, 3-8-21	0.04	<0.01	<0.06	<0.15						
44+44, 12", 8:24am, 39-21	0.02	<0.01	<0.06	<0.15						

Sample meets chemical requirements.

Sample will also meet other Steel Grade chemical requirements.

(1) API Specification 5L/ISO 3183, 44th edition, Oct. 1, 2007, PSL 1 pipe, Steel Grade B

(2) Nb + V

(3) Nb + V + Ti

ISO 9001

Prepared by: K. Banyas, Chemist

Approved by: D. M. McKay, Supervisor

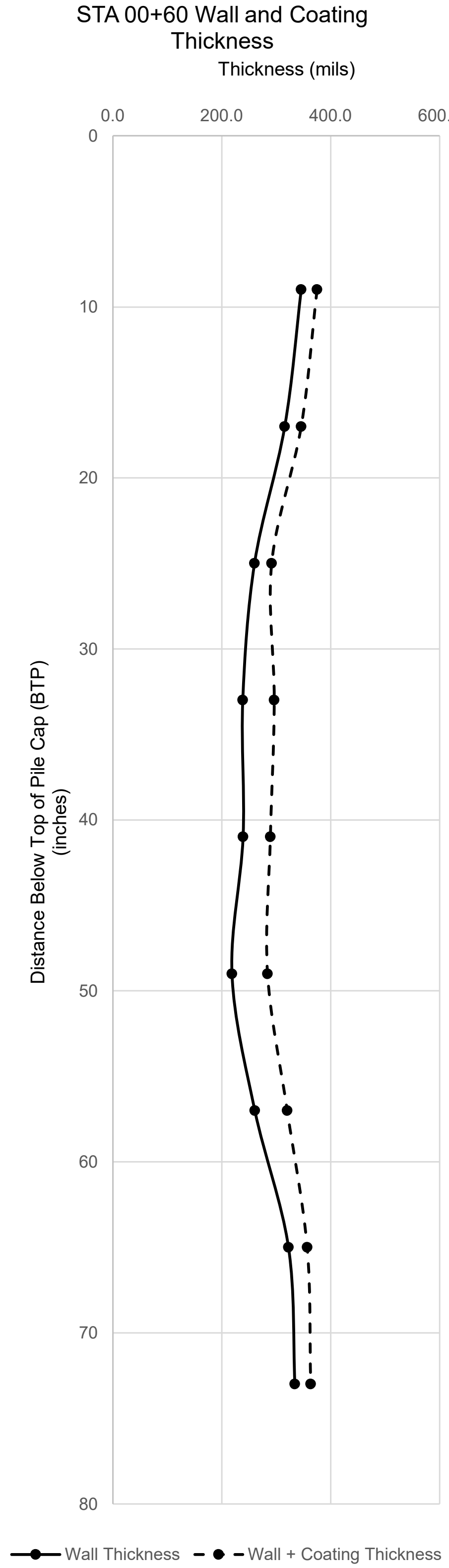
EXHIBIT 2

Ultrasonic Metal & Coating Thickness Measurements

Morgan Creek Harbor Corrosion Assessment Report
Jon Guerry Taylor & Associates, Inc.
May 26, 2021

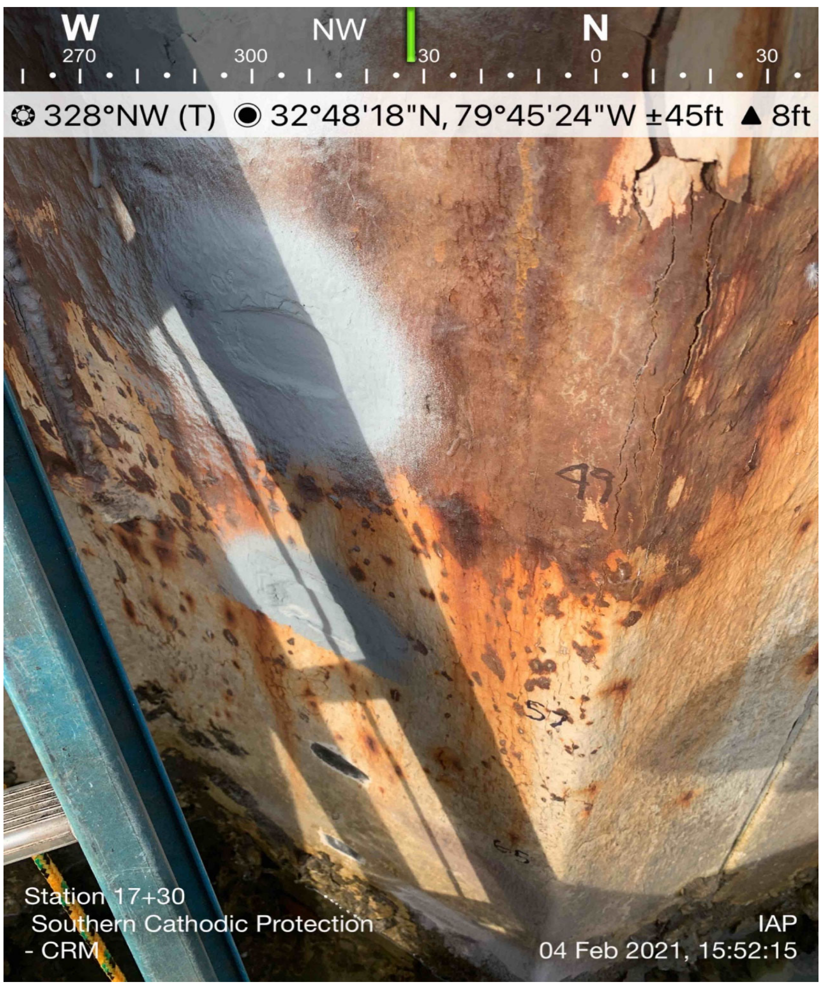
MATERIAL THICKNESS TEST REPORT - 0+60

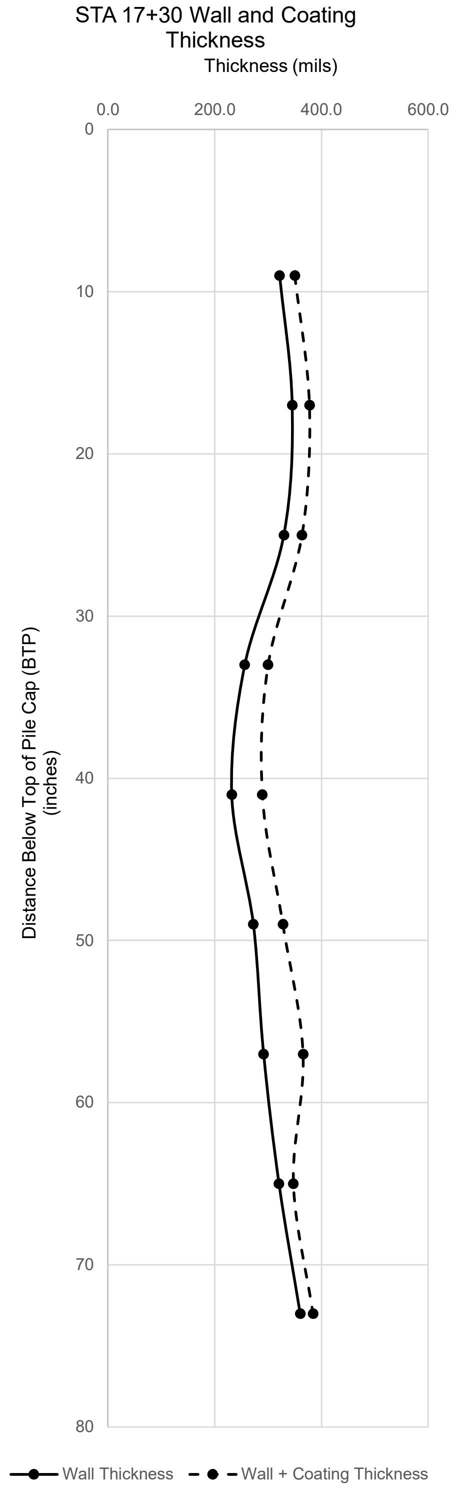
		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
9	1	346.0	2.4	349	342	28.96	2.21	32.7	25.5
17	2	315.7	1.9	318	313	30.11	2.94	36.7	26.7
25	3	260.2	7.7	268	250	31.51	2.48	35.0	27.9
33	4	238.4	0.8	240	237	58.03	5.01	67.8	50.0
41	5	239.2	2.9	245	236	49.94	4.38	55.1	42.5
49	6	218.7	2.9	221	214	65.41	3.09	68.9	61.0
57	7	260.8	2.0	264	257	59.27	2.33	63.5	56.5
65	8	322.6	1.0	324	321	34.06	2.54	38.2	28.8
73	9	334.4	1.6	338	333	29.07	3.00	33.6	26.2



MATERIAL THICKNESS TEST REPORT - 17+30

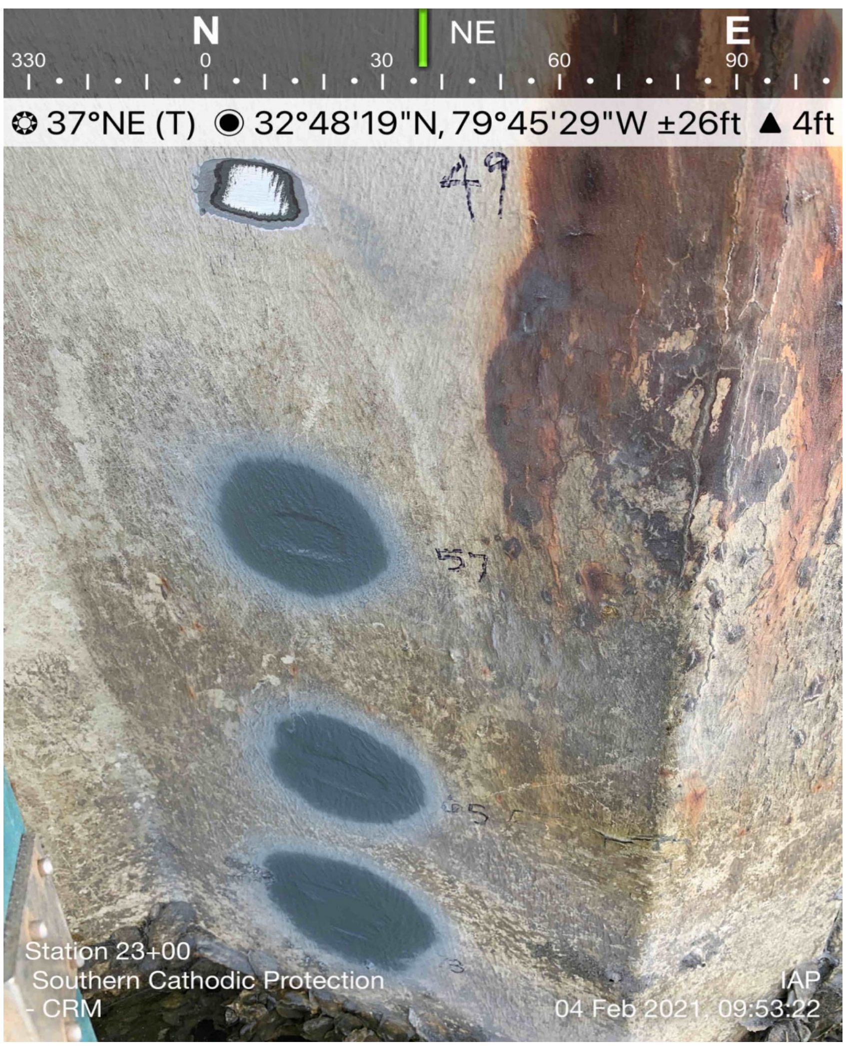
		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
9	1	321.5	1.1	323	319	28.67	1.19	30.2	26.9
17	2	345.4	3.7	349	337	32.21	1.87	35.0	30.0
25	3	329.7	1.1	331	328	33.95	2.61	36.5	27.6
33	4	256.3	1.5	260	255	43.75	2.56	47.1	39.6
41	5	232.0	4.5	240	225	57.23	3.39	64.1	50.8
49	6	272.5	0.7	273	271	55.30	2.79	59.0	50.8
57	7	291.6	6.9	303	283	74.10	1.29	76.3	72.2
65	8	320.4	2.1	324	317	27.02	2.13	30.0	24.6
73	9	360.1	3.5	365	353	24.04	2.13	27.8	20.8

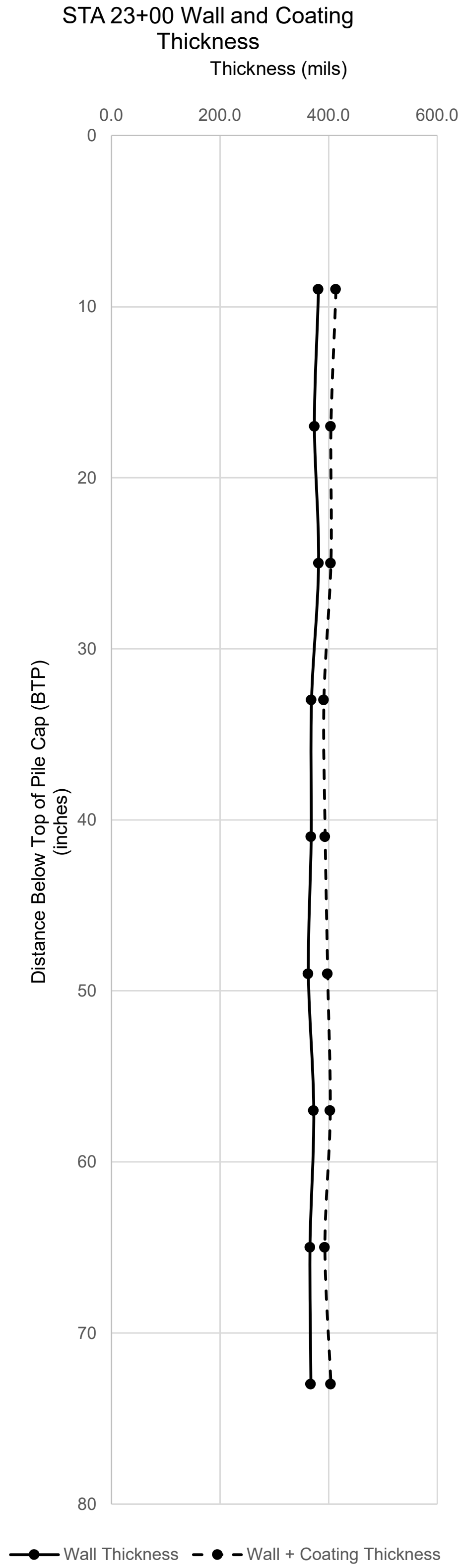




MATERIAL THICKNESS TEST REPORT - 23+00

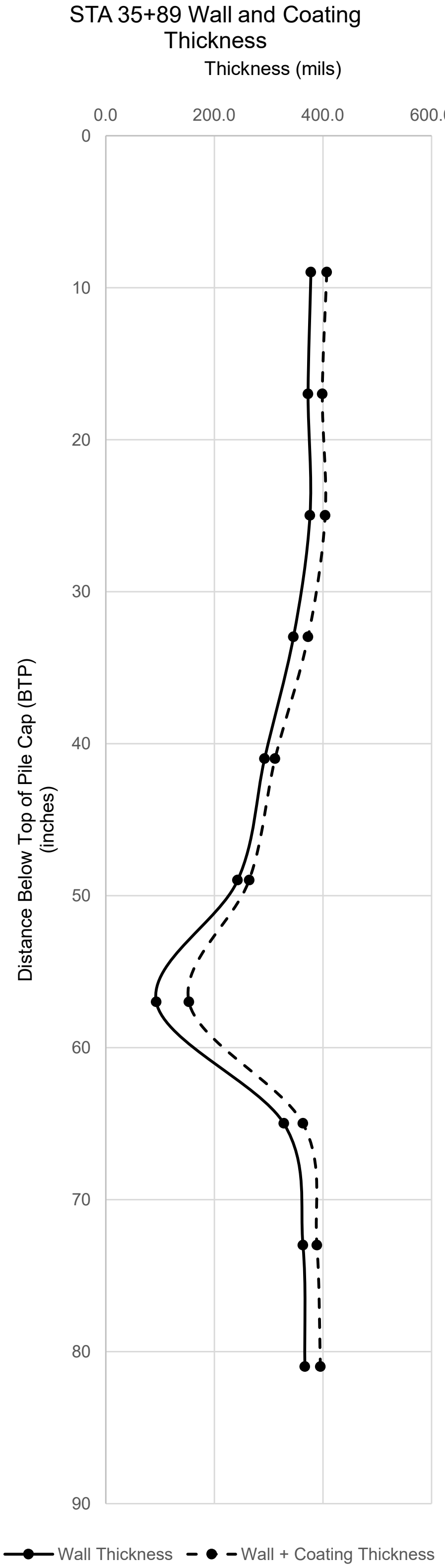
		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
9	1	381.3	2.9	386	376	32.31	2.05	35.8	29.2
17	2	373.9	1.5	377	372	30.29	1.23	32.2	28.7
25	3	381.5	1.0	383	380	22.62	1.01	24.3	20.5
33	4	368.2	1.8	370	366	22.88	2.03	28.0	21.4
41	5	367.5	0.7	368	366	25.97	1.29	27.7	23.1
49	6	362.7	1.1	364	360	35.34	1.74	37.6	33.3
57	7	372.4	1.4	374	370	30.43	1.04	31.9	28.7
65	8	365.7	1.2	367	363	27.36	1.99	31.3	25.3
73	9	367.2	1.1	369	366	37.07	3.35	41.9	31.7





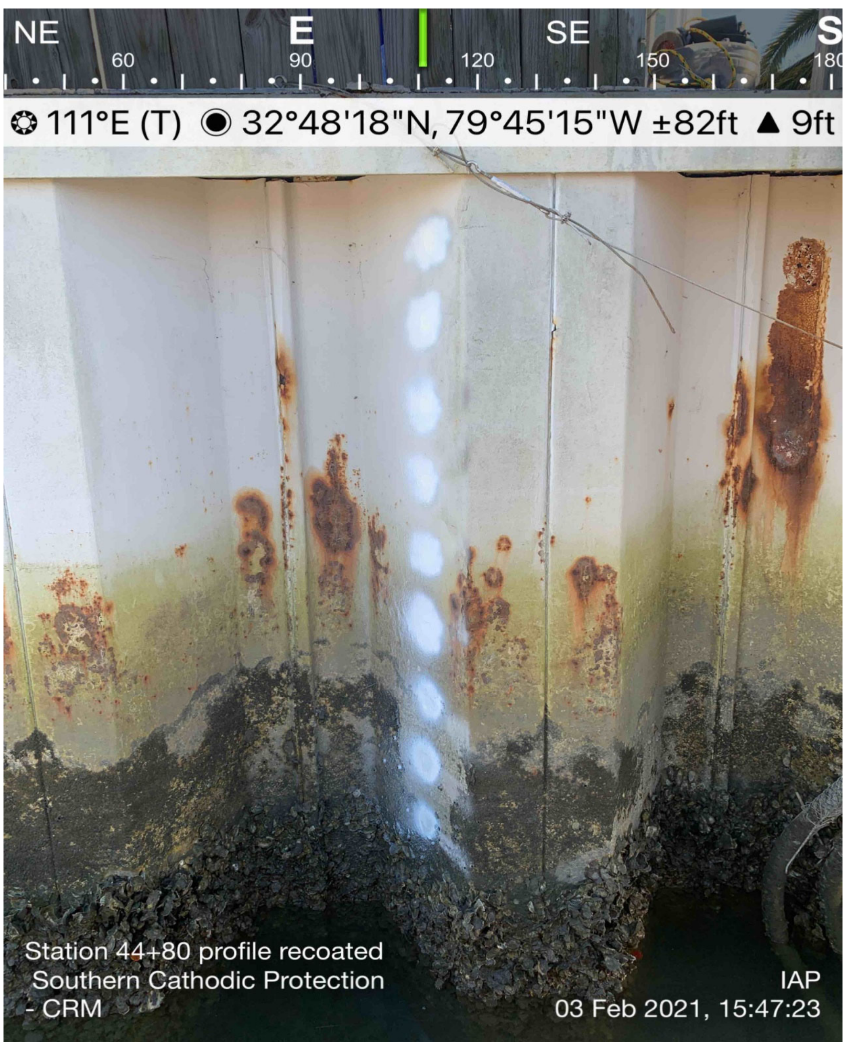
MATERIAL THICKNESS TEST REPORT - 35+89

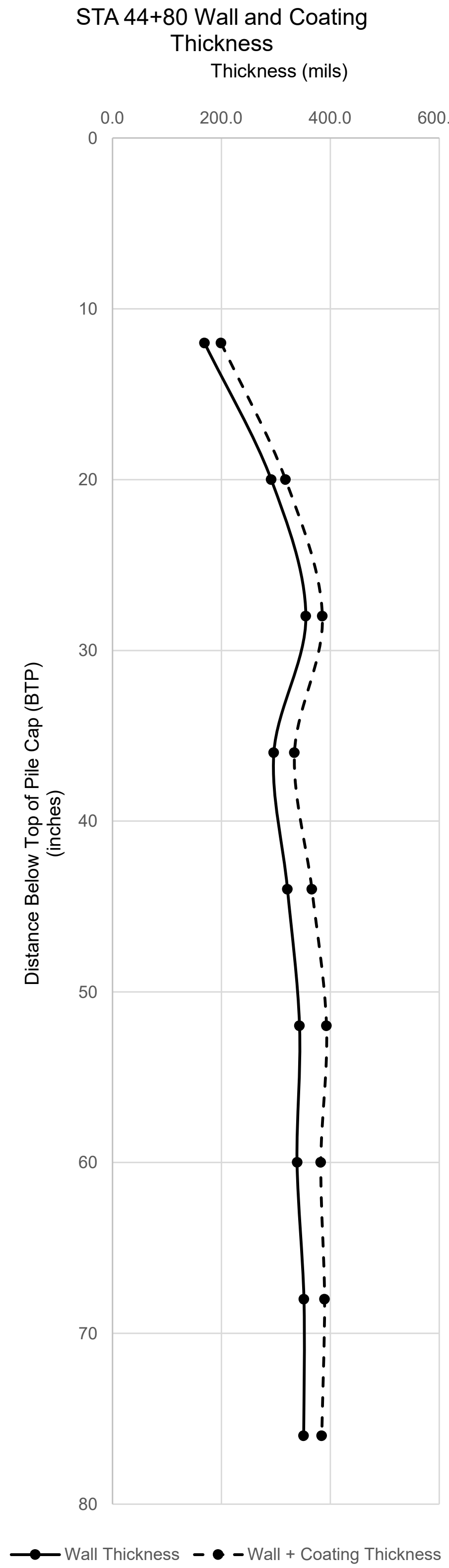
		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
9	1	377.7	2.3	381	373	29.37	3.35	34.6	27.0
17	2	372.7	3.9	377	364	25.96	2.05	30.0	22.8
25	3	375.9	1.5	379	374	27.84	1.92	29.8	23.9
33	4	345.7	2.6	351	342	26.82	1.08	28.0	25.1
41	5	292.4	1.1	295	291	19.12	3.42	25.7	14.2
49	6	242.8	8.2	250	233	21.12	1.49	23.5	18.7
57	7	93.1	2.8	97	89	60.06	6.55	73.1	50.6
65	8	327.9	1.7	330	324	34.98	10.19	54.7	19.0
73	9	363.0	1.1	364	361	25.57	3.04	30.6	21.2
81	10	366.7	2.4	371	363	28.59	1.55	31.1	26.0



MATERIAL THICKNESS TEST REPORT - 44+80

		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
12	1	168.9	1.4	167	171	30.58	1.04	29.1	32.3
20	2	291.3	2.2	286	293	26.64	1.07	24.8	28.8
28	3	354.9	1.7	351	357	30.64	3.10	26.5	37.3
36	4	296.4	2.0	294	300	37.91	2.93	33.8	42.2
44	5	321.4	1.0	319	322	44.68	1.93	41.2	57.4
52	6	343.7	0.5	343	344	49.34	2.84	44.8	55.0
60	7	339.1	1.3	337	341	43.18	2.67	38.2	46.5
68	8	351.5	1.0	350	353	37.86	3.01	32.0	42.4
76	9	351.3	0.7	351	353	33.14	1.77	30.6	35.9





MATERIAL THICKNESS TEST REPORT - 60+90

		Metal Thickness				Coating Thickness			
BTP	#	Mean	St. Dev.	Min.	Max.	Mean	St. Dev.	Min.	Max.
18	1	191.4	1.1	189	192	46.05	1.76	43.2	48.7
26	2	333.8	3.3	328	340	14.04	2.56	11.4	20.1
34	3	227.0	9.5	209	236	29.82	1.67	47.9	52.8
42	4	248.8	1.0	247	250	29.05	2.68	25.8	32.6
50	5	307.3	1.4	304	309	46.79	1.82	43.5	48.8
58	6	296.7	1.3	295	299	33.79	4.81	27.2	40.4
66	7	271.9	5.3	264	281	22.35	2.14	19.4	25.9
74	8	367.2	1.4	364	369	19.45	2.36	14.6	22.0
82	9	365.1	0.6	364	366	20.81	2.48	17.0	23.7
90	10	368.4	1.8	366	371	26.38	4.67	19.6	32.5

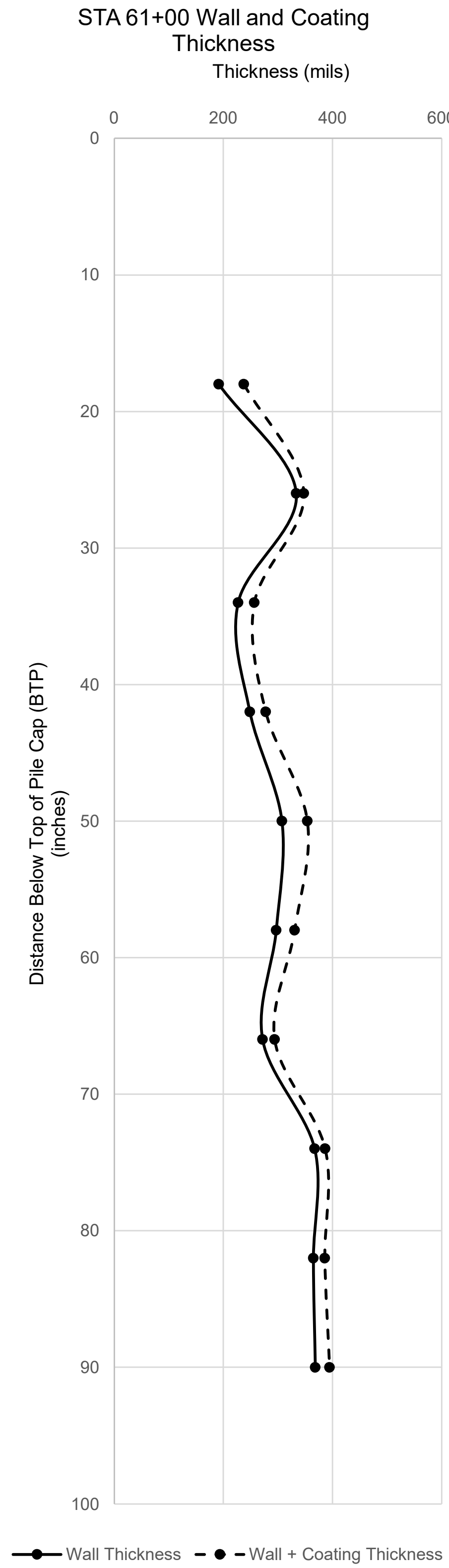


EXHIBIT 3

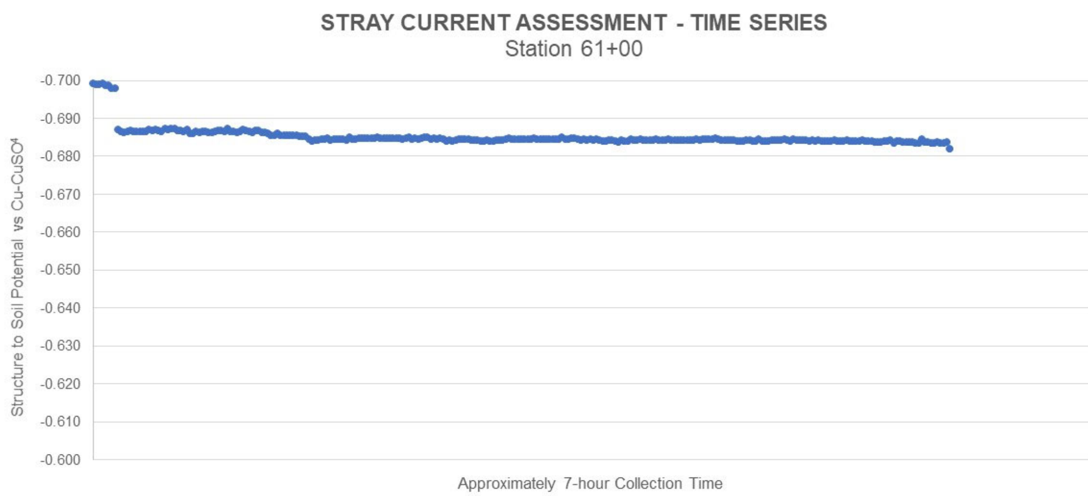
Stray Current Test Results: Data Logger & Spot Measurements

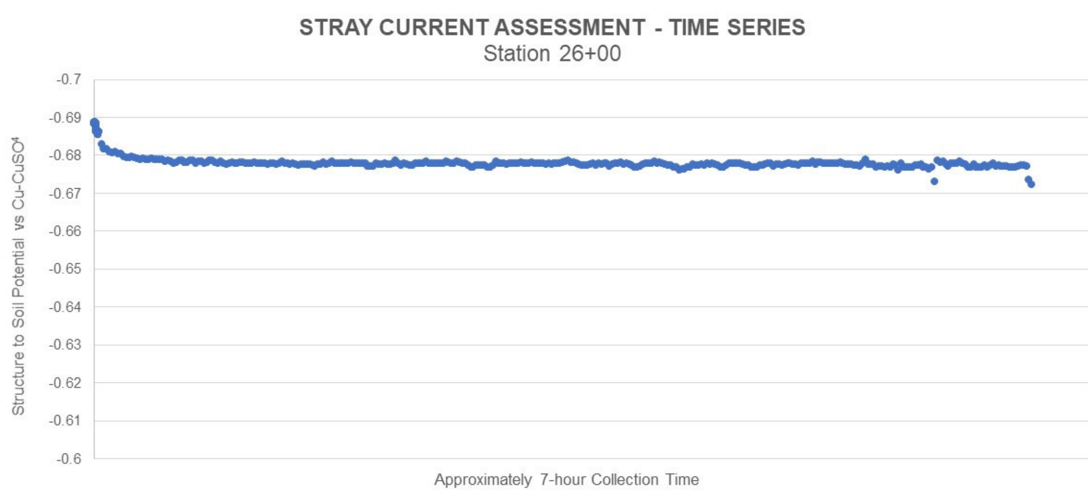
Morgan Creek Harbor Corrosion Assessment Report
Jon Guerry Taylor & Associates, Inc.
May 26, 2021

STRAY CURRENT POTENTIAL TESTING

Structure Tested	Station No.	Potential millivolts DC	Potential Volts AC	Notes
On Pile Cap	2+50	-658	0.00	
Dock Ramp	3+15	-1068	0.00	Ramp isolated from wall, potential source unknown
On Pile Cap	3+15	-608	0.00	
Private Dock	4+15	-613	0.00	
Private Dock	5+30	-607	0.00	
Private Dock	6+50	-609	0.00	
Ramp	7+70	-709	0.00	
Private Dock	7+70	-612	0.00	
Isolated Private Ramp	8+70	-598	0.00	
Isolated Private Ramp	9+90	-610	0.00	
Isolated Private Ramp	11+15	-595	0.00	
Isolated Private Ramp	12+45	-593	0.00	
Isolated Private Ramp	13+20	-712	0.00	
Isolated Private Ramp	13+20	-595	0.00	
Isolated Private Ramp	14+30	-600	0.00	
Isolated Private Ramp	15+50	-571	0.00	
Isolated Private Ramp	16+60	-593	0.00	
Isolated Private Ramp	17+50	-599	0.00	
Isolated Private Ramp	18+65	-592	0.00	
Isolated Private Ramp	21+10	-608	0.00	
Isolated Private Ramp	22+50	-605	0.00	
Isolated Private Ramp	23+80	-608	0.00	
Isolated Private Ramp	25+30	-606	0.00	
Isolated Private Ramp	28+20	-635	0.00	
Isolated Private Ramp	28+60	-637	0.00	
Isolated Private Ramp	29+10	-637	0.00	
Isolated Private Ramp	29+50	-626	0.00	
Isolated Private Ramp	29+90	-620	0.00	
Isolated Private Ramp	30+40	-633	0.00	
Isolated Private Ramp	30+90	-643	0.00	
Isolated Private Ramp	31+30	-641	0.00	
Isolated Private Ramp	31+80	-629	0.00	
Isolated Private Ramp	32+30	-646	0.00	
Isolated Private Ramp	32+40	-646	0.00	
Isolated Private Ramp	33+00	-638	0.00	
Isolated Private Ramp	33+50	-640	0.00	
Isolated Private Ramp	34+10	-649	0.00	
Isolated Private Ramp	34+40	-646	0.00	
Isolated Private Ramp	34+95	-647	0.00	
Isolated Private Ramp	35+50	-634	0.00	
On Pile Cap	35+90	-641	0.00	

Isolated Private Ramp	35+90	-856	0.00
Private Ramp	36+90	-694	0.00
Private Ramp	37+20	-641	0.00
Private Ramp	37+70	-653	0.00
Private Ramp	38+20	-644	0.00
Private Ramp	38+60	-657	0.00
Wood Ramp @ J Dock	44+75	-735	0.00
Aluminum Ramp @ H Dock	46+00	-656	0.00
Aluminum Ramp @ G Dock	48+00	-654	0.00
Aluminum Ramp @ F Dock	49+50	-664	0.00
Aluminum Ramp @ E Dock	51+10	-664	0.00
Aluminum Ramp @ D Dock	52+80	-664	0.00
Aluminum Ramp @ C Dock	55+00	-661	0.00
Private Ramp	56+40	-643	0.00
Aluminum Ramp @ B Dock	57+00	-670	0.00
Aluminum Ramp @ A Dock	59+00	-704	0.00
Wall @ Ramp A Dock	59+00	-662	0.00
Aluminum Ramp	60+00	-700	0.50


STRAY CURRENT ASSESSMENT - TIME SERIES
Station 61+00
Structure to Soil Potential vs Cu-CuSO4
-0.700
-0.690
-0.680
-0.670
-0.660
-0.650
-0.640
-0.630
-0.620
-0.610
-0.600
Approximately 7-hour Collection Time


STRAY CURRENT ASSESSMENT - TIME SERIES
Station 26+00
Structure to Soil Potential vs Cu-CuSO4
-0.7
-0.69
-0.68
-0.67
-0.66
-0.65
-0.64
-0.63
-0.62
-0.61
-0.6
Approximately 7-hour Collection Time

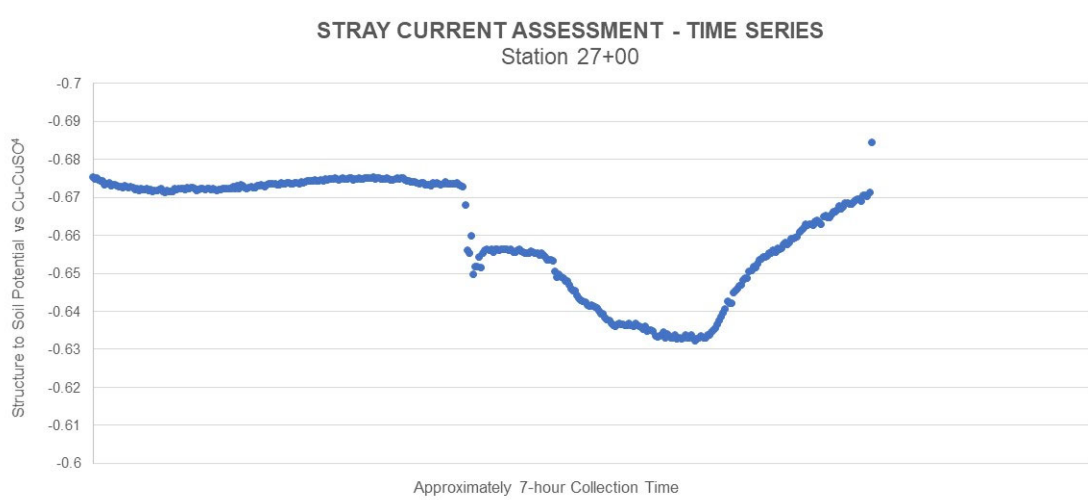

STRAY CURRENT ASSESSMENT - TIME SERIES
Station 27+00
Structure to Soil Potential vs Cu-CuSO4
-0.7
-0.69
-0.68
-0.67
-0.66
-0.65
-0.64
-0.63
-0.62
-0.61
-0.6
Approximately 7-hour Collection Time

EXHIBIT 4

Electrochemical Potential Measurements – Vertical Profiles

Morgan Creek Harbor Corrosion Assessment Report
Jon Guerry Taylor & Associates, Inc.
May 26, 2021

POTENTIAL PROFILE MEASUREMENTS

Station No.	Potential Measurements Water Surface millivolts DC	Mid-Depth millivolts DC	Mud Line millivolts DC	Top of Pile Soil Surface millivolts DC	Notes
0+00	N/A	N/A	-668	-455	
1+00	-679	-679	-674	-414	
2+00	-674	-676	-678	-518	
3+00	-675	-649	-676	-398	
4+00	-677	-679	-680	-399	
5+00	-680	-681	-682	-409	
6+00	-668	-675	-679	-435	
7+00	-672	-675	-676	-441	
8+00	-664	-668	-671	-431	
9+00	-664	-668	-671	-388	
10+00	-672	-675	-677	-453	
11+00	-664	-667	-667	-457	
12+00	-669	-671	-672	-462	
13+00	-673	-675	-676	-334	
14+00	-672	-675	-678	-452	
15+00	-668	-671	-672	-489	
16+00	-670	-673	-675	-519	
17+00	-672	-676	-678	-486	
18+00	-673	-675	-677	-405	
19+00	-679	-679	-678	-496	
20+00	-679	-683	-686	-422	
21+00	-681	-683	-684	-383	
22+00	-684	-685	-686	-428	
23+00	-687	-689	-689	-416	
24+00	-689	-690	-690	-426	
25+00	-688	-688	-689	-435	
26+00	-683	N/A	-684	-532	End of wall, shallow water
27+00	N/A	N/A	N/A	-558	At teeing ground, end of wall, no water
28+00	-669	-669	-669	-433	
29+00	-678	-678	-678	-485	
30+00	-671	-670	-670	-403	
31+00	-680	-679	-680	-387	
32+00	-645	-640	-642	-440	
33+00	-662	-647	-649	-425	
34+00	-628	-616	-620	-319	
35+00	-669	-667	-669	-412	
36+00	-674	-675	-677	-339	
37+00	-668	-668	-669	-410	
38+00	-668	-668	-668	-403	

39+00	-670	-670	-671	-415
40+00	-677	-677	-677	-426
41+00	-679	-679	-680	-385
42+00	-637	-639	-642	-402
43+00	-645	-645	-643	-342
44+00	-673	-673	-673	-397
45+00	-658	-653	-653	-454
46+00	-650	-647	-647	-424
47+00	-638	-638	-638	-485
48+00	-662	-646	-642	-487
49+00	-670	-652	-650	-492
50+00	-658	-658	-651	-401
51+00	-651	-658	-651	-363
52+00	-656	-656	-657	-431
53+00	-670	-650	-650	-439
54+00	-669	-657	-657	-461
55+00	-671	-668	-669	-385
56+00	-671	-673	-672	-380
57+00	-681	-680	-679	-476
58+00	-656	-614	-610	-426
59+00	-656	-619	-615	-477
60+00	-660	-636	-634	-453
61+00	-665	-642	-661	-650

EXHIBIT 5

Electrochemical Properties of Soil & Water Samples

Morgan Creek Harbor Corrosion Assessment Report
Jon Guerry Taylor & Associates, Inc.
May 26, 2021

MORGAN CREEK HARBOR SOIL SAMPLES - LAB TESTING

Project Name:	14773 - Jon Guerry Taylor and Associates - Morgan Creek Harbor Sheet Pile Assessment
Sample Date:	1/28/21-2/4/21, 3/8/21-3/9/21

Sam. No.	Sample Collection Location, Depth[1], Time, Date	pH 1 - 14	Resistivity ohm-cm	Chloride mg/L	Sulfate mg/L	Sulfides + or -	Redox mV	Description
1	00+60, 33"; 1405, 3/8/21	6	3,360	>614	-	-	-	Moist, dark tan sand
2	17+30, 41"; 1248, 3/8/21	6	6,800	>614	-	-	-	Moist, dark tan sand
3	21+18, 36", 1210, 3/8/21	6	10,800	<MDL	-	-	-	Moist, dark grey sand
4	34+00, 41"; 0745, 3/9/21	5	1,240	286	-	-	-	Large gravel
5	35+81, 57"; 1327, 3/8/21	7	128	>614	-	-	-	Gravel with dark brown liquid mud
6	44+44, 12"; 0824, 3/9/21	6	11,200	<MDL	-	-	-	Dark brown sand
7	23+00, 12"; 1415, 2/4/21	5	48,000	<MDL	-	-	-	Dark grey, fine sand
8	27+50, 6"; 1605, 1/28/21	5	76	361	-	-	-	Dark, thick mud/clay
9	35+89, 20"; 17:00, 2/3/21	6	12,800	<MDL	-	-	-	Dark grey, fine sand

Laboratory Temperature: Approx. 72 F

<MDL = less than method detection limit of 32 mg/L chlorides.

mg/L = milligrams per liter, equivilant to parts per million (ppm)

1. Depth = measured in inches below top of pile cap (BTP)

MORGAN CREEK HARBOR WATER SAMPLES - LAB TESTING								
Project Name:	14773 - Jon Guerry Taylor and Associates - Morgan Creek Harbor Sheet Pile Assessment							
Sample Date:	2/3/21, 2/4/21							
Sam. No.	**Sample Collection Location, Time**	**pH** 1 - 14	**Resistivity** ohm-cm	**Chloride** mg/L	**Sulfate** mg/L	**Sulfides** + or -	**Redox** mV	**Description**
1	Sta. 00+60; 17:00	6	29.2	-	-	-	-	Clear water sample from harbor
2	Sta. 17+30; 12:01	6	32	-	-	-	-	Clear water sample from harbor
3	Sta. 23+00; 10:33	6	31.6	-	-	-	-	Clear water sample from harbor
4	Sta. 35+89; 18:09	6	32.4	-	-	-	-	Clear water sample from harbor
5	Sta. 44+80; 14:58	6	33.2	-	-	-	-	Clear water sample from harbor
6	Sta. 61+30; 11:00	6	37.2	-	-	-	-	Clear water sample from harbor

Laboratory Temperature: Approx. 72 F

<MDL = less than method detection limit of 600 mg/L sulfates

mg/L = milligrams per liter, equivilant to parts per million (ppm)