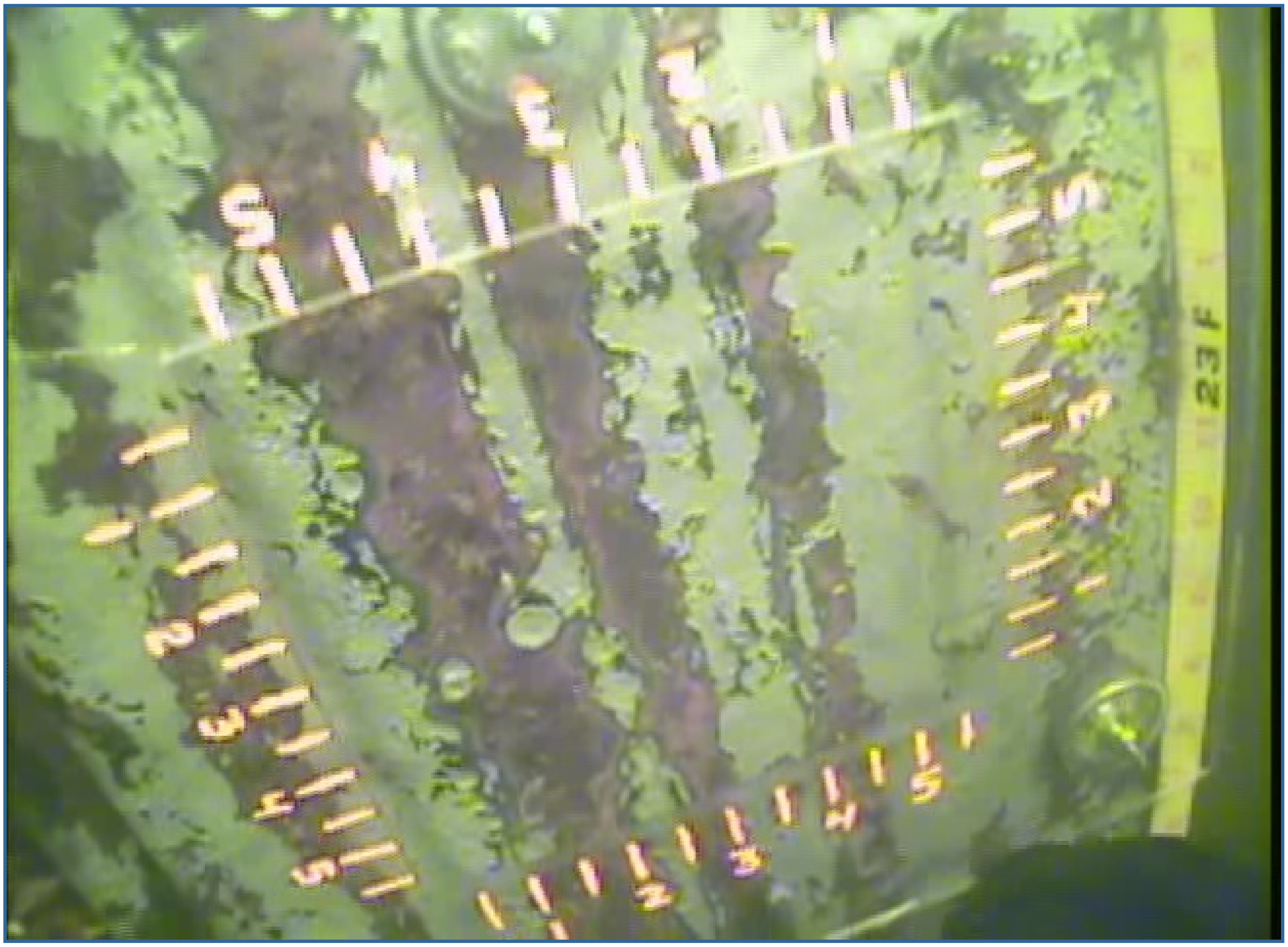
DSPA CORROSION INVESTIGATION REPORT



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DSPA CORROSION INVESTIGATION REPORT

AMI #061016 DATE: JULY to DECEMBER, 2006

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Project Description

The Accelerated Freshwater Corrosion Study in the Duluth / Superior Harbor was initiated in 2003 to further investigate the findings of preliminary accelerated corrosion data. In 2004, a panel of corrosion experts was brought together by the financial support by the Minnesota and Wisconsin Sea Grant programs, the University Of Minnesota Duluth (UMD) Natural Resources Research Institute the Army Corps of Engineers (ACOE) and the Duluth Seaway Port Authority (DSPA). The results from the corrosion expert panels two day workshop was published by the Army Corps of Engineers in the ERDC/CERL SR-05-3 publication dated March 2005. The panel of experts present made recommendations on future short and long term testing which would be necessary to narrow down the list of possible causes of accelerated corrosion and to determine the full extent of the process around the entire harbor. The recommendations for the short term included corrosion rate monitoring, water chemistry analysis, corrosion product and microbiologically induced corrosion (MIC) analysis, stray current testing and the critically needed condition assessments and structural characterization. Long term recommendations included condition based inspection strategy for repair / replacement management, ongoing monitoring, developing a standard replacement design using both coatings and cathodic protection (CP), and initiating a corrosion characterization survey of other great lakes port facilities.

Scope of Work

The scope of work included in this report was recommended by the expert panel as the short term recommendations for the corrosion study. Through funding from the Minnesota DNR, the Duluth Seaway Port Authority was able to contract with AMI Consulting engineers to complete the following investigations and data gathering on the non-federal structures:

Non-Federal Structure Data Gathering
Underwater visual and tactile inspection
Non destructive testing
Water Quality Measurements (Bulk water completed by ACOE)
Corrosion rate measurements
Biological Sampling (testing to be completed by UMD)
Coupon tray engineering, design and installation
Complete documentation

All data was to be collected and reported in a manner consistent with the needs of the study being undertaken by both the DSPA and the Army Corps of Engineers. Through meetings with the local corrosion committee members, the Duluth Superior harbor inspection points were located and chosen based on their proximity to one another throughout the harbor and based on the existence of adequate steel members to be inspected. The sample points extended from the Oliver Bridge in the St Louis River to the harbor entries on both the Superior and Duluth sides. All structures would require very precise timing and coordination because of the significant shipping activity in these areas and the abrupt change in weather affecting the sites.

AMI Consulting Engineers utilized our 22 foot Hewes Craft pilot house dive boat with a 200HP Honda motor and a surface supplied dive spread. The diver's surface supplied air was provided from a high pressure bank system to the diver's helmet. The primary helmet was a SL-27 with a band mask standby system. Bailout bottles were required for all dives. The diver's visual inspections were documented utilizing an Outland color video camera and light. This system was connected to a computer system capable of collecting and backing up all video data colleted. The non-destructive testing equipment utilized for the project was a Dakota Ultrasonics MX3 system with an underwater housing and transducer. The system was calibrated with a certified calibration step block, 4340 FE SN#06-1200, before every use to insure accuracy of the measurements. Standard dive and field data forms were generated and utilized to collect all the general field data and then transferred into the electronic forms.

AMI Consulting Engineers provided the following detailed scope of services as directed by Jim Sharrow of the DSPA:

The detailed scope of services finalized was as follows:

- Attend a meeting with the DSPA and other corrosion committee members to organize the investigation and set protocols for work at the selected investigation sites.

- Developed with the DSPA a permission form and release for work on private property selected. Acquired signed permission and submitted insurance certificates to each property owner.

- Prepared a dive plan policy and procedures, emergency action assessment and safety plan.

- Developed protocol to advise the local authorities and private owners on weekly and daily movement for security concerns.

- Prepare all pre/ post dive and field collection forms.

- Provided all dive equipment, cleaning equipment, digital video camera equipment, GPS and Non destructive testing equipment.

- Provide a three man dive team meeting all OSHA, Coast Guard and ADCI standards and regulations for commercial diving.

- Properly mark above the waterline a permanent reference mark to IGLD with a grinder and record GPS location data in Latitude/Longitude format.

- Perform specific underwater visual and tactile inspections on all approved non-federal structure locations. Inspections included all cleaning, NDT and corrosion measurements

- Documented conditions with digital video system.

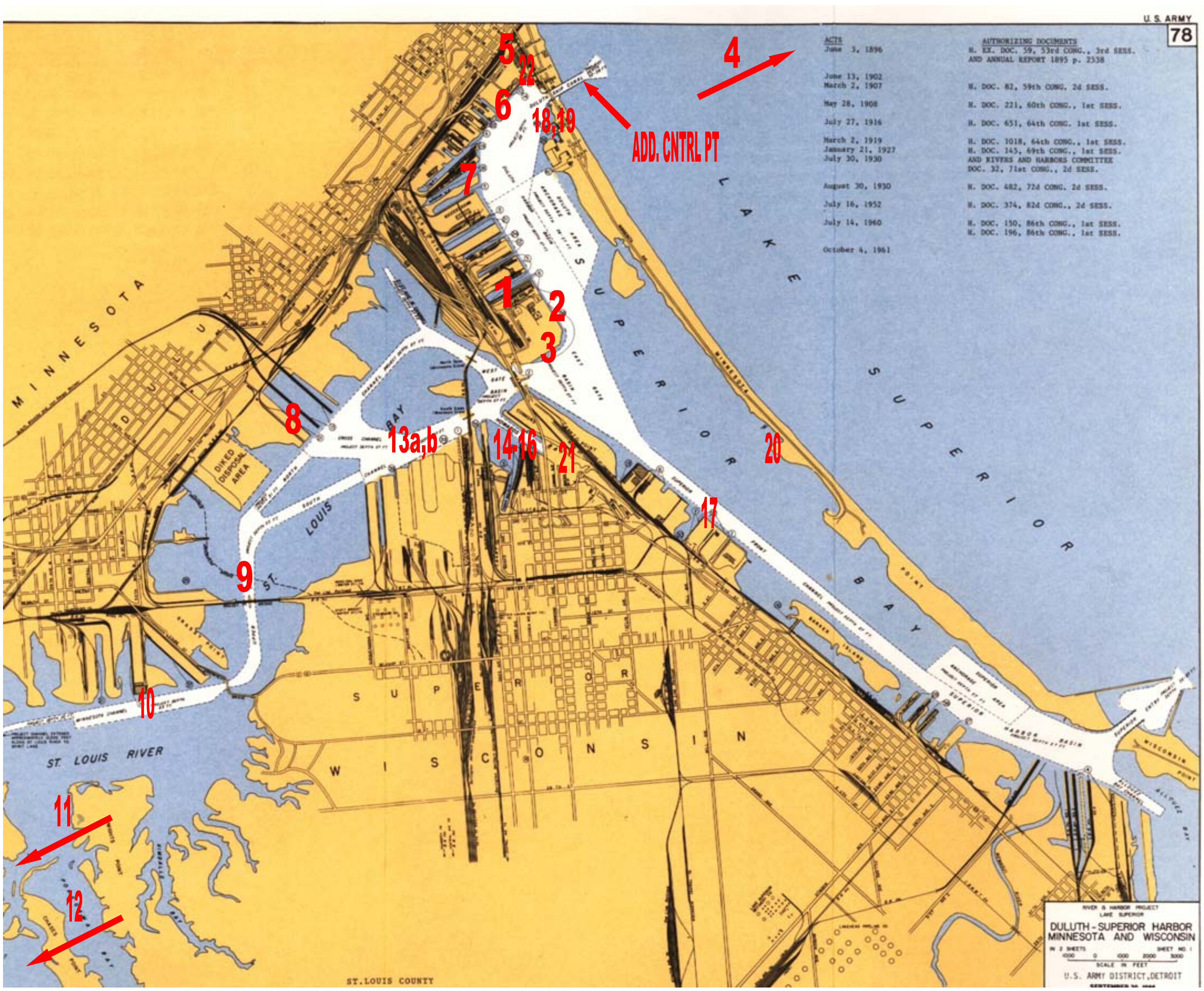
- Recorded all marine growth notes, overall plate thickness measurements, 4 pit depth readings, 4 diameter readings and concentrations at two foot elevation to -10 feet IGLD and then five foot increments to the mud line. All measurements were taken within a 6"x6" relative area for comparison.

- Performed instantaneous water quality measurements utilizing the Quanta Hydro Lab.

- Assisted Dr. Randall Hicks at UMD in the collection of biological samples.
- Performed instantaneous Linear Polarization corrosion rate measurements.
- Designed, fabricated and installed coupon trays and coupons.

Field Data Collection

The collection of the underwater data and topside data was conducted between the dates of July 20th 2006 and November 29th, 2006. The project started with the inspections at the DSPA Berth 1 and ended with the final corrosion measurements at the Duluth entry. To provide proper time management and minimize down times, the water quality measurements and the underwater corrosion measurements were taken at the same time.



Site 1-DSPA Bulkhead Berth 1 - Duluth

The DSPA Berth 1 facility is operated by Lake Superior Warehousing and consisted of a steel sheet pile bulkhead with a metal cap. This facility sees moderate use for the receipt and shipping of general cargo in foreign and domestic trade, including heavy lift items and finished steel products. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD and below on the out pans and instantaneous water quality measurements. Nothing unusual was noted at the site.

Site 2- DSPA Bulkhead Berth 4 – Duluth

The DSPA Berth 4 facility is operated by the Murphy Oil USA company and consisted of a steel sheet pile bulkhead with a metal cap. This facility sees high use for the refueling of all types of vessels for both the foreign and domestic trade. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD and below on the out pans, instantaneous water quality measurements and instantaneous corrosion measurement. This site was fitted with a coupon tray with coupons for measurements in 2007. This site has seen a high amount of scour due to the activity level.

Site 3- DSPA Bulkhead Berth 6 – Duluth

The DSPA Berth 6 facility is operated by the DSPA and consisted of a steel sheet pile bulkhead with a metal cap. This facility sees low use for the receipt and shipping of general cargo in foreign and domestic trade, including heavy lift items. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. Nothing unusual was noted at the site.

Site 4- CN Dock 1 – Two Harbors

The CN Dock 1 is an iron ore pellet vessel loading dock which services both domestic and international shipping. The dock is located outside the Duluth Superior harbor in Agate bay off Lake Superior in Two Harbors, MN. There is a breakwater dividing the small safe harbor from the lake. The bulkhead consists of steel sheet piling with a concrete cap and has recently seen relatively low use. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. The corrosion was generally less concentrated than on the Duluth Superior Harbor structures and appeared to be in much larger connected masses when present. The dome shaped nodules were not present, but a similar thick orange mass was present over the corroded areas.

Site 5- Minnesota Slip Bulkhead - Duluth

The Minnesota Slip bulkhead is operated by the City of Duluth and consists of a steel sheet pile bulkhead with a metal cap. This facility only receives charter, museum and pleasure craft. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. A city storm sewer outlet was present and flowing within 15 feet of the measurement site.

Site 6- DECC Bulkhead- Duluth

The DECC bulkhead is operated by the City of Duluth and consists of a steel sheet pile bulkhead with a metal cap. This facility receives charter, museum, cruise vessels and tour boat craft. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements.

Site 7- Cargill Bulkhead - Duluth

The Cargill bulkhead is owned and operated by Cargill Inc. The bulkhead consists of a steel sheet pile bulkhead with a metal cap. This facility only sees moderate use for the export shipping of general grains for foreign and domestic trade. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. The steel at this site was perforated.

Site 8- Hallett Dock 5 - Duluth

The Hallett 5 bulkhead is owned and operated by Hallett Dock Company. The bulkhead consists of a steel sheet pile bulkhead with a metal cap. This facility only sees moderate use for the import of general bulk materials. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans, instantaneous water quality measurements and instantaneous corrosion measurements. This site was fitted with a coupon tray with coupons for measurements in 2007.

Site 9- Mn/DOT Bong Bridge Cell – Duluth

The Bong Bridge protective cell is owned and maintained by the Minnesota DOT. The cell consists of flat steel sheet pile with a concrete cap. This cell only sees low activity for the protection of the bridge piers from ships that may accidentally loose control in the main shipping channel. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. The steel at this site was originally coated with some form of coal tar epoxy during erection which has retarded the corrosion.

Site 10- Hallett Dock 7

The Hallett 7 bulkhead is owned and operated by Hallett Dock Company. The bulkhead consists of wood Wakefield piling and a concrete cap. This facility only sees low use for the import of general bulk materials. The field data collection for this site included instantaneous water quality measurements and instantaneous corrosion measurements. This site was fitted with a coupon tray with coupons for measurements in 2007.

Site 11- Spirit Lake Marina Pipe Piles – Duluth

The Spirit Lake Marina is operated privately by Judy King. The docks are primarily timber support open wood piling. The area inspected was repaired with sections of steel pipe allowing for the inspection of an additional steel structure this far up stream. This facility only receives charter and pleasure craft. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the bottom of the steel jackets and instantaneous water quality measurements. Tate & Lyle Chemical has a plant intake and power transformer structure located on the adjacent property only 50 feet from the measurements at Spirit Lake Marina.

Site 12- CN Oliver Bridge Pier – Oliver

The Oliver Bridge is owned and operated privately by the CN Railway. The Bridge is primarily constructed with concrete piers. Due to a scour problem around the western pier, steel sheet piling was added to prevent undermining of the bridge pier foundation. The channels on each side of the bridge piers only see pleasure craft. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans, instantaneous water quality measurements and instantaneous corrosion measurements. This site was fitted with a coupon tray with coupons for measurements in 2007. It was also noted during a private bridge inspection that the steel nosing for ice breaking purposes on the upstream side of the bridge piers had heavy pitting which is consistent with the findings on the sheet piling.

Sites 13a & b- Midwest Energy Resources Wharf – Superior

The Midwest Energy wharf is owned and operated by Midwest Energy. The wharf consists of an open steel H-pile bulkhead with a reinforced concrete deck. This facility sees very high usage for the export of coal. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans, instantaneous water quality measurements and instantaneous corrosion measurements. This site was fitted with a coupon tray with coupons for measurements in 2007.

Site 14- Cenex Harvest States East Bulkhead – Superior

The CHS East bulkhead is owned and operated by Cenex Harvest States. The bulkhead consists of a steel sheet pile bulkhead with a deep concrete cap (extending to 3 feet below IGLD) over 75% of the entire bulkhead. This facility only sees moderate use for the export of grain products. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from -3 feet IGLD to the mud line on the out pans and instantaneous water quality measurements. A storm water outlet is present at the inner end of the slip.

Site 15- Cenex Harvest States West Bulkhead – Superior

The CHS West bulkhead is owned and operated by Cenex Harvest States. The bulkhead consists of a steel sheet pile bulkhead with a concrete cap over the entire inner 550 feet of bulkhead. This bulkhead is scheduled for replacement due to perforations, soil loss and anchorage concerns. This inner end of the facility is only used to retain the soil under the dock structure which supports the grain bins next to the waterfront. These bins are used for the storage of different grain products which are exported. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. Nothing else unusual was noted at the site.

Site 16- Cenex Harvest States West Rehabilitated Bulkhead – Superior

The CHS West rehabilitated bulkhead is owned and operated by Cenex Harvest States. The bulkhead consists of a new steel sheet pile bulkhead with a metal cap. This new metal bulkhead was isolated from the previous steel sheet pile wall by the use of crushed stone and the tie back rods were isolated by being encased in concrete. This facility only sees low use by ships and is primarily used to retain the soil under the dock structure which supports the grain bins next to the waterfront. These bins are used for the storage of different grain products which are exported. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. Only aggressive corrosion of the mill scale was noted at the site.

Site 17- Cutler Magner Bulkhead – Superior

The Cutler Magner bulkhead is owned and operated by Cutler Magner. The bulkhead consists of a steel sheet pile bulkhead with a metal cap. This facility only sees moderate use for the import of Limestone and Coal materials. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans, instantaneous water quality measurements and instantaneous corrosion measurements. This site was fitted with a coupon tray with coupons for measurements in 2007.

Site 18- Lakehead Boat Basin Galv Bulkhead- Duluth

The Lakehead Boat Basin is owned and operated by Joel Johnson. The bulkhead consists of a galvanized steel sheet pile bulkhead with a galvanized metal cap. This facility sees moderate use by both charter and private recreational boats. It is important to note that this dock is not believed to have been electrically isolated from the old steel dock during rehabilitation. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements.

Site 19- Lakehead Boat Basin Original Bulkhead- Duluth

The Lakehead Boat Basin is owned and operated by Joel Johnson. The bulkhead consists of a steel sheet pile bulkhead with a metal cap. This facility sees moderate use by both charter and private recreational boats. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. The general water depth was very shallow along the bulkhead inspected and perforations were present.

Site 20- Community Sailing Dock Bulkhead – Duluth

The Community Sailing Dock bulkhead is owned and operated by the City of Duluth and volunteers. The bulkhead consists of a steel sheet pile bulkhead with a metal cap. This facility sees very low use by sail boats and private recreational boats. The field data collection for this site included visual inspection and measurements of the corrosion present at elevations from IGLD to the mud line on the out pans and instantaneous water quality measurements. The general water depth was very shallow along the bulkhead inspected.

Site 21- John Sherwin Vessel @ Fraser Shipyard - Superior

The Vessel John Sherwin is owned and operated by Interlake Steamship of Cleveland. The ship hull was constructed in 1958 with steel plate and then coated for corrosion protection. The field data collection for this vessel included visual inspection and manual pitting measurements of the corrosion present from the water line to the keel.

Site 22- William Irvin Vessel – Duluth

The Vessel William Irvin is owned by U.S. Steels Great Lakes Fleet and operated by the Duluth Entertainment and Convention Center. The ship hull was constructed in 1937 with steel plate and then coated for corrosion protection. The field data collection for this vessel included visual inspection and manual pitting measurements of the corrosion present from the water line to the keel. It is important to note the concentration of the pitting was higher along the bows keel than on the hull plate. The coating is wearing and will need replacement or touch up in the near future.

General Assessment of Visual and Corrosion Data

In general the data collected was consistent with the structures that had been previously inspected in the other areas of the harbor. It's important to note that previously measured corrosion in other investigations researched was always reported from the current waterline or from the top of dock, not IGLD, which is the zero depth and reference for this study. With the water levels being much lower than what has been seen over the past years, the excessive pitting noted in the past is closer to the visual surface. This is very evident when you look at the high water marks on the structures around the harbor. Additionally the muscle population was thriving and present up higher on the sheet pile structures this year due to the mild ice season during the past winter.

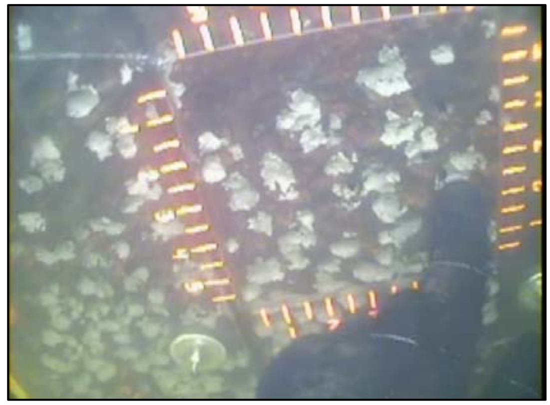
The general conditions seen at most sites within the harbor are as follows:

0 to 0.5 feet below IGLD

Generally the full material thickness remains with a lower severity of pitting.

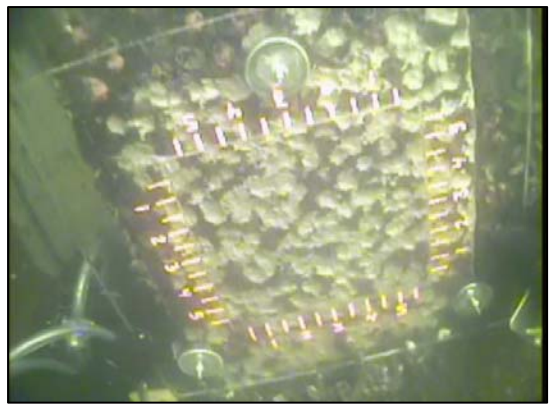
0.5 to 3 feet below IGLD

Uniform material thickness losses. High concentration and very deep scoop type pitting present. Perforation is present on sheet piling 3/8" or less in thickness that is 30 years or older.



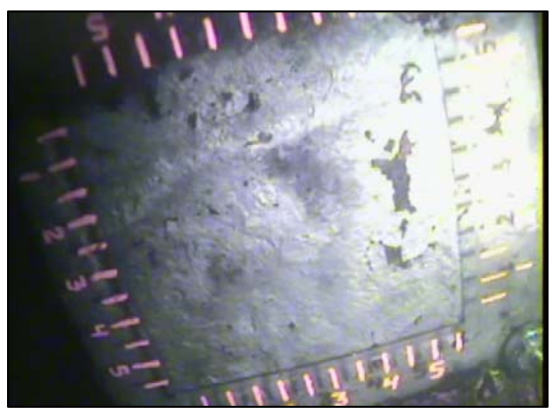
4 to 10 feet below IGLD

Uniform material thickness losses. High concentration of pitting over the entire surface with a transition from deep to shallow scoop type pitting from 4 to 10 feet. Large pitted areas tend to have numerous small 1/16 to 1/8 inch diameter pits within the larger pitted area.



10 to 32 feet below IGLD

Minor uniform material thickness losses. High to moderate very small concentrated pitting which tends to reflect more of an overall etched surface than actual pitting. In most areas the mill scale has been removed only and a very low concentration of actual deep pits existed.



It has been found in this Minnesota DNR funded study that the major differences in the degree of corrosion and type occurred as we inspected sites towards the Duluth entry and at the area at the CN Dock in Two Harbors. Both areas tend to see more flushing of fresh water than the general harbor area. The two harbors dock being the most unusual with large masses of the orange nodule type material v.s. individual orange nodules as found in the main Duluth/Superior Harbor.

Water Quality

Water Quality measurements were collected utilizing the Quanta Probe by Hydrolab. The probe was outfitted to take measurements that included depth, PH, Dissolved Oxygen, Conductivity, Turbidity, Temperature, Oxygen Reduction Potential (ORP) and Salinity at a few sites. Certain parts of the probe were calibrated at the factory and then individual site measurements based on the local barometric readings were added each day. Data for each site was taken at the time of the underwater inspections, but prior to the disturbance of the natural water conditions due to the cleaning and movement of the diver. Bulk water sample data was collected under the ACOE contract at a different date and time for all federal and non-federal structures. AMI assisted Altech Environmental in the collection of all bulk water samples. AMI is waiting for the release of this data by the ACOE for use in the non-federal study portion of the project.

Measured ranges for the data collected in July 2006 are as follows:

Temperature: 49° to 85° F

PH: 7.55 to 9.41

Dissolved Oxygen: 4.46 to 11.68 mg/L

Conductivity: 0.102 to 0.258 mS/cm

Turbidity: 1.7 to 48.6 NTU

ORP: 220 to 506 mV

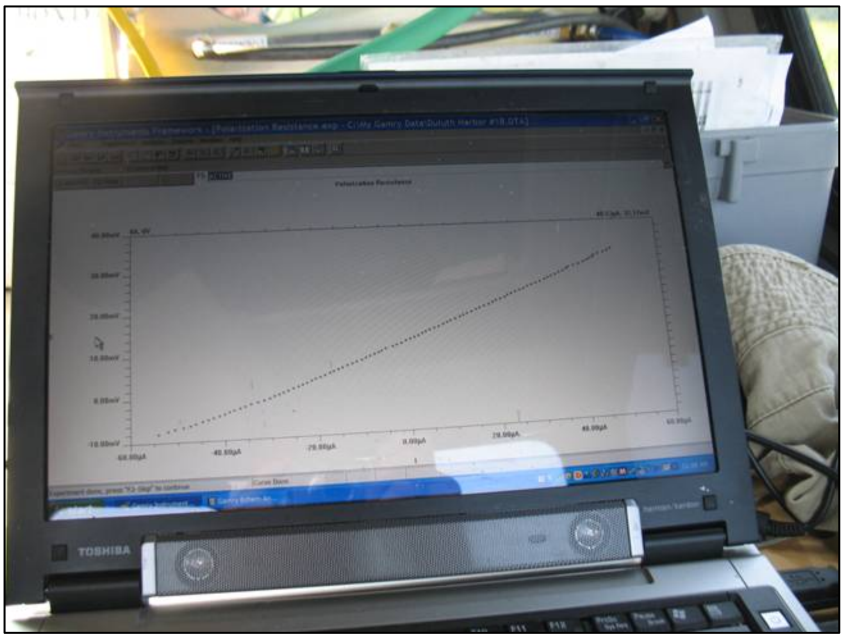
Salinity: 0.06 to 0.08 PSS

The notable changes in water quality occurred at the measurements made at Two Harbors and at the hypothetical harbor East / West border at the Blatnick Bridge. Areas of water quality to the West of the Blatnick Bridge (St Louis Bay, Howard's Bay and up river to Oliver Bridge) had consistently higher water temperatures, PH, Conductivity, and ORP with lower dissolved oxygen readings. The measurement areas of the lower harbor were relatively constant from the Duluth to the Superior sites. The Two Harbors site had lower water temperature, conductivity and ORP with higher dissolved oxygen readings.

Linear Polarization Resistance Measurements

Linear Polarization Resistance (LPR) is probably the most common test method used in assessing the corrosiveness of an environment with respect to a metal. It is both relatively simple to perform, given the right computer driven test equipment, and provides reproducible results.

AMI Consulting Engineers hired corrosion experts Bushman & Associates (B&A) to assist AMI in performing the LPR tests and provide professional assessment of the results for the critical preselected sites throughout the harbor. AMI installed 6 out of 8 LPR test probes at the preselected locations on August 23, 2006 and LPR test probe #7 on August 29th, 2006. On September 7th, 2006, AMI and B&A proceeded with the first round of LPR measurements in the Duluth / Superior Harbor. These measurements were taken at the height of the typical corrosion rate season where we would typically see the most sunlight and highest water temperature readings. At the end of each computer controlled scan, the average corrosion rate for the test probe being scanned in the water was calculated. See Table 1 for the average corrosion rates. Since underground and submerged metal corrosion is almost always of the pitting type, it is common practice to multiply this average rate shown by a factor of 5, 10 or 20 to determine the pitting or perforation rate that can be expected. B&A often uses a rate of 7.5 times the average rate as a reasonable approximation of the pitting rate.



Resistance measurements are displayed on laptop screen.

One of the probes is visually inspected prior to being reinstalled.

Location Description	Test Locate No.	Scan No.	LPR Probe Ser. No.	Corrosion Rate (mpy)
Oliver Bridge	1	A	Ser. No. 06-98-1005	**4.167740**
Oliver Bridge	1	B	Ser. No. 06-98-1005	**5.750072**
Oliver Bridge	1	C	Ser. No. 06-98-1005	**5.554085**
Oliver Bridge	1	D	Ser. No. 06-98-1005	**5.941934**
Hallett 7 Dock	2	A	Ser. No. 06-08-1003	**5.400351**
Hallett 7 Dock	2	B	Ser. No. 06-08-1003	**5.207576**
Hallett 7 Dock	2	C	Ser. No. 06-08-1003	**5.403211**
Hallett 5 Dock	3	A	Ser. No. 06-08-1007	**6.367826**
Hallett 5 Dock	3	B	Ser. No. 06-08-1007	**6.209100**
Hallett 5 Dock	3	C	Ser. No. 06-08-1007	**6.494123**
Midwest Energy Dock	4	A	Ser. No. 06-08-1008	**6.065133**
Midwest Energy Dock	4	B	Ser. No. 06-08-1008	**6.185771**
Midwest Energy Dock	4	C	Ser. No. 06-08-1008	**6.031089**
DSPA Berth 4	5	A	Ser. No. 06-08-1004	**4.030746**
DSPA Berth 4	5	B	Ser. No. 06-08-1004	**3.699939**
DSPA Berth 4	5	C	Ser. No. 06-08-1004	**4.014178**
US Army COE Duluth Entry	6	A	Ser. No. 06-08-1006	**1.977549**
US Army COE Duluth Entry	6	B	Ser. No. 06-08-1006	**2.165742**
US Army COE Duluth Entry	6	C	Ser. No. 06-08-1006	**2.012401**
Superior Cutler Magner	7	A	Ser. No. 06-08-1009	**4.541889**
Superior Cutler Magner	7	B	Ser. No. 06-08-1009	**4.641087**
Superior Cutler Magner	7	C	Ser. No. 06-08-1009	**4.496408**

Table 1: September 7, 2006 LPR Measurements

Later in the year on October 17, 2006 an 8th LPR probe was added at the Superior Entry to provide complete coverage of the harbor. The second round of LPR measurements represents the corrosion rate over a longer period of time from the height of the normal corrosion potential in late August to the time of measurement just before the harbor started to freeze up on November 28th, 2006. Table 2 on page 15 shows the results from this longer period of LPR probe exposure. Looking at the data from both the short term at the height of the normal expected corrosion potential and the longer term data over a period of change from warm to cooler weather in the harbor, we start to generate information on the time periods maximum potential and a more average rate through the changes from a warm to colder weather conditions. Multiplying the average of rates measured for each location by 7.5 for the Short Term values in Table 1, we get the following pitting corrosion rates in mpy.

Oliver Bridge	**40.15094**	**DSPA Berth 4**	**29.36216**
Hallett 7	**40.02785**	**USACOE Duluth Entry**	**15.38923**
Hallett 5	**47.67762**	**Superior Cutler Magner**	**34.19846**
Midwest Energy	**45.70491**		

Location Description	Test Locate No.	Scan No.	LPR Probe Ser. No.	Corrosion Rate (mpy)
Oliver Bridge	1	A	Ser. No. 06-98-1005	**0.641771**
Oliver Bridge	1	B	Ser. No. 06-98-1005	**0.649696**
Oliver Bridge	1	C	Ser. No. 06-98-1005	**0.644368**
Hallett 7 Dock	2	A	Ser. No. 06-08-1003	**1.200194**
Hallett 7 Dock	2	B	Ser. No. 06-08-1003	**1.203105**
Hallett 7 Dock	2	C	Ser. No. 06-08-1003	**1.199111**
Hallett 5 Dock	3	A	Ser. No. 06-08-1007	**2.419158**
Hallett 5 Dock	3	B	Ser. No. 06-08-1007	**2.491389**
Hallett 5 Dock	3	C	Ser. No. 06-08-1007	**2.687911**
Midwest Energy Dock	4	A	Ser. No. 06-08-1008	**2.352064**
Midwest Energy Dock	4	B	Ser. No. 06-08-1008	**2.370468**
Midwest Energy Dock	4	C	Ser. No. 06-08-1008	**2.304466**
DSPA Berth 4	5	A	Ser. No. 06-08-1004	**2.147834**
DSPA Berth 4	5	B	Ser. No. 06-08-1004	**2.119015**
DSPA Berth 4	5	C	Ser. No. 06-08-1004	**2.122074**
US Army COE Duluth Entry	6	A	Ser. No. 06-08-1006	**0.871615**
US Army COE Duluth Entry	6	B	Ser. No. 06-08-1006	**0.881193**
US Army COE Duluth Entry	6	C	Ser. No. 06-08-1006	**0.884629**
Superior Cutler Magner	7	A	Ser. No. 06-08-1009	**1.755004**
Superior Cutler Magner	7	B	Ser. No. 06-08-1009	**1.752357**
Superior Cutler Magner	7	B	Ser. No. 06-08-1009	**1.722814**
US Army COE Superior Entry	8	A	Ser. No. 06-08-1002	**1.854376**
US Army COE Superior Entry	8	B	Ser. No. 06-08-1002	**1.782855**
US Army COE Superior Entry	8	C	Ser. No. 06-08-1002	**1.784687**

Table 2: November 28, 2006 LPR Measurements

Multiplying the average of rates measured for each location by 7.5 for the longer term values in Table 2, we get the following pitting corrosion rates in mpy.

Oliver Bridge	**4.83959**	**DSPA Berth 4**	**15.97231**
Hallett 7	**9.00602**	**USACOE Duluth Entry**	**6.59359**
Hallett 5	**18.99614**	**Superior Cutler Magner**	**13.07544**
Midwest Energy	**17.56749**	**USACOE Superior Entry**	**13.55480**

Converting the longer term pitting corrosion rate numbers into inches per year we get a minimum rate of 0.005 inches per year to a maximum of 0.019 inches per year if this was representative of the entire year average rate. Over 30 years this converts to a pitting depth range of 0.15 to 0.57 inches, depending on the location in the harbor.

I feel it is important to note that the major changes that occurred during the time period from late August to November 28th, 2006 appear to be the cooler water temperatures and the shorter days which represent less benefit form sunlight. In the summary of the initial workshop findings temperature was believed to not be significant, but we believe the data clearly shows a correlation between water temperature and corrosion rate.

Sample Tray Installation

After numerous meetings with the corrosion committee members, AMI designed a preliminary coupon sample tray. The initial discussions of the coupon tray design primarily revolved around the issue of isolation of the coupon materials from the existing steel walls. If the coupons were in contact directly to the existing corroding steel, it has been shown in other study's that the new metal will corrode faster than the existing steel due to the difference in electrical resistance. If the steel was isolated from the existing steel using a non-conductive material the concern is then the samples would not represent the sheet piling as it is grounded to the soil. After review and comments, it was found that through previous dive inspections on wood crib systems, patches that had been installed which were not directly grounded still corroded a similar manner to that of the sheet piling that is grounded. Due to this observation, the decision was made to isolate the samples from the existing steel using a non-conductive material. The coupon material utilized would be ASTM A328 steel material, which is the primary material used for hot rolled sheet piling.

The final tray design went through a few iterations. After determining the final position of the tray which would best serve the study and determining the final number of samples needed, a final design layout was determined and a prototype was constructed. The prototype served as a visual product to show all interested parties the working design and to determine the cost of fabrication. From this prototype, most of the fabrication bugs were worked out, a final fabrication cost was determined for budgeting and a final CAD layout was completed. See Appendix F for the final drawing of the tray. Seven trays were constructed by a local fabricator for installation.

It is planned that one or two samples will be taken out every six months at each site. These samples will be utilized to measure physical overall corrosion loss, provide in-situ biological growth for culturing and DNA testing and would be used to study the changes and affects of the corrosion on the steel samples themselves. The final installation site locations were determined by the committee to provide the most scientific benefit while providing the broadest range of coverage. Before each sample was installed in the trays at each site around the harbor they were carefully marked for future identification. After each sample was marked it was measured for size and very precisely weighed. A complete chart of the sample identifiers, sizes, numbers and dates of install can be found in appendix F. The samples were then installed in each sample tray and secured in place for future removal. Six of the seven sample trays were installed in 2006, with the seventh sample tray scheduled to be installed on the Superior Entry in 2007.

Summary

The previously reported corrosion conditions as discussed in the 2004 ACOE Document ERDC/CERL SR-05-3 on the Fresh Water Corrosion in the Duluth – Superior Harbor existed on the majority of the structures within the harbor confines. The major difference noticed during the corrosion inspections was at the CN Railway Dock in Two Harbors. Although some pitting, orange masses and corrosion was present, its visual appearance was different in many aspects. From the general harbor to the Oliver Bridge, typical characteristics of the corrosion were present with minor differences in marine growth, size, pitting penetration and concentration.

The general penetration of the pitting within the 0 to 4 feet IGLD water level on all the facilities in the main harbor older than 30 years was typically 0.25 to 0.375 of and inch and most of the 0.375 inch sheet pile structures older than thirty years were close to being perforated or perforated from 1 to 3 feet below IGLD. Although the Oliver Bridge site is not in the general harbor confines, similar conditions existed on the steel structures, which were previously believed to not have been affected by the accelerated corrosion. The active levels of the accelerated corrosion problem were evident when looking at the newer steel sheet pile installed at Cenex Harvest States in 2003, with orange nodules covering over 50 to 75% of the sheet pile surfaces with measurable pitting size and penetration. The other sheet pile inspected in the Duluth Superior harbor less than 30 years old had a degree of uniform corrosion and pitting relative to its age. From the inspection data it appears that the corrosion rates, overall level of corrosion and pitting becomes less from the main harbor area towards Lake Superior through the Duluth Entry, but stays relatively consistent from the main harbor towards the Superior Entry.

The data from the areas investigated should be carefully evaluated before overall conclusions or claims are made pertaining to the accelerated corrosion issue. Although this information provides a good cross section of the general harbor, other areas not currently inspected could have different characteristics and degree of corrosion not previously discovered.

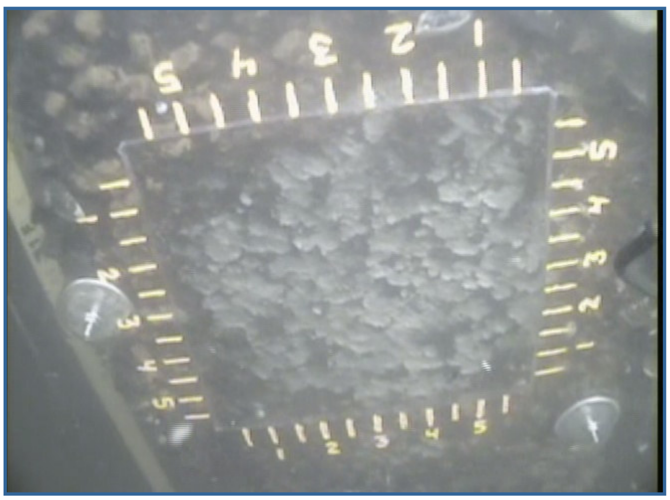
Respectfully Submitted:

Chad Scott, P.E.
AMI Consulting Engineers, P.A.

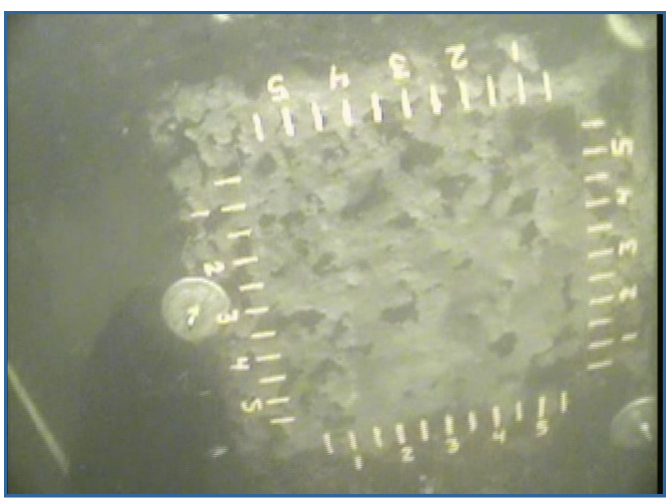
APPENDIX A

Photo Index

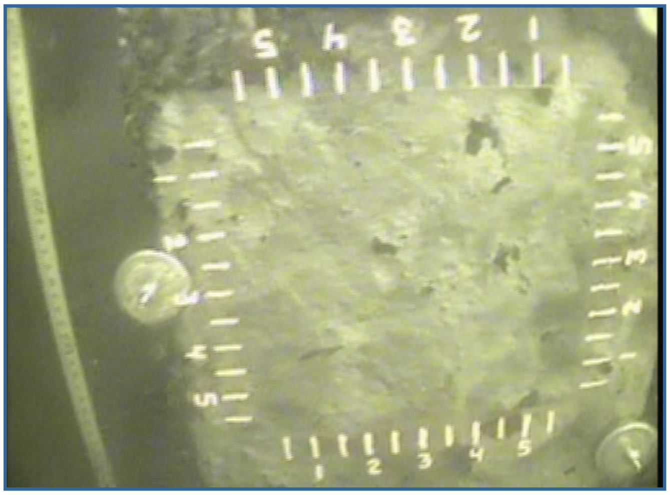
DSPA Berth 1- 0 feet



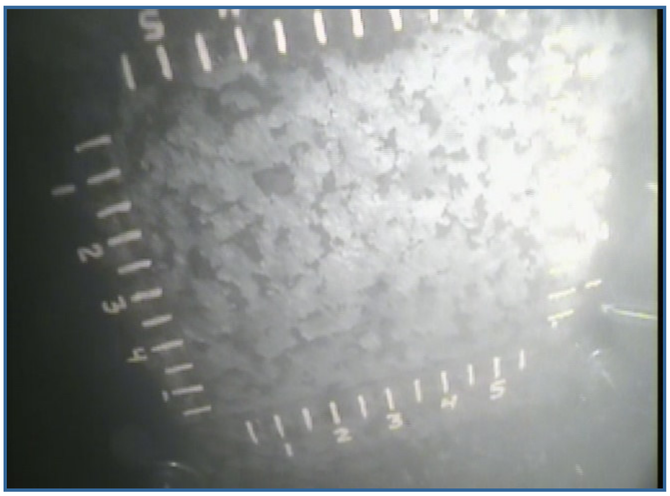
DSPA Berth 1- 2 feet



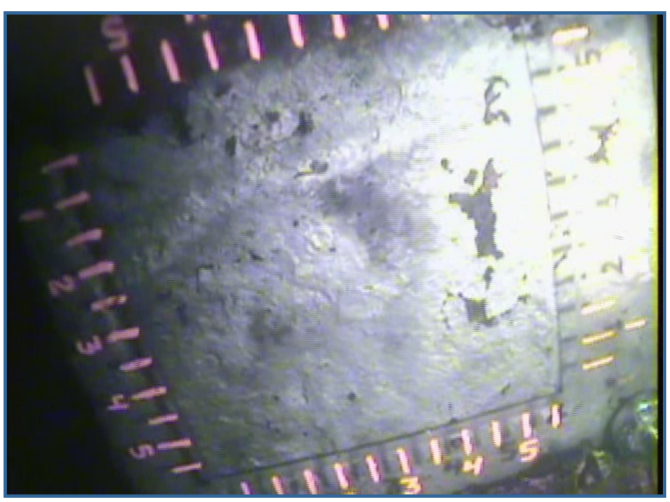
DSPA Berth 1- 4 feet



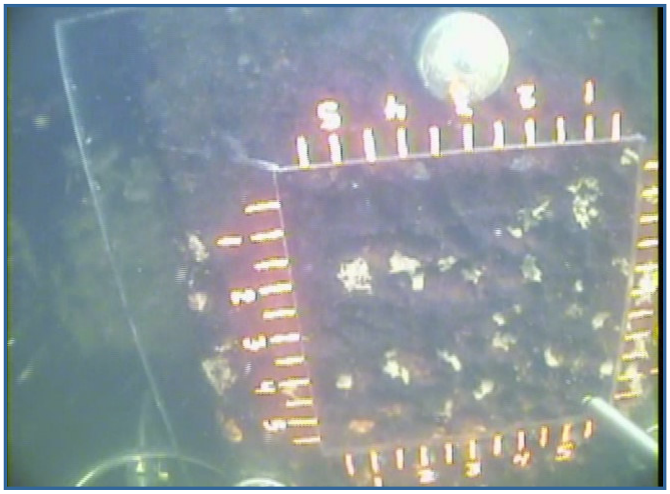
DSPA Berth 1- 6 feet



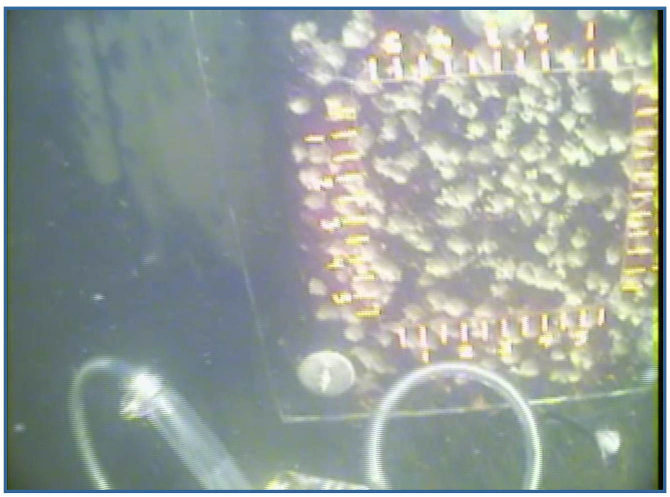
DSPA Berth 1- 8 feet



DSPA Berth 1- 10 feet



DSPA Berth 4- 0 feet



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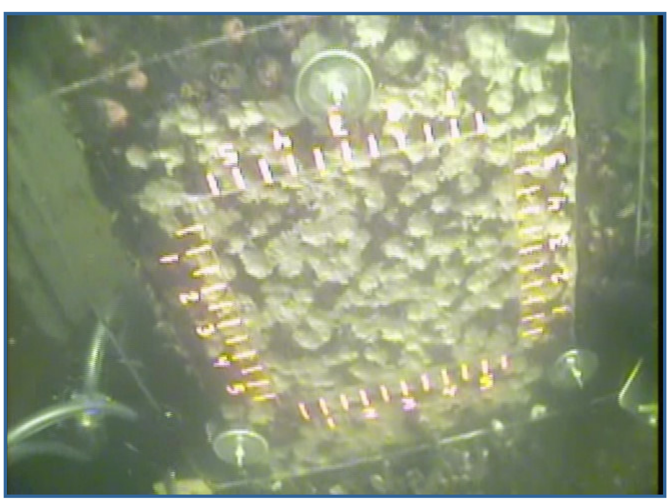

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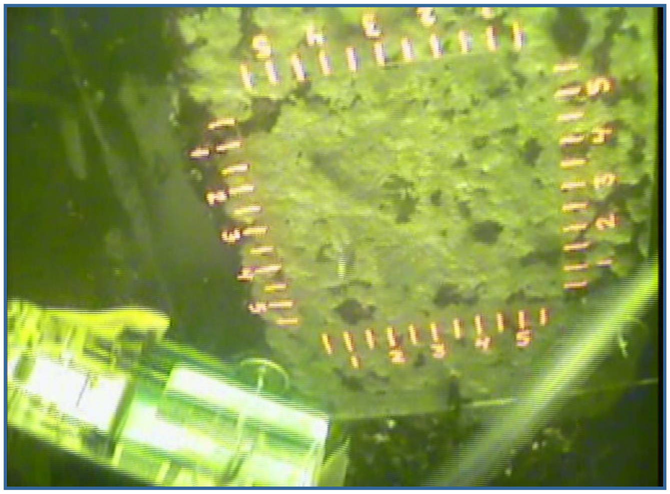

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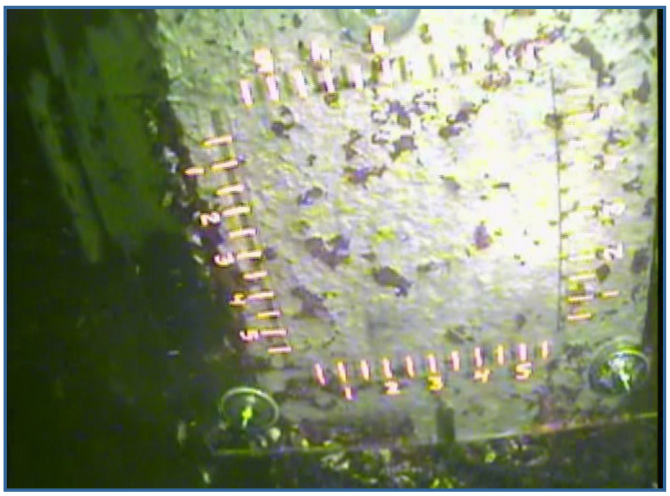
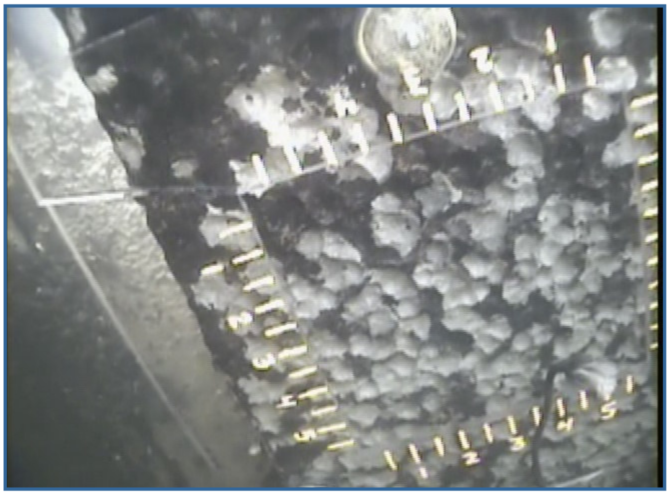


DSPA Berth 4- 8 feet

DSPA Berth 4- 10 feet



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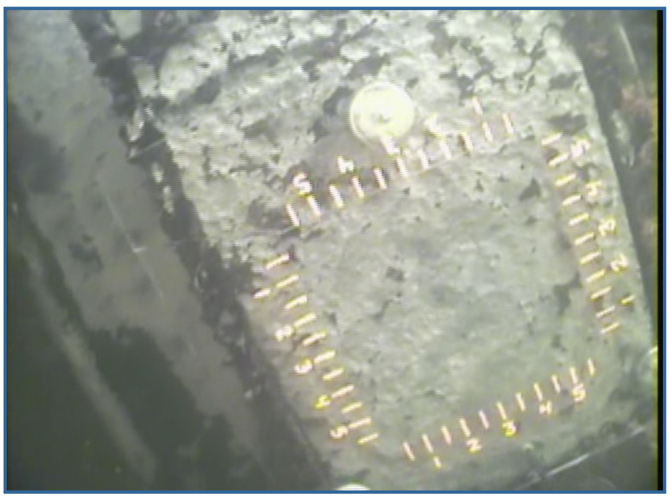

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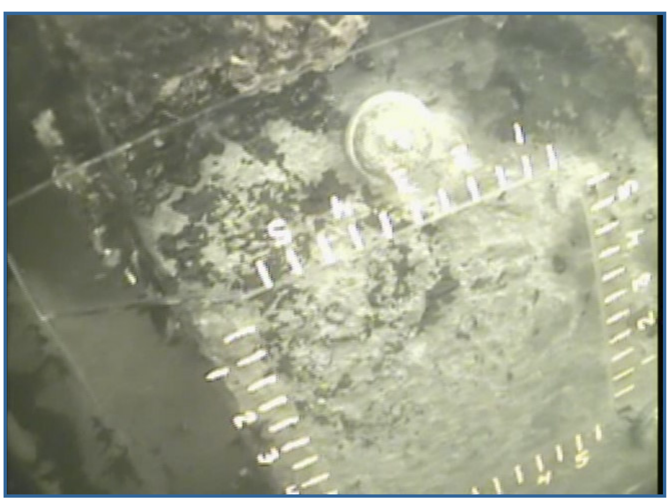

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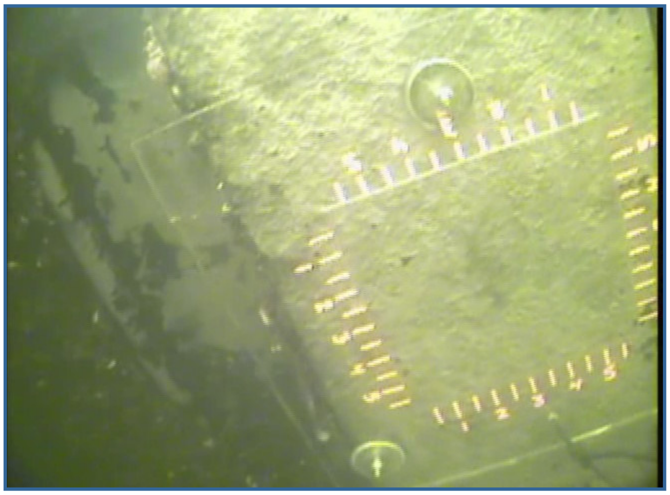

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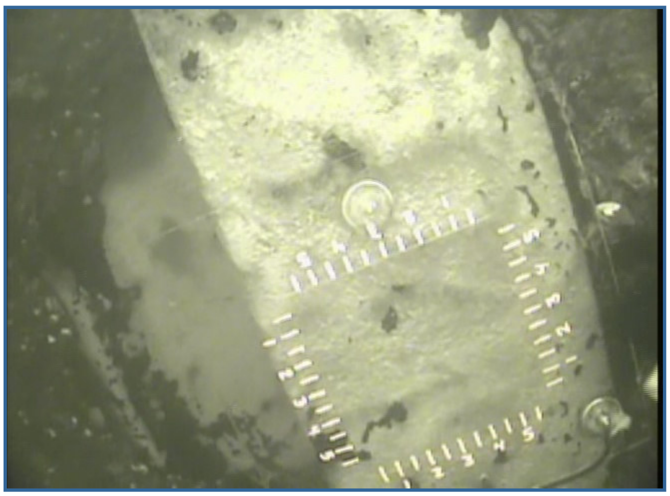

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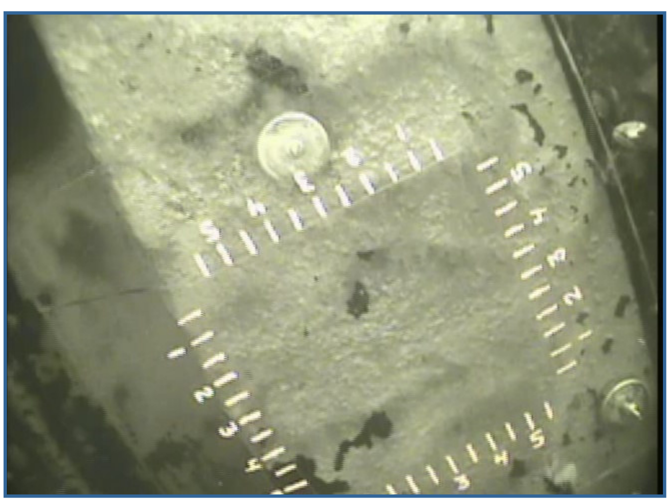
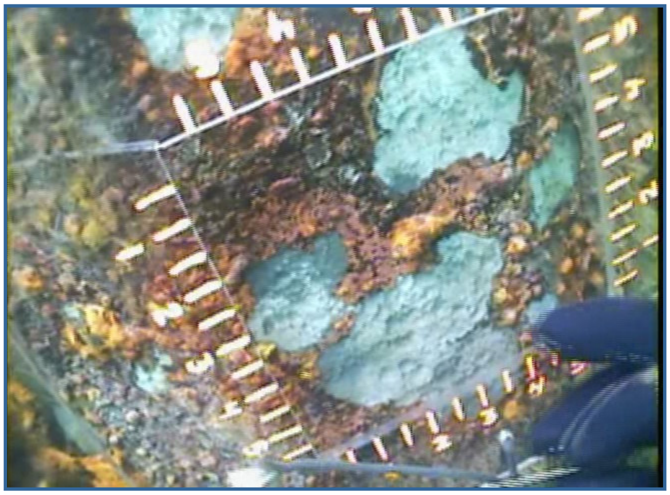


DSPA Berth 6- 10 feet

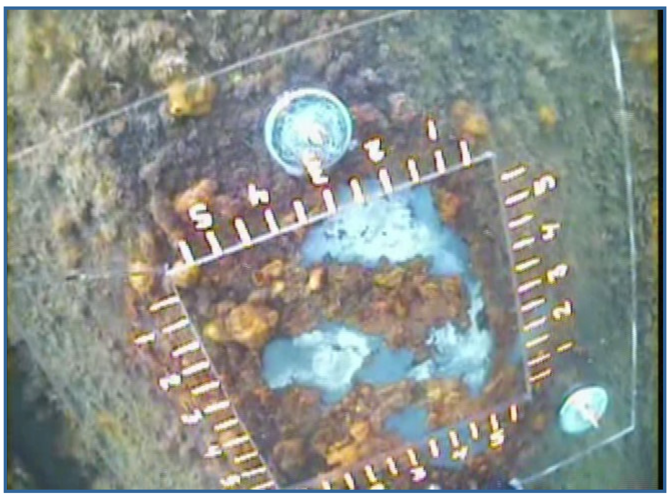
CN Two Harbors- 0 feet

CN Two Harbors- 2 feet



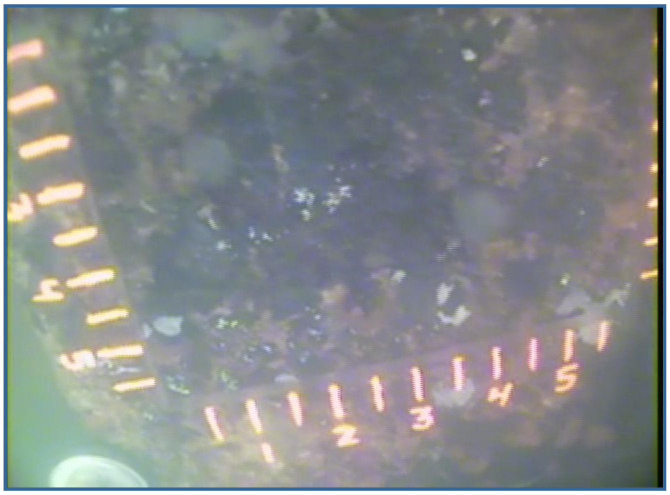
CN Two Harbors- 4 feet

CN Two Harbors- 6 feet

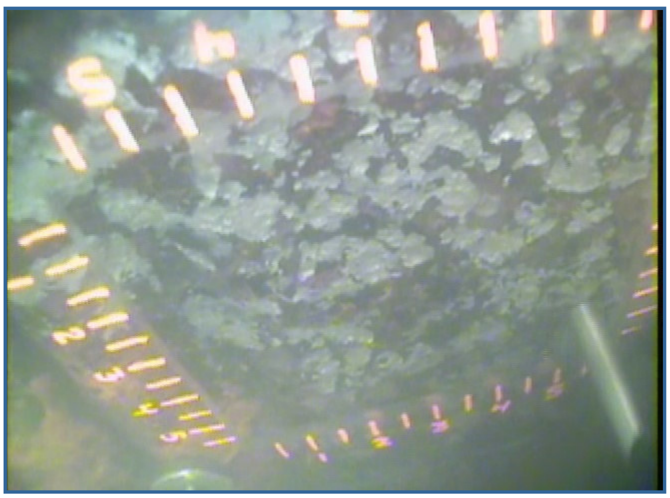


CN Two Harbors- 8 feet

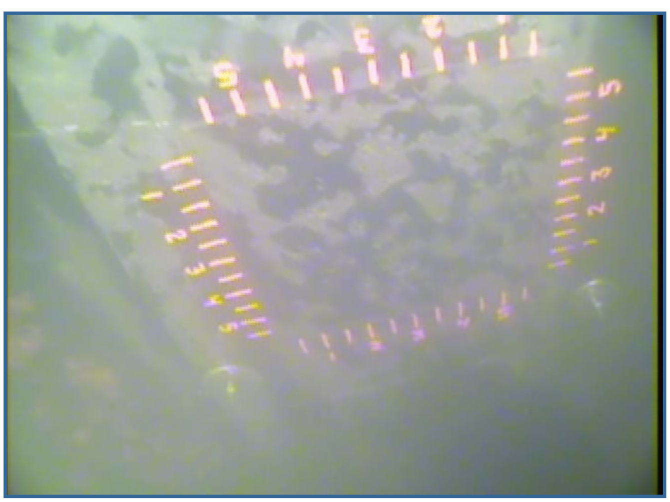
CN Two Harbors- 10 feet



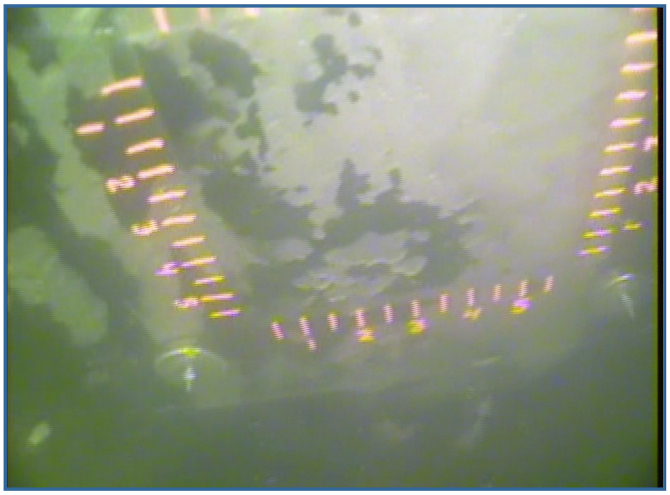
Minnesota Slip- 0 feet



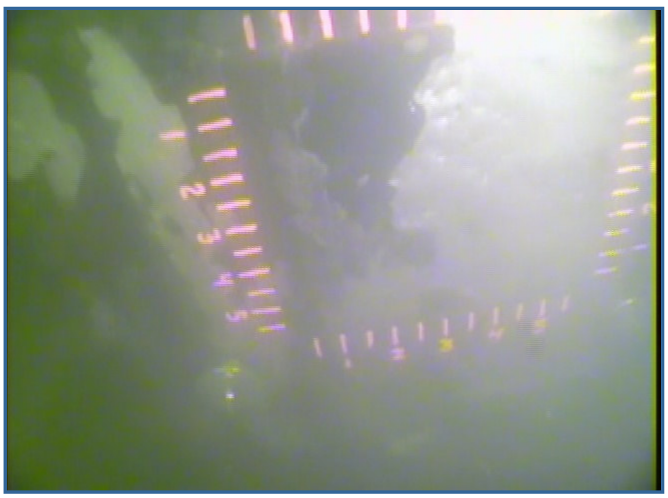
Minnesota Slip- 2 feet



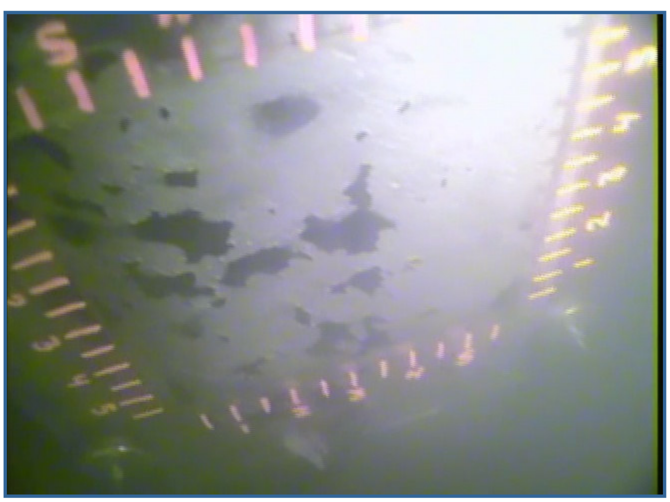
Minnesota Slip- 4 feet



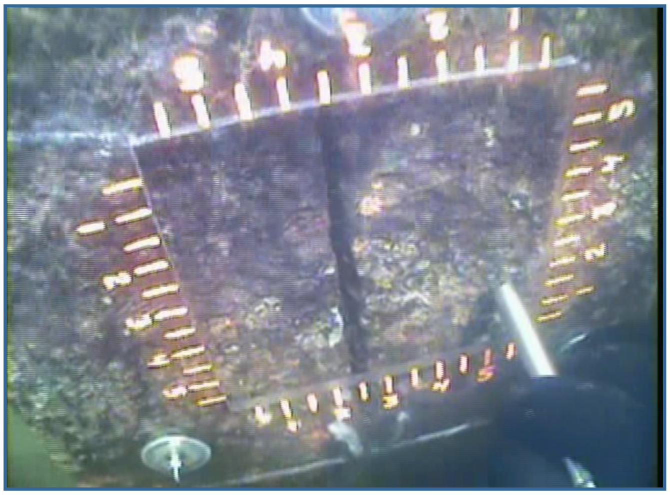
Minnesota Slip- 6 feet



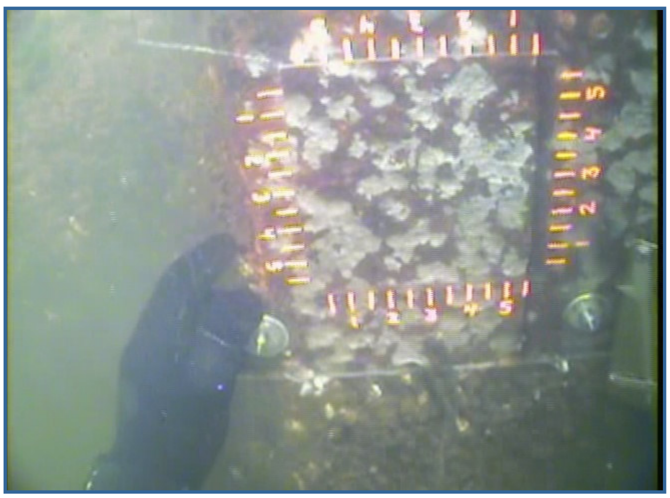
Minnesota Slip- 8 feet



Minnesota Slip- 10 feet



DECC Dock- 0 feet



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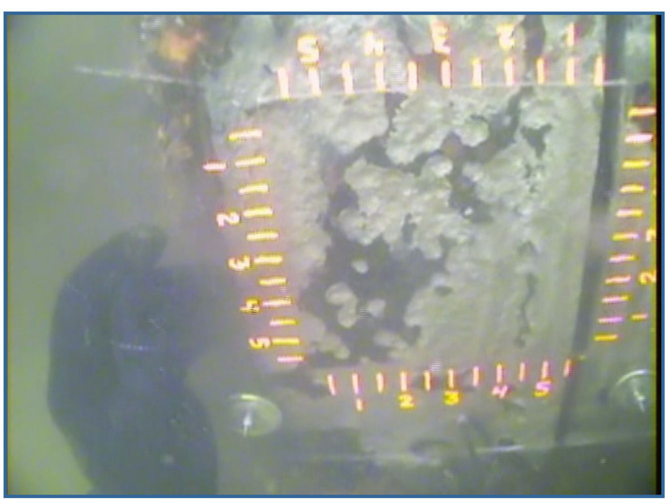

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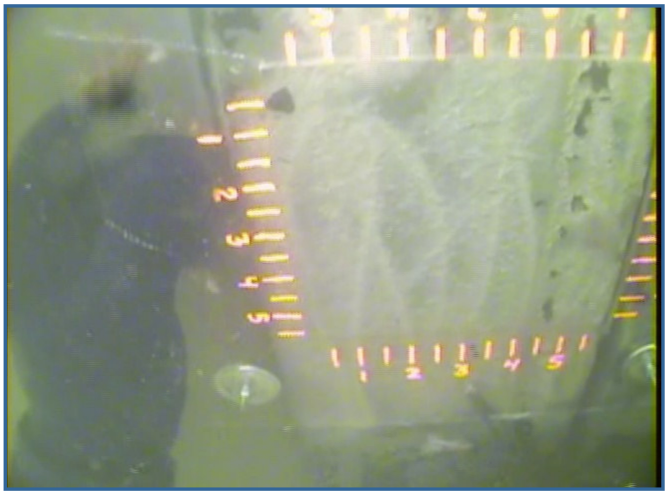

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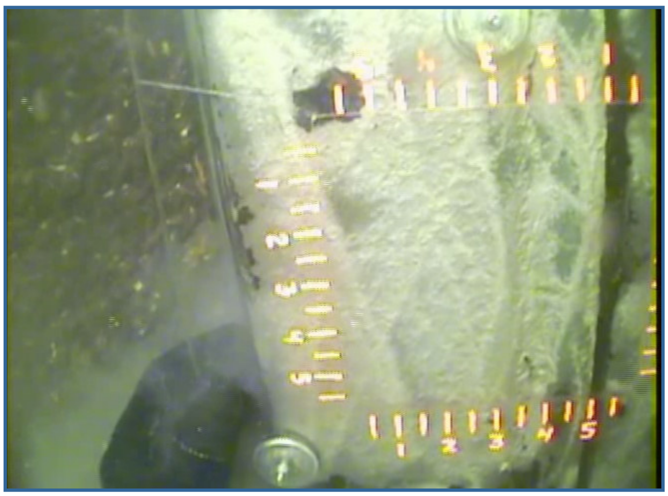

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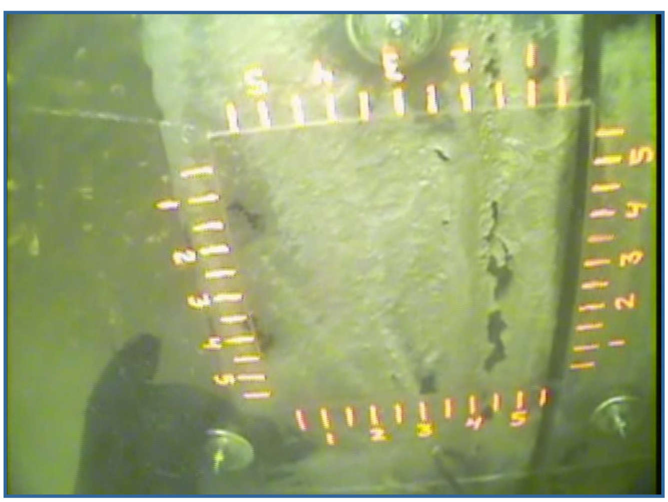
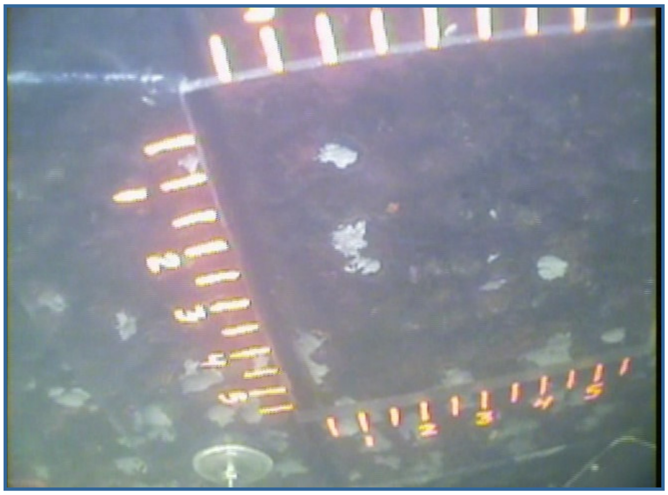


DECC Dock- 10 feet



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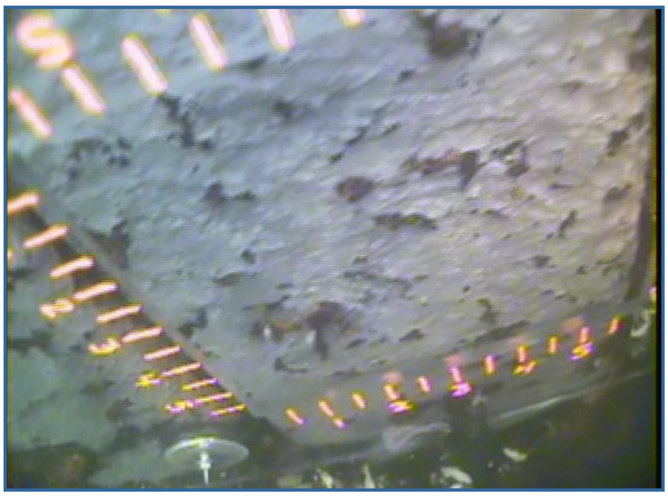

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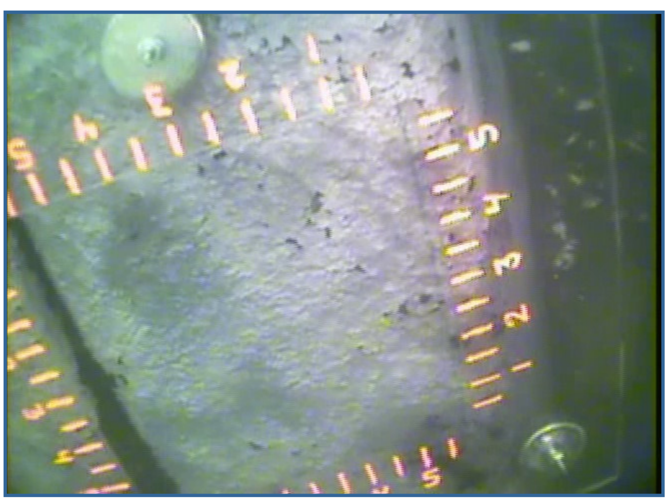

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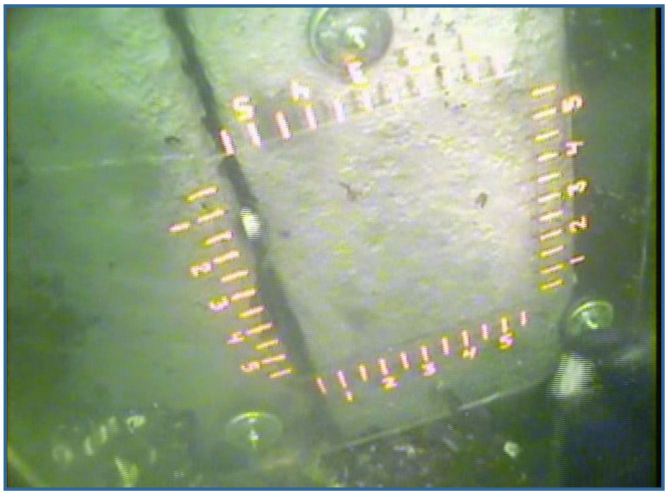

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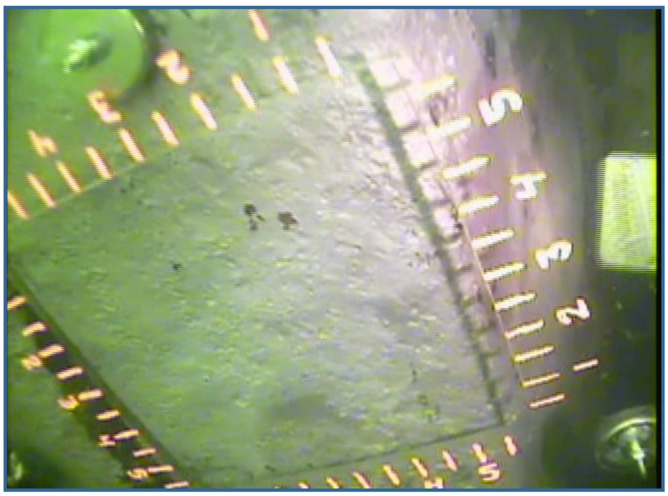

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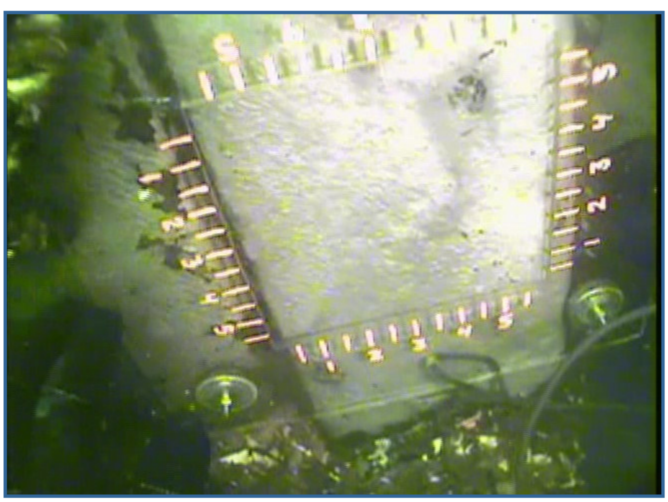

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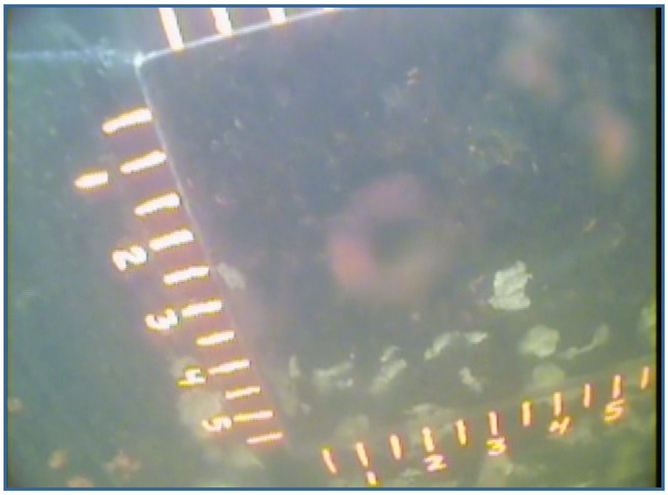
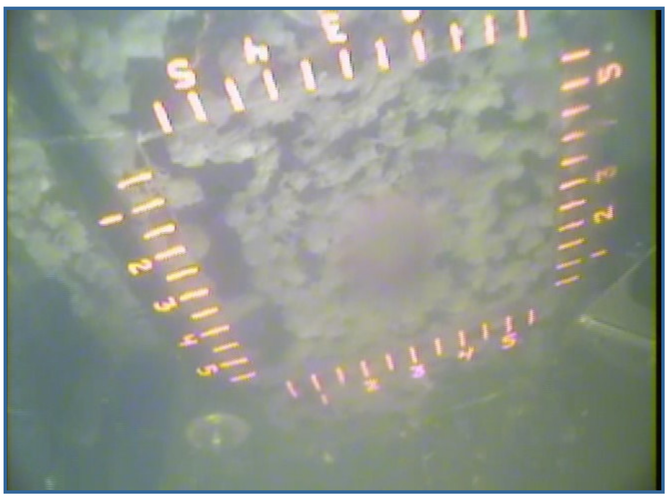


Hallett Dock 5- 0 feet



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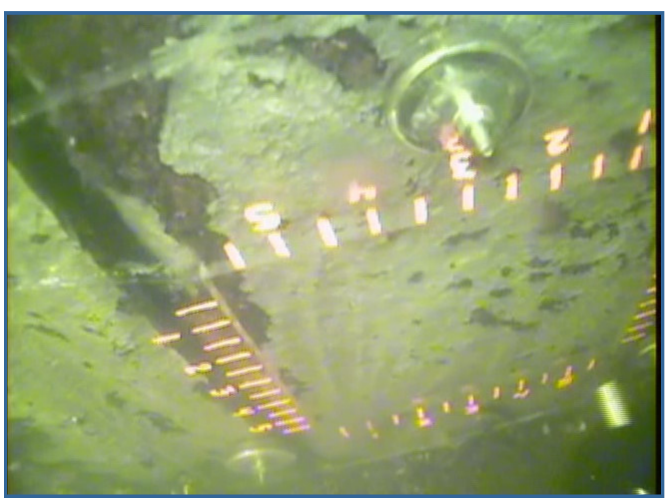

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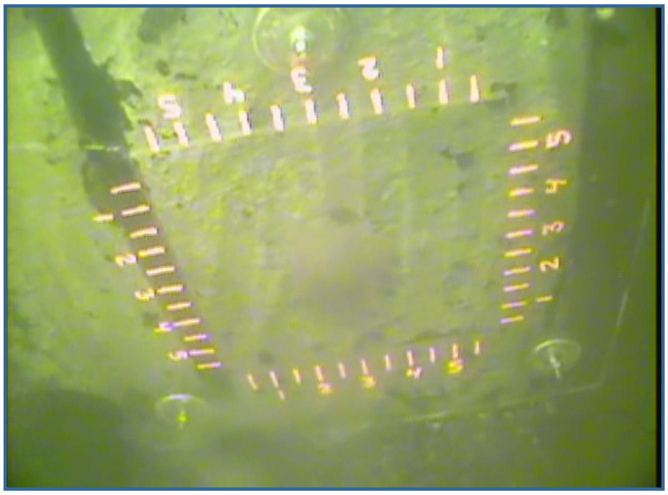
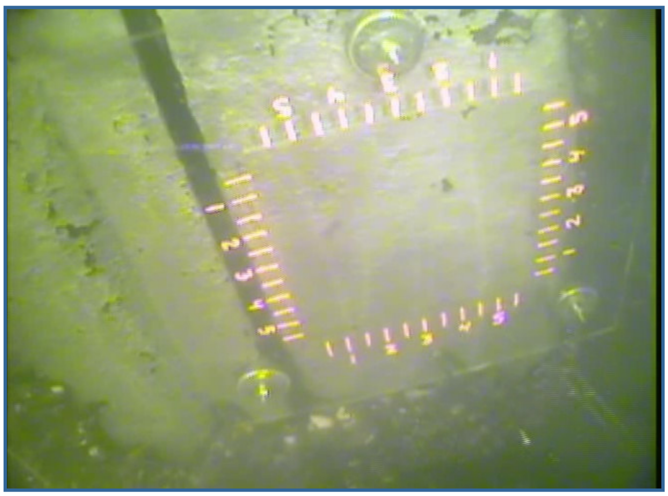
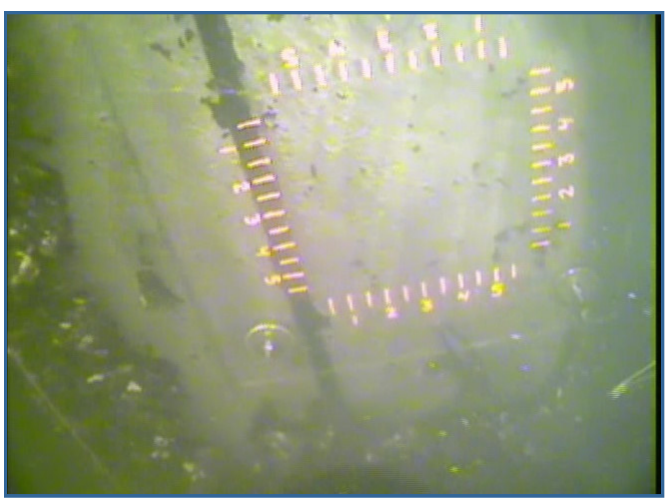


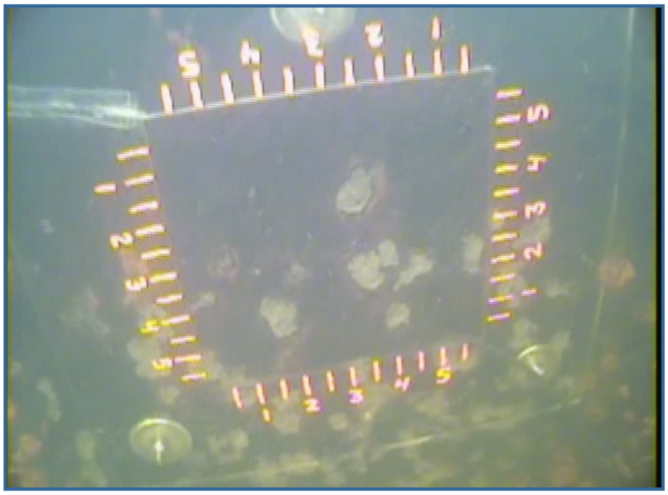
Hallett Dock 5- 6 feet



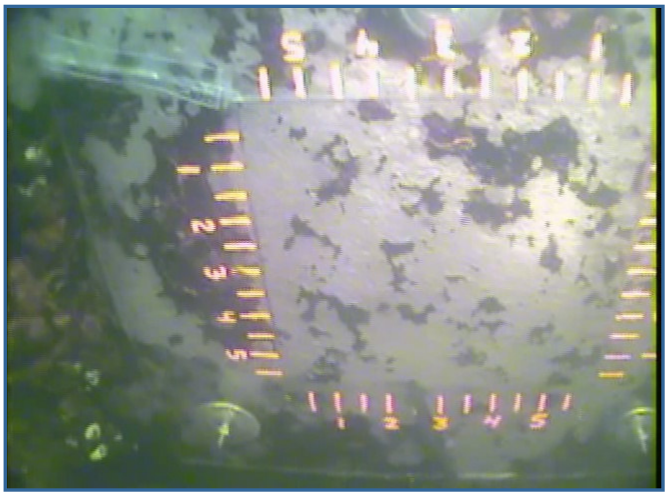
Hallett Dock 5- 8 feet



Hallett Dock 5- 10 feet

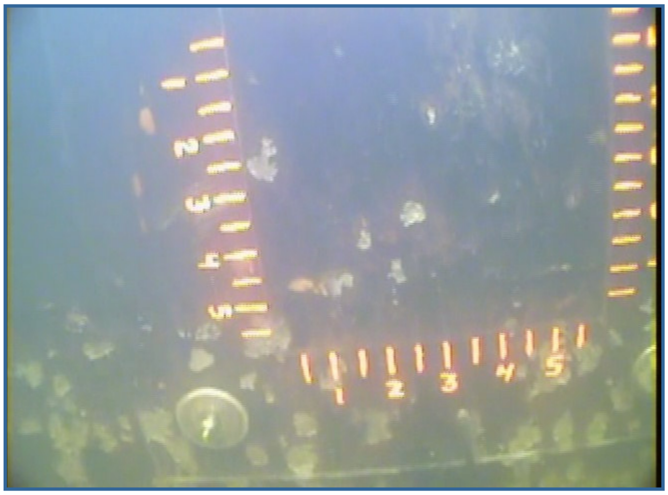


Bong Bridge Cell- 0 feet

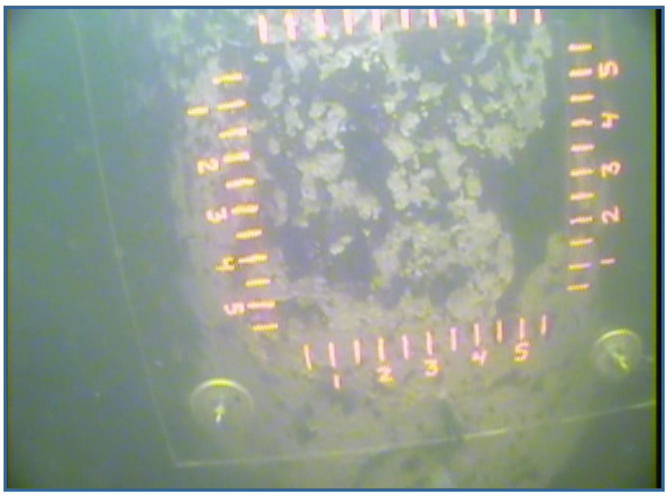


Bong Bridge Cell- 2 feet

Bong Bridge Cell- 10 feet

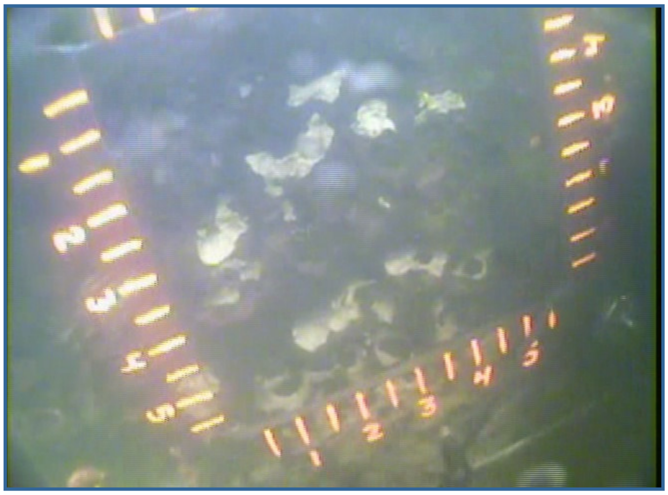


Spirit Lake Marina- 0 feet

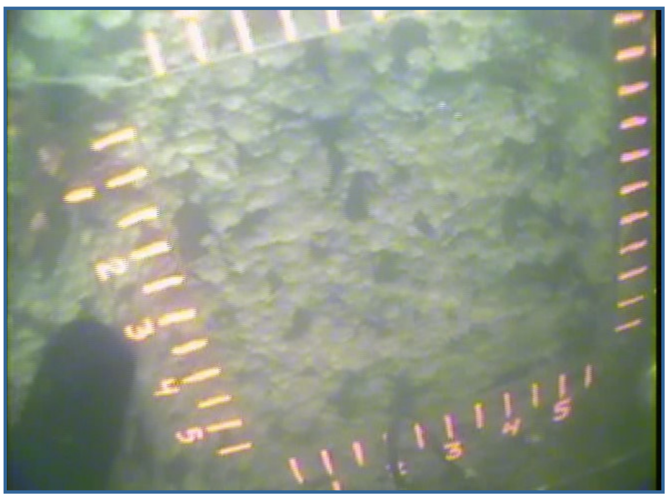


Spirit Lake Marina- 2 feet

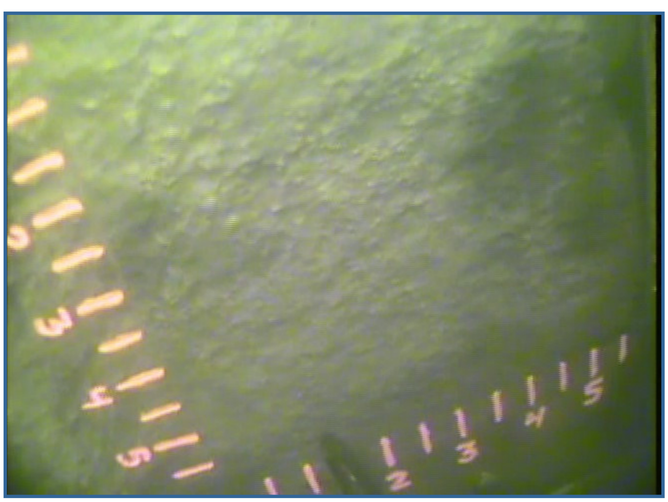
Spirit Lake Marina- 3 feet



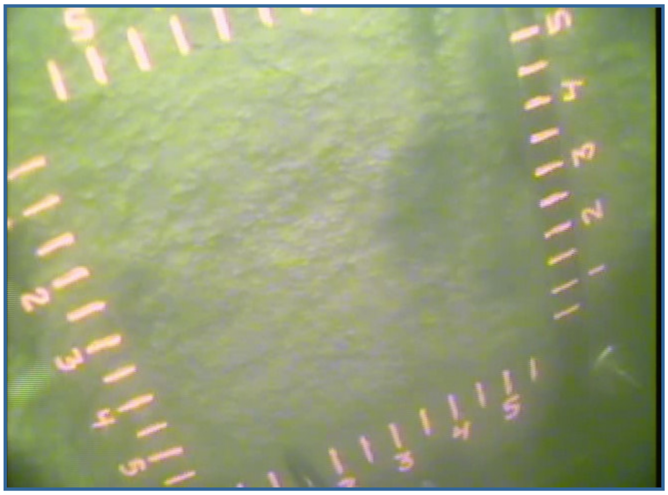
Oliver Bridge- 0 feet



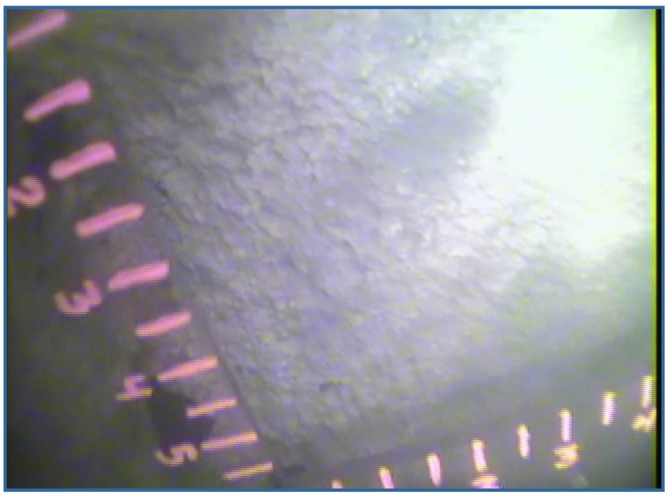
Oliver Bridge- 2 feet



Oliver Bridge- 4 feet

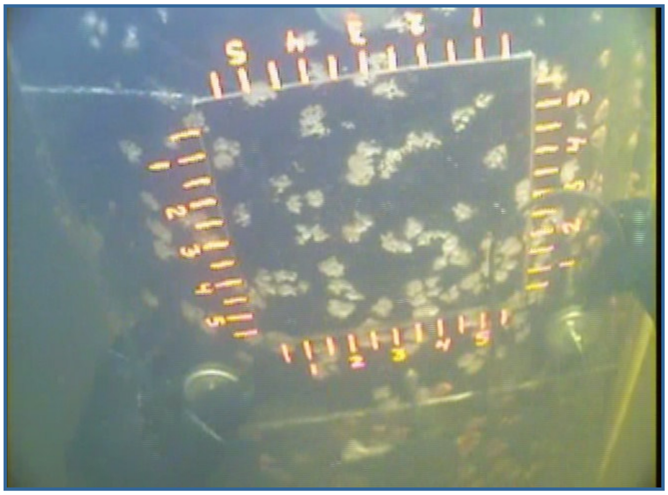


Oliver Bridge- 6 feet

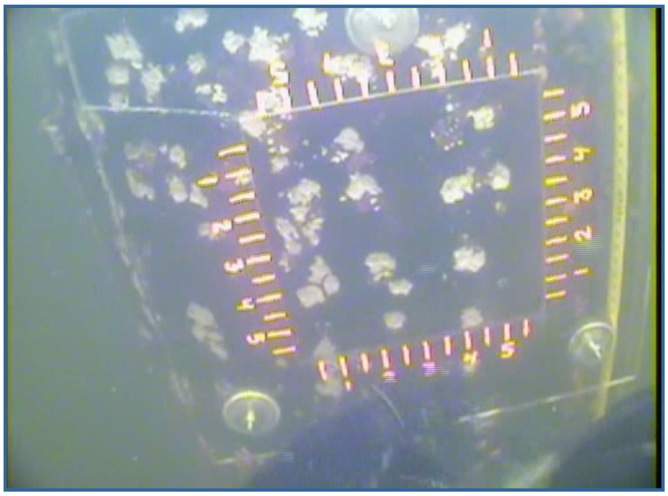


Oliver Bridge- 8 feet

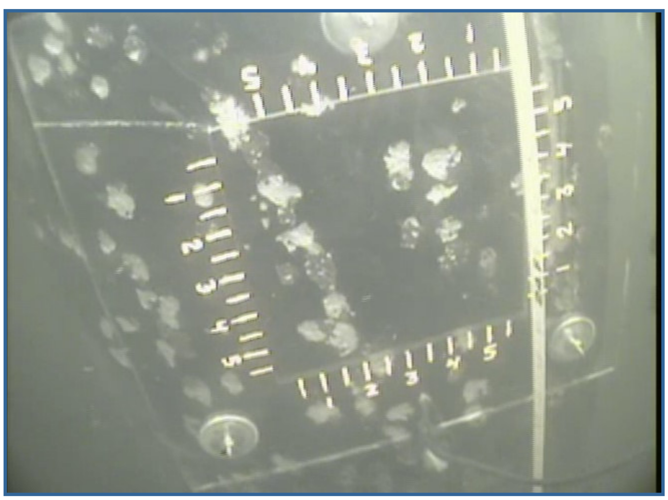
Oliver Bridge- 10 feet



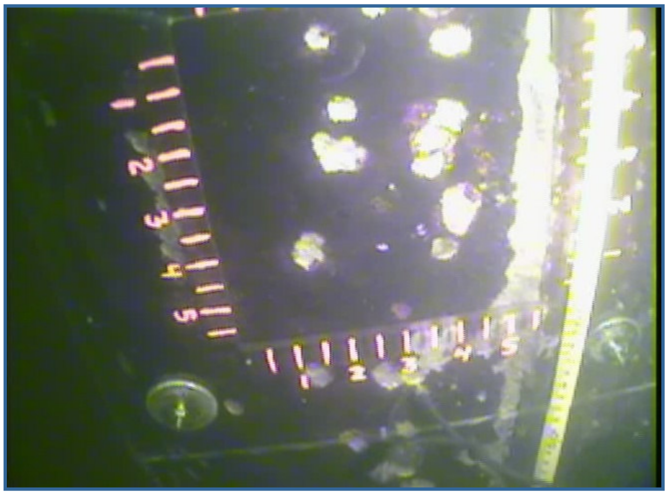
Midwest Energy (Pile w/ Jacket)- 0 feet



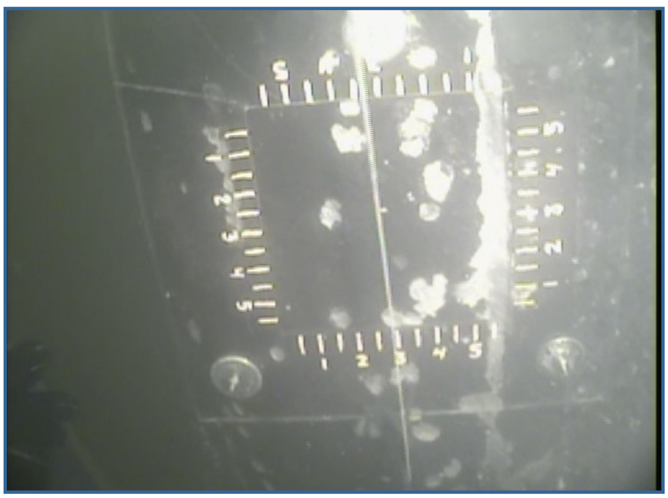
Midwest Energy (Pile w/ Jacket)- 2 feet



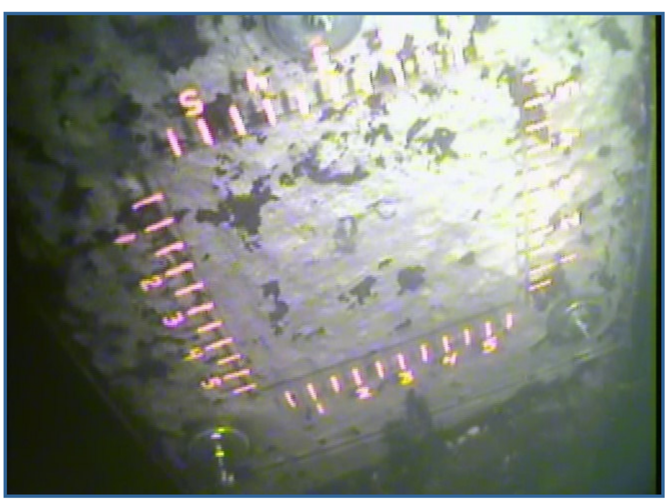
Midwest Energy (Pile w/ Jacket)- 4 feet



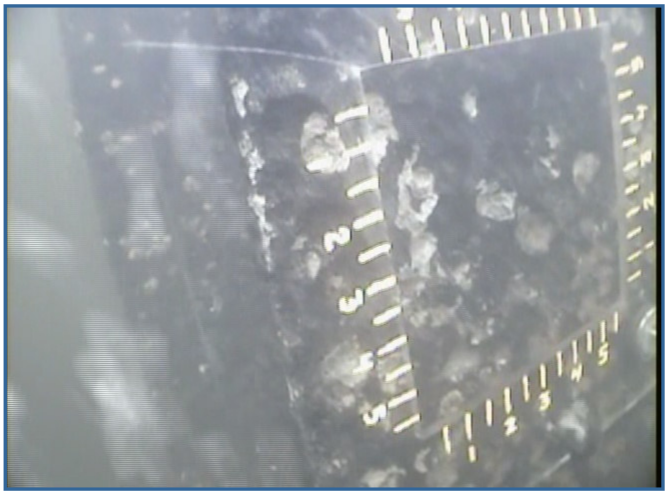
Midwest Energy(Pile w/ Jacket) - 6 feet



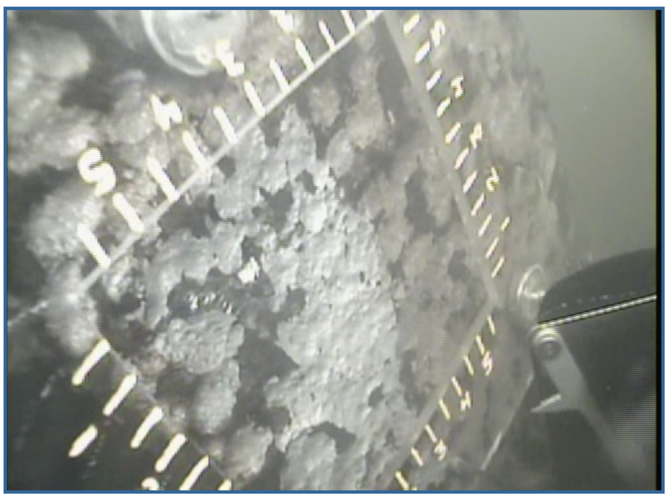
Midwest Energy(Pile w/ Jacket) - 8 feet



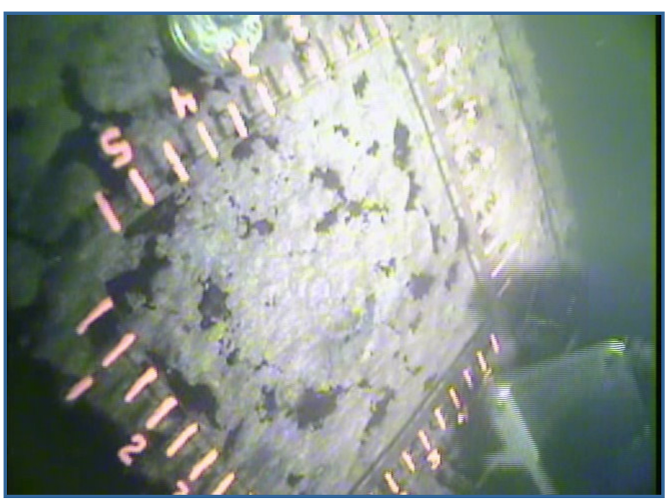
Midwest Energy (Pile w/ Jacket)- 10 feet



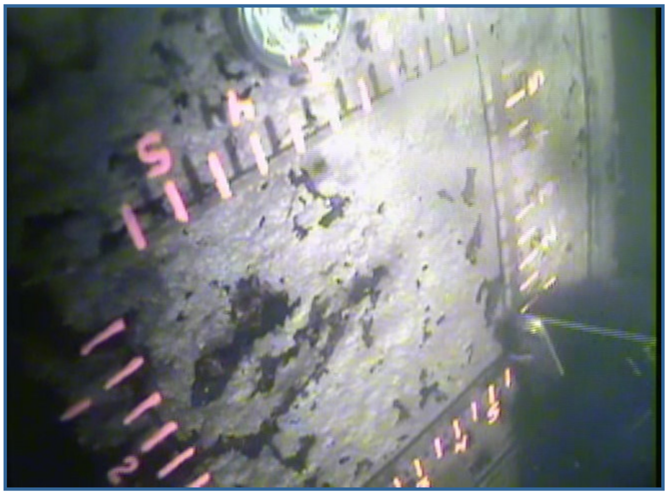
Midwest Energy (Pile w/o Jacket)- 0 feet



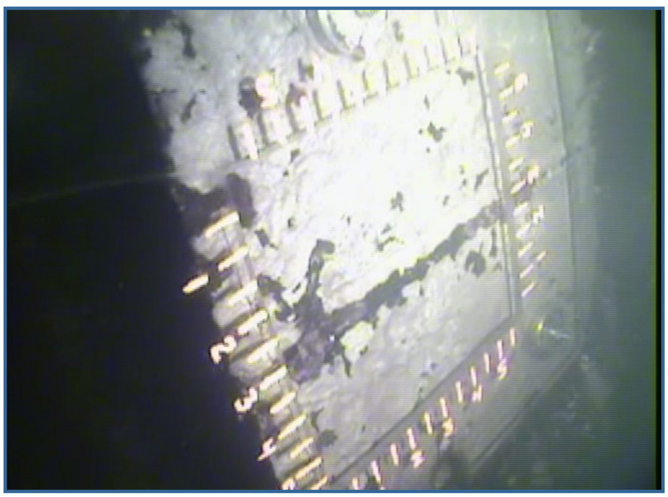
Midwest Energy (Pile w/o Jacket) - 2 feet



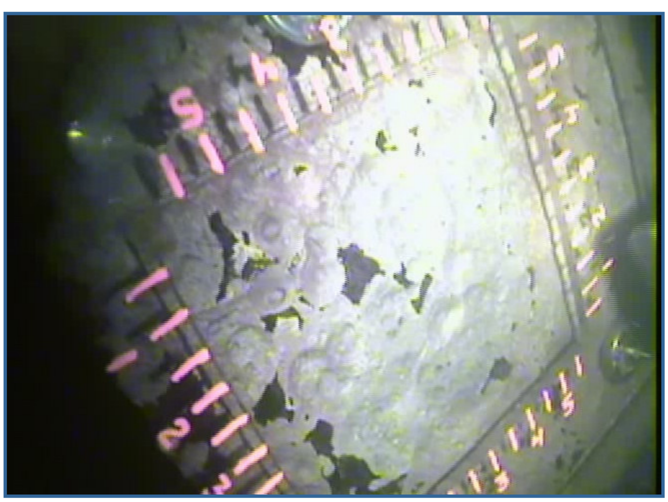
Midwest Energy (Pile w/o Jacket) - 4 feet



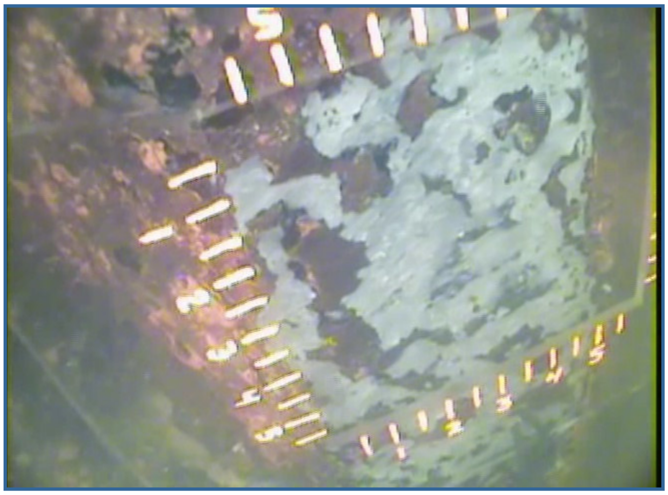
Midwest Energy (Pile w/o Jacket) - 6 feet



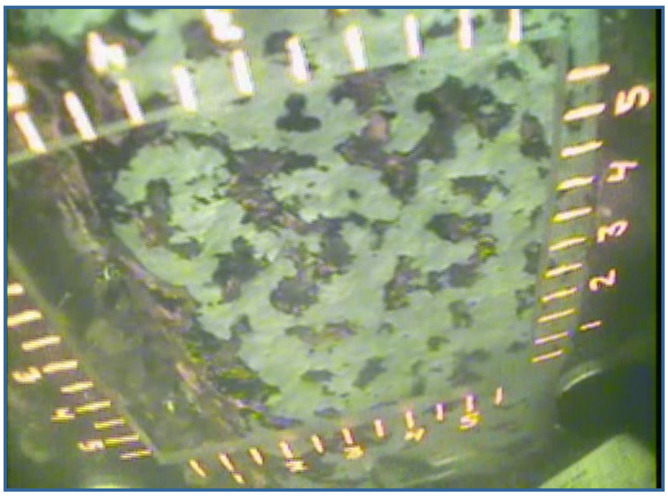
Midwest Energy (Pile w/o Jacket) - 8 feet



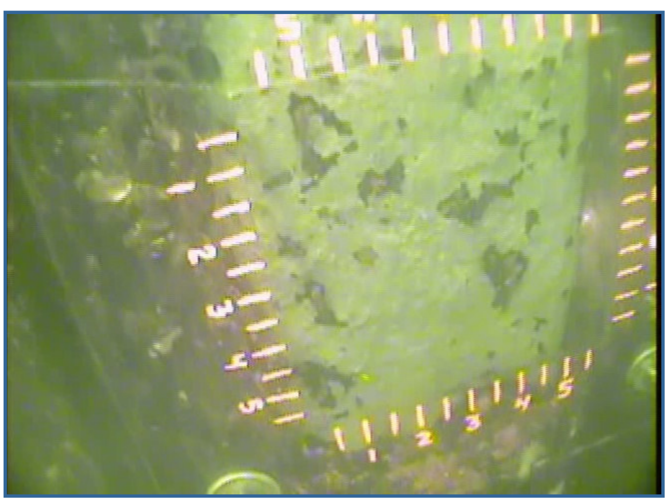
Midwest Energy (Pile w/o Jacket) - 10 feet



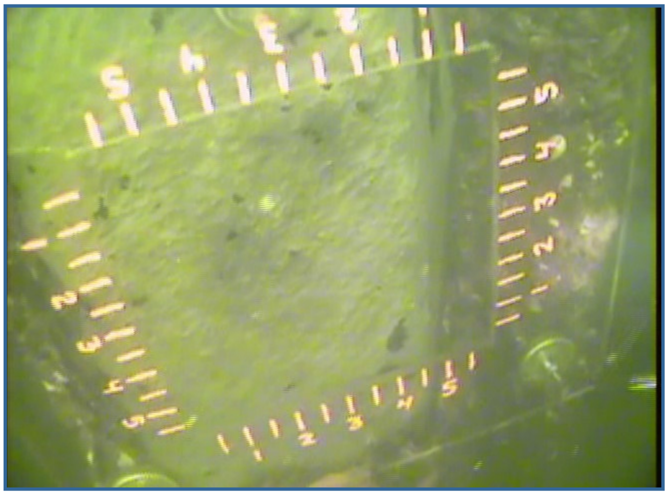
CHS 1- 2 feet



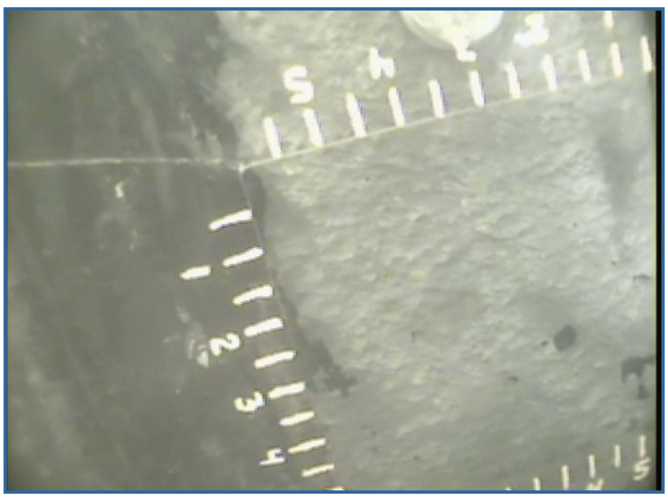
CHS 1- 4 feet



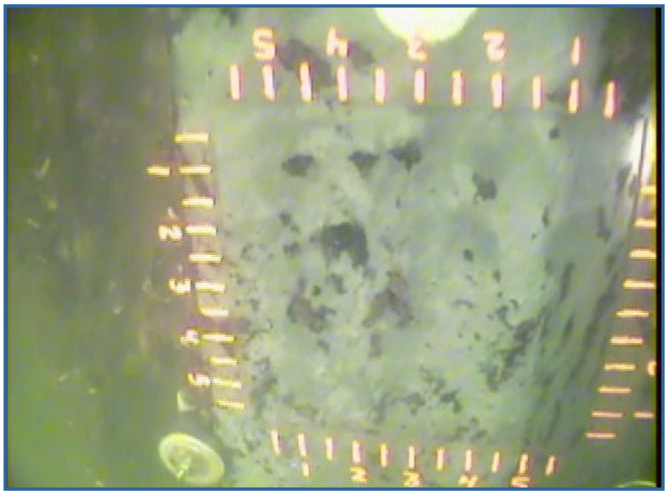
CHS 1- 6 feet



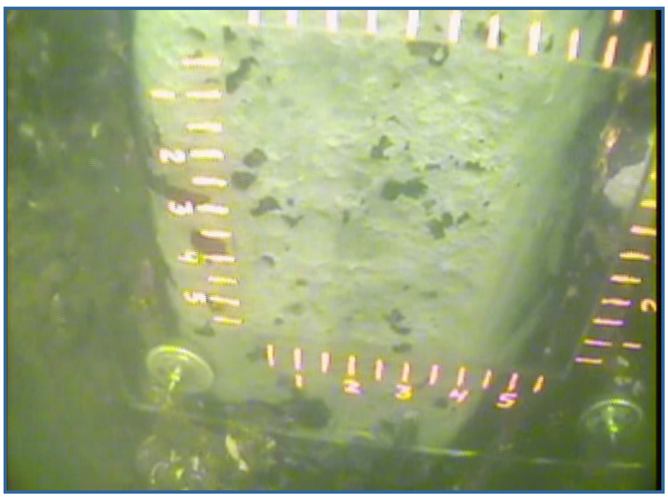
CHS 1- 8 feet



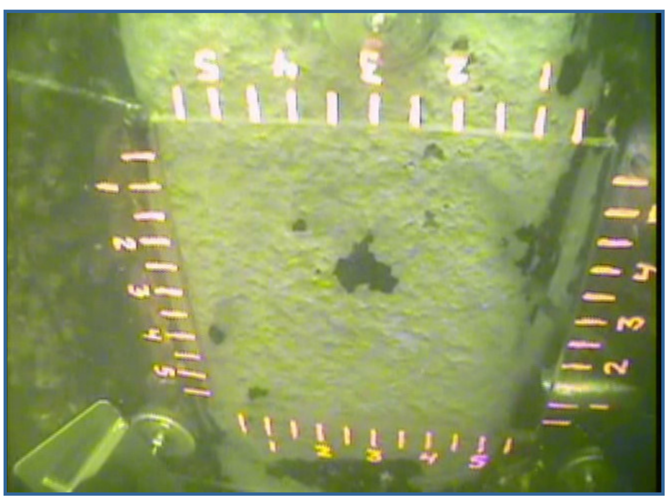
CHS 1- 10 feet



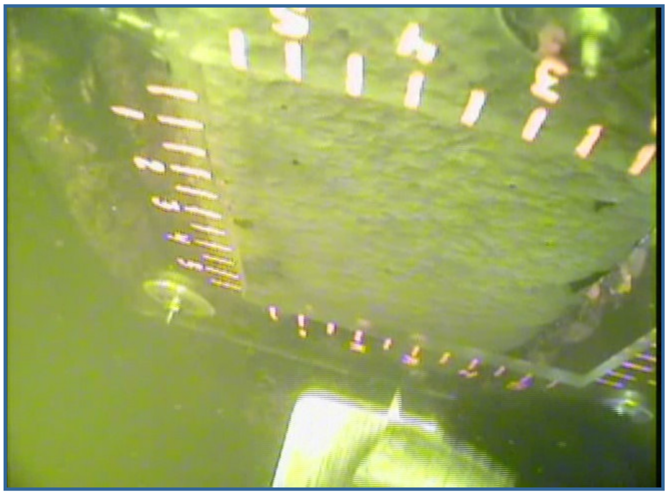
CHS 2- 2 feet



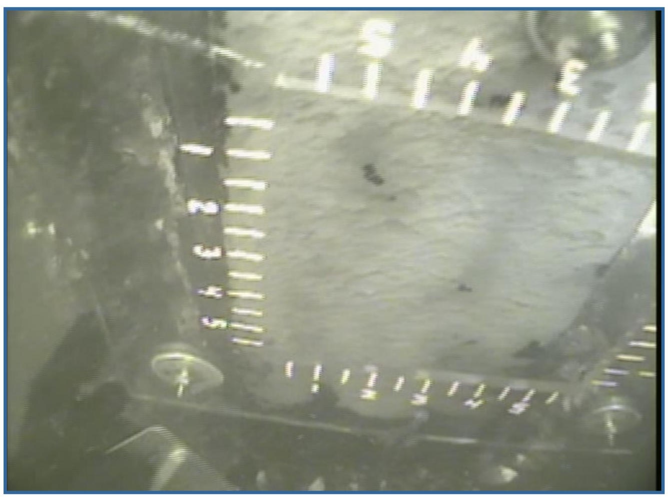
CHS 2- 4 feet



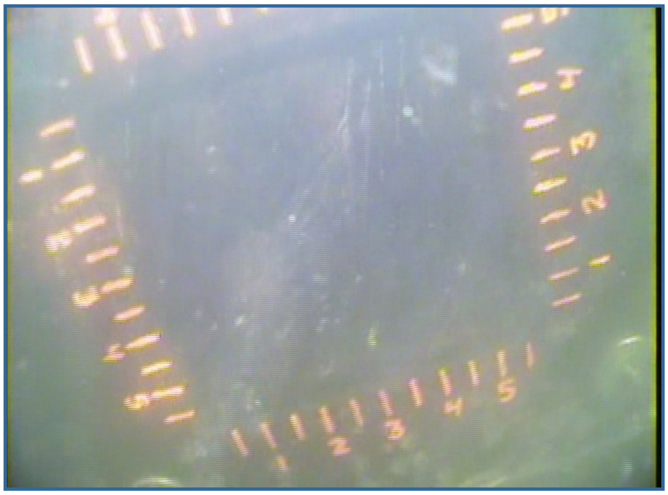
CHS 2- 6 feet



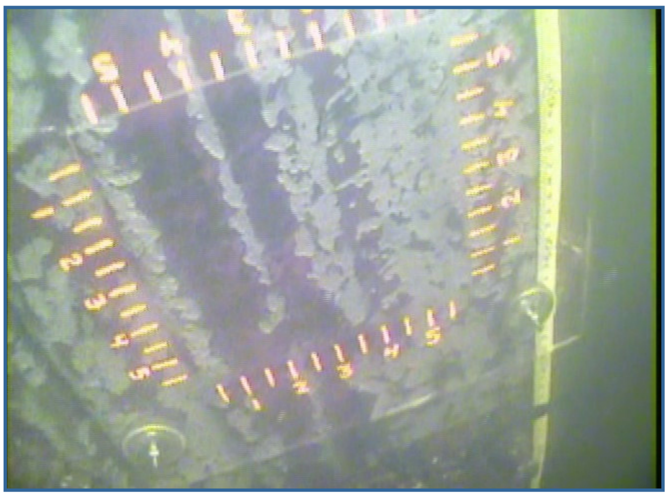
CHS 2- 8 feet



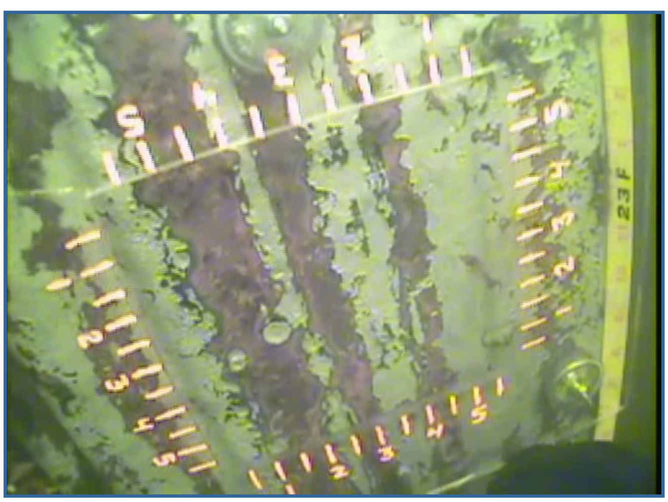
CHS 2- 10 feet



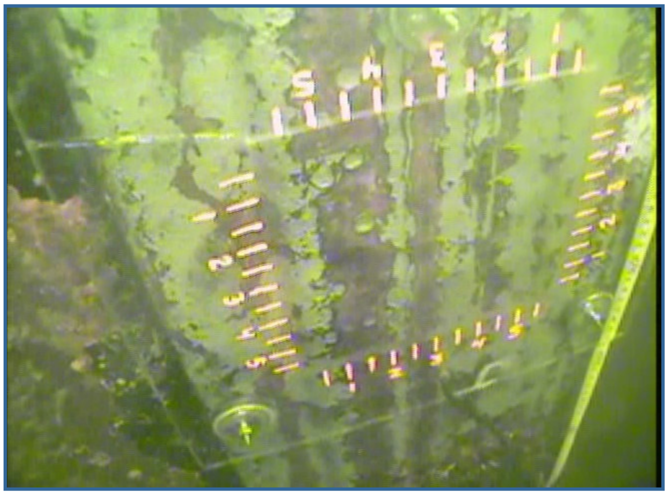
CHS 3- 0 feet



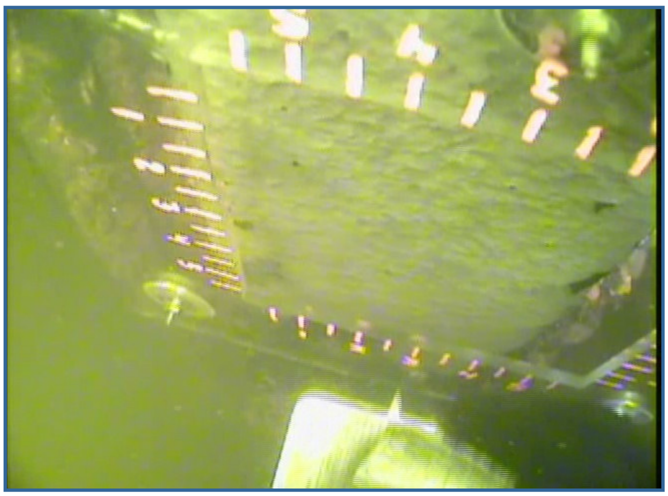
CHS 3- 2 feet



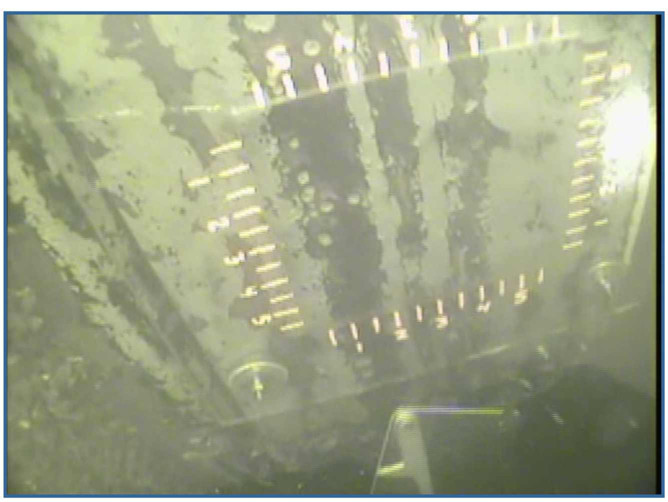
CHS 3- 4 feet



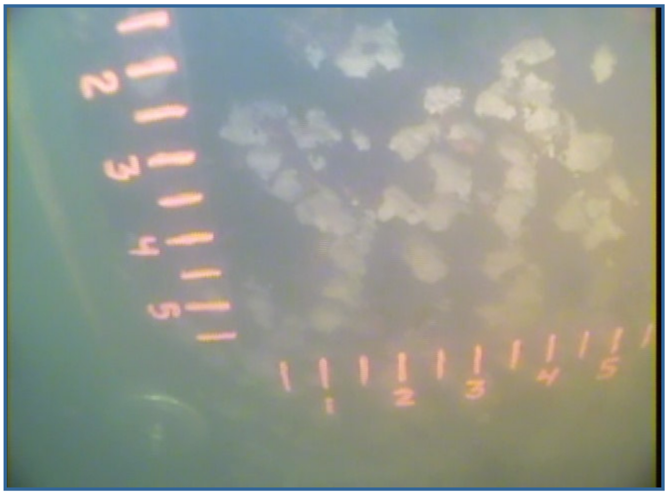
CHS 3- 6 feet



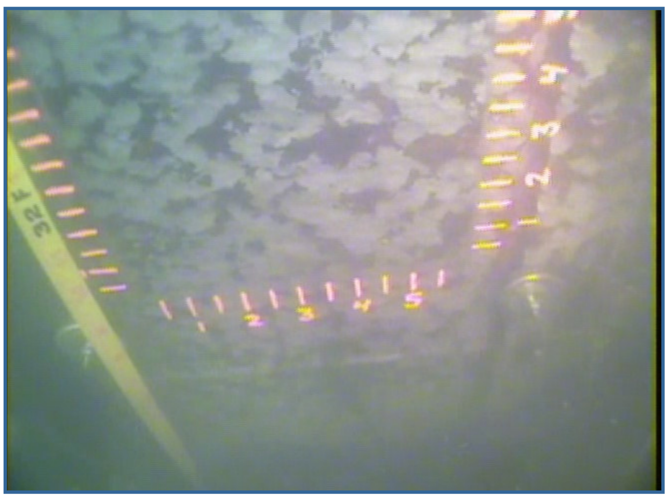
CHS 3- 8 feet



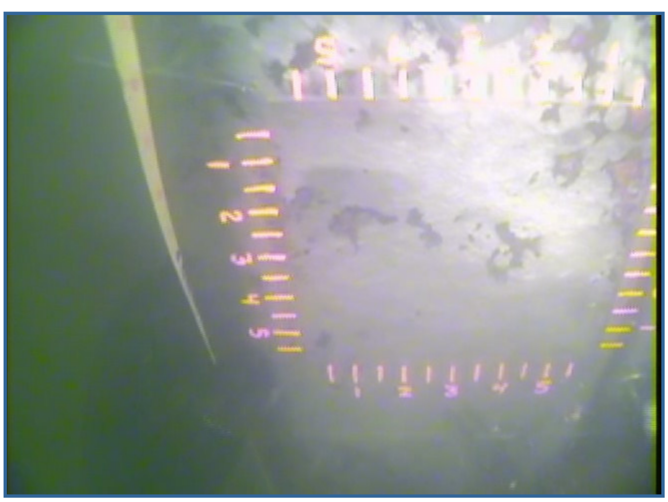
CHS 3- 10 feet



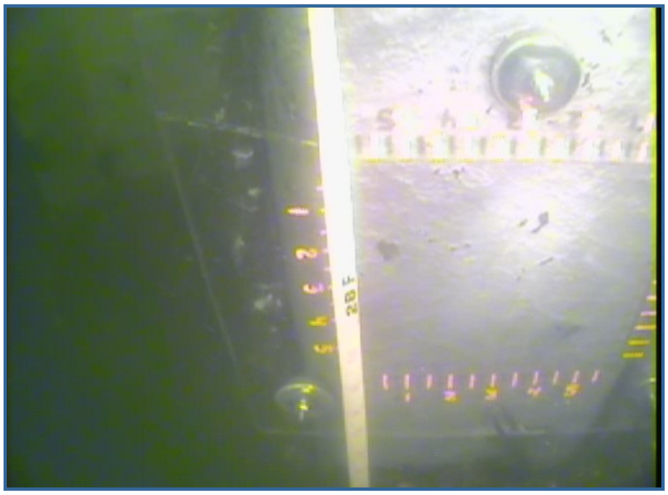
Cutler Magner - 0 feet



Cutler Magner - 2 feet

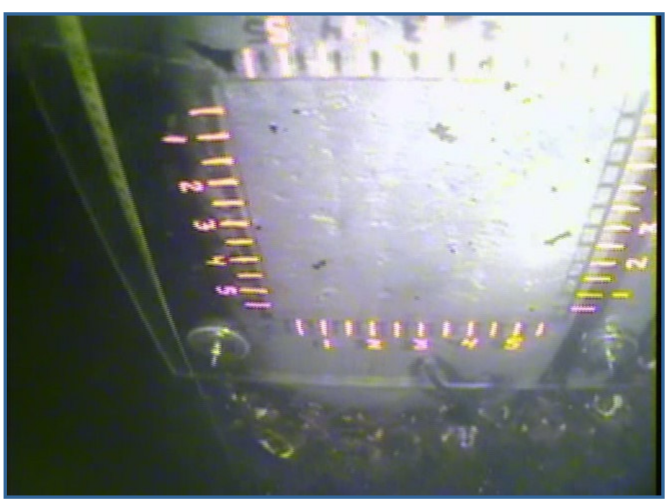


Cutler Magner - 4 feet

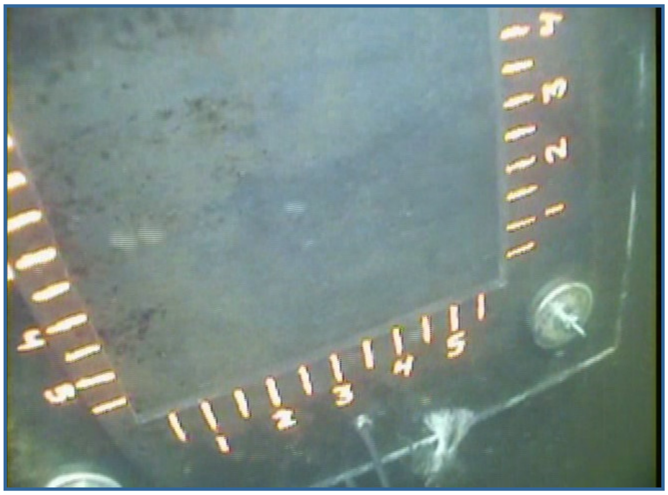


Cutler Magner - 6 feet

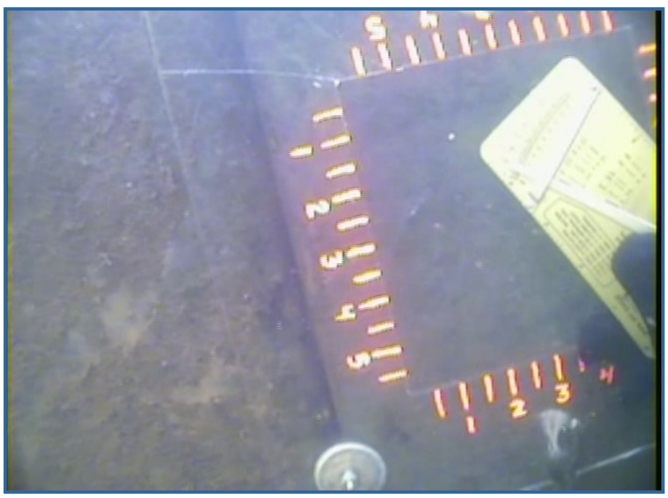
Cutler Magner - 8 feet



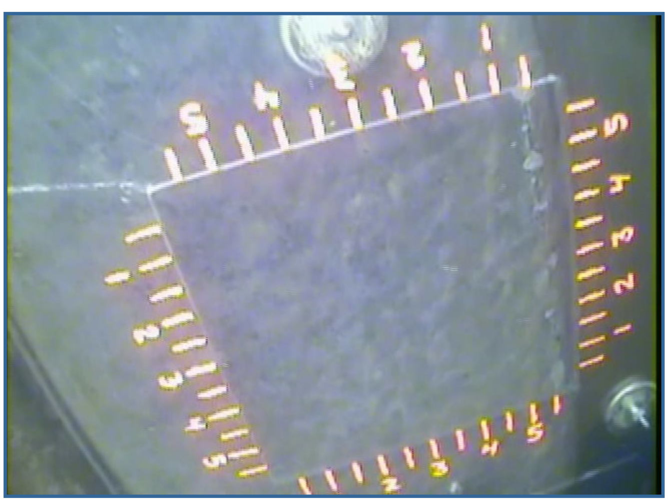
Cutler Magner- 10 feet



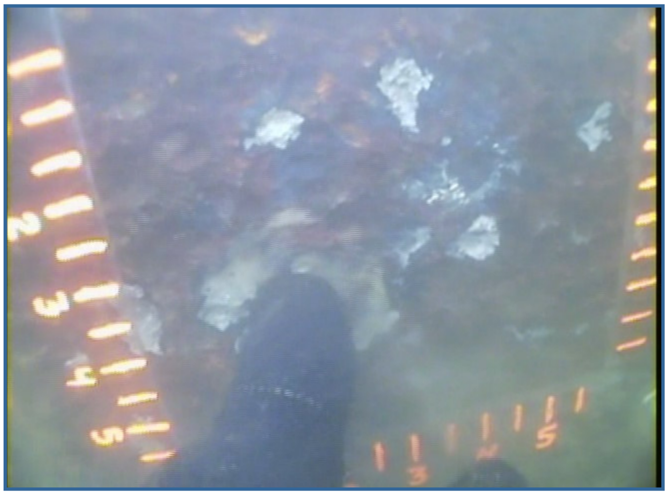
Lakehead Boat Basin (galvanized sheet pile) - 0 feet



Lakehead Boat Basin (galvanized sheet pile) - 2 feet

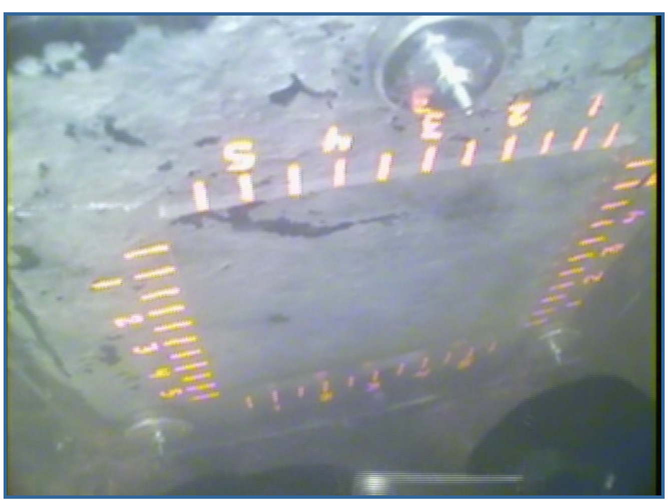


Lakehead Boat Basin (galvanized sheet pile) - 4 feet

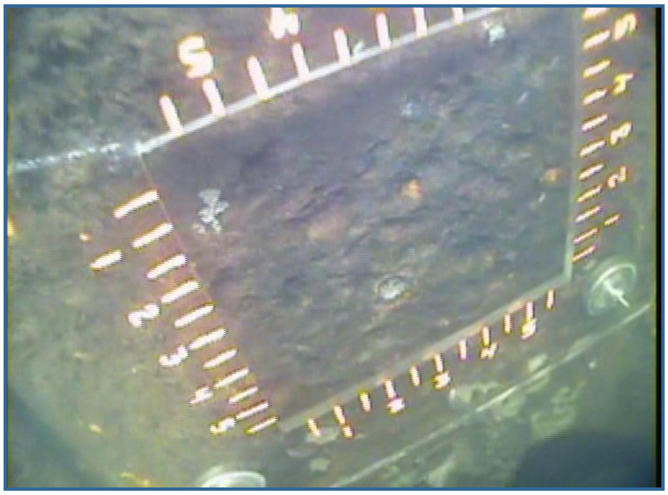


Lakehead Boat Basin (steel sheet pile) - 0 feet

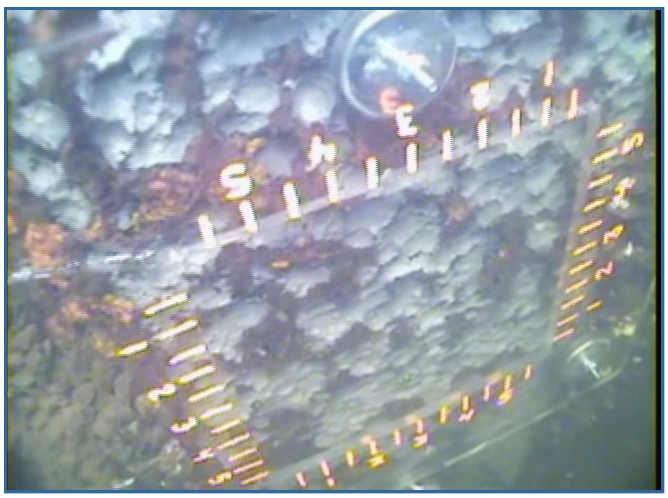
Lakehead Boat Basin (steel sheet pile) - 2 feet



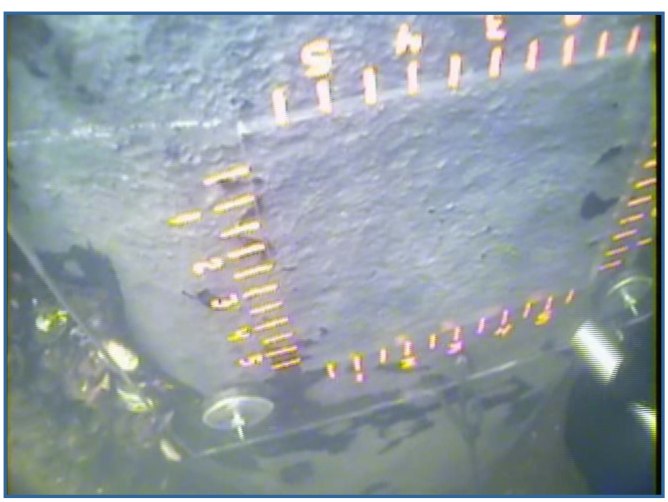
Lakehead Boat Basin (steel sheet pile)- 4 feet



Community Sailing Dock- 0 feet



Community Sailing Dock- 2 feet



Community Sailing Dock- 4 feet

APPENDIX B

Harbor Structure Data Forms

Site I.D. Number: 1

SITE INFORMATION

Facility	Duluth Seaway Port Authority
City	Duluth Seaway Port Authority
Location	Berth 1
Lat./ Long.	N46°45.495/ W92°06.151
Facility Information	
Owner	DSPA

STRUCTURE INFORMATION

Wall Length	1600 feet
Depth Driven	58 feet
Average Depth	31 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ38
Era Installed	1950's
Year Installed	1957
Original Thickness	Fl=1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 2

SITE INFORMATION

Facility	Duluth Seaway Port Authority
City	Duluth
Location	Berth 4
Lat./ Long.	N46°45.480/ W92°05.776
Facility Information	
Owner	DSPA

STRUCTURE INFORMATION

Wall Length	2200 feet
Depth Driven	58 feet
Average Depth	31 feet
Ice Scour	No
Sun Exposure	Northeast
Activity Level	High
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ38
Era Installed	1950's
Year Installed	1957
Original Thickness	Fl=1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 3

SITE INFORMATION

Facility	Duluth Seaway Port Authority
City	Duluth
Location	Berth 6
Lat./ Long.	N46°45.495/ W92°06.151
Facility Information	
Owner	DSPA

STRUCTURE INFORMATION

Wall Length	1375 feet
Depth Driven	58 feet
Average Depth	31 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ38
Era Installed	1950's
Year Installed	1957
Original Thickness	Fl=1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 4

SITE INFORMATION

Facility	CN- Two Harbors
City	Two Harbors
Location	Dock 1
Lat./ Long.	N47°00.931/ W91°40.258
Facility Information	Taconite Load out Facility
Owner	Canadian National Railway

STRUCTURE INFORMATION

Wall Length	1406 feet
Depth Driven	unk
Average Depth	30 feet
Ice Scour	No
Sun Exposure	North
Activity Level	Low
Structure Type	Bulkhead
Type of Wall	Steel Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MP-115
Era Installed	1910's
Year Installed	1912
Original Thickness	0.375
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number 5

SITE INFORMATION

Facility	Minnesota Slip
City	Duluth
Location	North Wall
Lat./ Long.	N46°47.018/ W92°05.865
Facility Information	William A. Irvin & Lake Superior and Charter Fishing Docks
Owner	Marine Iron & Ship Building Co. and City of Duluth

STRUCTURE INFORMATION

Wall Length	150 feet
Depth Driven	unk
Average Depth	16 feet
Ice Scour	No
Sun Exposure	Southeast
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ-38
Era Installed	unk
Year Installed	unk
Original Thickness	1/2"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number	6

SITE INFORMATION

Facility	DECC		
City	Duluth		
Location	DECC	Lat./ Long.	N46°46.765/ W92°05.906
Facility Information			
Owner	City of Duluth		

STRUCTURE INFORMATION

Wall Length	950 Feet
Depth Driven	28 feet
Average Depth	14 Feet
Ice Scour	No
Sun Exposure	Southeast
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ-38
Era Installed	1964
Year Installed	1960's
Original Thickness	Fl=1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 7

SITE INFORMATION

Facility	Cargill
City	Duluth
Location	Berth 1
Lat./ Long.	N46°46.166/ W92°06.312
Facility Information	
Owner	Cargill Inc.

STRUCTURE INFORMATION

Wall Length	1700 feet
Depth Driven	unk
Average Depth	28 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Concrete cap w/ timber cribbing, 900 ft fronted w/ sheet pile

PILE INFORMATION

Manufacturer	Bethleham Steel
Type	PZ-27
Era Installed	unk
Year Installed	unk
Original Thickness	3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 8

SITE INFORMATION

Facility	Hallett Dock 5
City	Duluth
Location	North face of Dock 5
Lat./ Long.	N46°44.734/ W92°07.943
Facility Information	Misc Bulk Material
Owner	Hallett Dock Company

STRUCTURE INFORMATION

Wall Length	2400 feet
Depth Driven	50 feet
Average Depth	25 feet
Ice Scour	No
Sun Exposure	Northeast
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ-38
Era Installed	1980's
Year Installed	1988
Original Thickness	FL=1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 9

SITE INFORMATION

Facility	Bong Bridge Cell
City	Duluth Harbor
Location	South side of west pier
Lat./ Long.	N46°43.882/ W92°08.668
Facility Information	
Owner	Mn/DOT

STRUCTURE INFORMATION

Wall Length	
Depth Driven	
Average Depth	27 feet
Ice Scour	No
Sun Exposure	West
Activity Level	Low
Structure Type	Pier Protection Cell
Type of Wall	Sheet Pile Cell

PILE INFORMATION

Manufacturer	US Steel
Type	PSA 28
Era Installed	1980's
Year Installed	1986
Original Thickness	1/2"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	Yes
Year Coated	1986
Coating Name	unk
Coating Manufacturer	unk
Coating Type	Coal Tar Epoxy
Location	4 to 8 feet below IGLD

Site I.D. Number: 11

SITE INFORMATION

Facility	Spirit Lake Marina
City	Duluth
Location	Inner Wall
Lat./ Long.	46°42.433/ W92°12.172
Facility Information	Located on St. Louis River
Owner	Jim & Judy King

STRUCTURE INFORMATION

Wall Length	125 feet
Depth Driven	
Average Depth	8 feet
Ice Scour	No
Sun Exposure	Southeast
Activity Level	Low
Structure Type	Wood pile dock
Type of Wall	steel jacketed wood piles

PILE INFORMATION

Manufacturer	unk
Type	12" Sch 40 Pipe
Era Installed	1980's
Year Installed	Late 80's
Original Thickness	0.375
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 12

SITE INFORMATION

Facility	Oliver Bridge
City	Oliver
Location	West Pier
Lat./ Long.	N46°39.391/ W92°12.165
Facility Information	Sheet Pile Cell driven around pier to stop scour
Owner	Canadian National Railway

STRUCTURE INFORMATION

Wall Length	140 feet
Depth Driven	40 feet
Average Depth	26 feet
Ice Scour	no
Sun Exposure	South
Activity Level	Low
Structure Type	Bridge Pier
Type of Wall	Sheet Pile Cell

PILE INFORMATION

Manufacturer	Bethlehem
Type	SP?
Era Installed	1900's
Year Installed	unk
Original Thickness	.625"
Hot or Cold Rolled	Hot
Capped (Yes/No)	No
ASTM Specification	

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 13

SITE INFORMATION

Facility	MERC
City	Superior
Location	Bent 43
Lat./ Long.	N46°44.571/ W92°06.891
Facility Information	
Owner	Midwest Energy Resources Co, a Division of Detroit Edison

STRUCTURE INFORMATION

Wall Length	1215 feet
Depth Driven	85
Average Depth	27 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	High
Structure Type	Steel Pile, Concrete Decked Wharf, Some Steel Jackets
Type of Wall	Steel Pile Bents

PILE INFORMATION

Manufacturer	UNK
Type	HP12x74
Era Installed	1970's
Year Installed	1974
Original Thickness	0.61
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A36

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 14

SITE INFORMATION

Facility	CHS
City	Superior
Location	East Dock Elevator 2
Lat./ Long.	N46°44.399/ W92°05.965
Facility Information	
Owner	Cenex Harvest States

STRUCTURE INFORMATION

Wall Length	1175 feet
Depth Driven	50 feet
Average Depth	27
Ice Scour	Yes- on concrete
Sun Exposure	East
Activity Level	Low
Structure Type	Conc. Bulkhead supported by timber crib w/ sheet pile front
Type of Wall	Steel Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MP115
Era Installed	1960's
Year Installed	1963
Original Thickness	3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Concrete
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 15

SITE INFORMATION

Facility	CHS
City	Superior
Location	West Dock- Inner End
Lat./ Long.	N46°44.377/ W92°06.155
Facility Information	
Owner	Cenex Harvest States

STRUCTURE INFORMATION

Wall Length	1165 feet
Depth Driven	
Average Depth	24 feet
Ice Scour	Yes- on concrete
Sun Exposure	Northwest
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ-27
Era Installed	1960's
Year Installed	1963
Original Thickness	0.375
Hot or Cold Rolled	Hot
Capped (Yes/No)	Concrete
ASTM Specification	

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 16

SITE INFORMATION

Facility	CHS
City	Superior
Location	West Dock- Rehab Area
Lat./ Long.	N46°44.406/ W92°06.151
Facility Information	
Owner	Cenex Harvest States

STRUCTURE INFORMATION

Wall Length	1165 feet
Depth Driven	50 feet
Average Depth	24
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	HOESCH
Type	2500
Era Installed	2000
Year Installed	2003
Original Thickness	.492FL / .375W
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 17

SITE INFORMATION

Facility	Cutler Magner
City	Superior
Location	North Wall
Lat./ Long.	N46°43.993/ W92°04.498
Facility Information	Limestone Dock
Owner	Cutler Magner Co

STRUCTURE INFORMATION

Wall Length	570 feet
Depth Driven	55 feet
Average Depth	24 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Moderate
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	MZ-32
Era Installed	1960's
Year Installed	
Original Thickness	Fl= 1/2", Wb=3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 18

SITE INFORMATION

Facility	Lakehead Boat Basin
City	Duluth
Location	North Pier
Lat./ Long.	N46°46.457/ W92°05.563
Facility Information	Private boat marina
Owner	Joel Johnson

STRUCTURE INFORMATION

Wall Length	250 feet
Depth Driven	20 feet
Average Depth	8 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	PZ-27
Era Installed	2000
Year Installed	2002
Original Thickness	0.375
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	Yes
Year Coated	2002
Coating Name	Galvanizing
Coating Manufacturer	
Coating Type	Hot Dip Galvanized
Location	Full Length

Site I.D. Number: 19

SITE INFORMATION

Facility	Lakehead Boat Basin
City	Duluth
Location	South Wall
Lat./ Long.	N46°46.454/ W92°05.522
Facility Information	Private boat marina
Owner	Joel Johnson

STRUCTURE INFORMATION

Wall Length	175 feet
Depth Driven	12 feet
Average Depth	5 feet
Ice Scour	No
Sun Exposure	Northwest
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	PSA 23
Era Installed	1960's
Year Installed	1965
Original Thickness	3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

Site I.D. Number: 20

SITE INFORMATION

Facility	Community Sailing Dock
City	Duluth
Location	Outer Wall
Lat./ Long.	N46°43.932/ W92°03.408
Facility Information	Operated by Duluth Community Sailng Assoc.
Owner	City of Duluth

STRUCTURE INFORMATION

Wall Length	50 feet
Depth Driven	unk
Average Depth	5 feet
Ice Scour	No
Sun Exposure	Southwest
Activity Level	Low
Structure Type	Bulkhead Wall
Type of Wall	Anchored Sheet Pile

PILE INFORMATION

Manufacturer	US Steel
Type	PMA 22
Era Installed	unk
Year Installed	unk
Original Thickness	3/8"
Hot or Cold Rolled	Hot
Capped (Yes/No)	Yes
ASTM Specification	A328

COATING INFORMATION

Coating (Y/N)	No
Year Coated	
Coating Name	
Coating Manufacturer	
Coating Type	
Location	

APPENDIX C

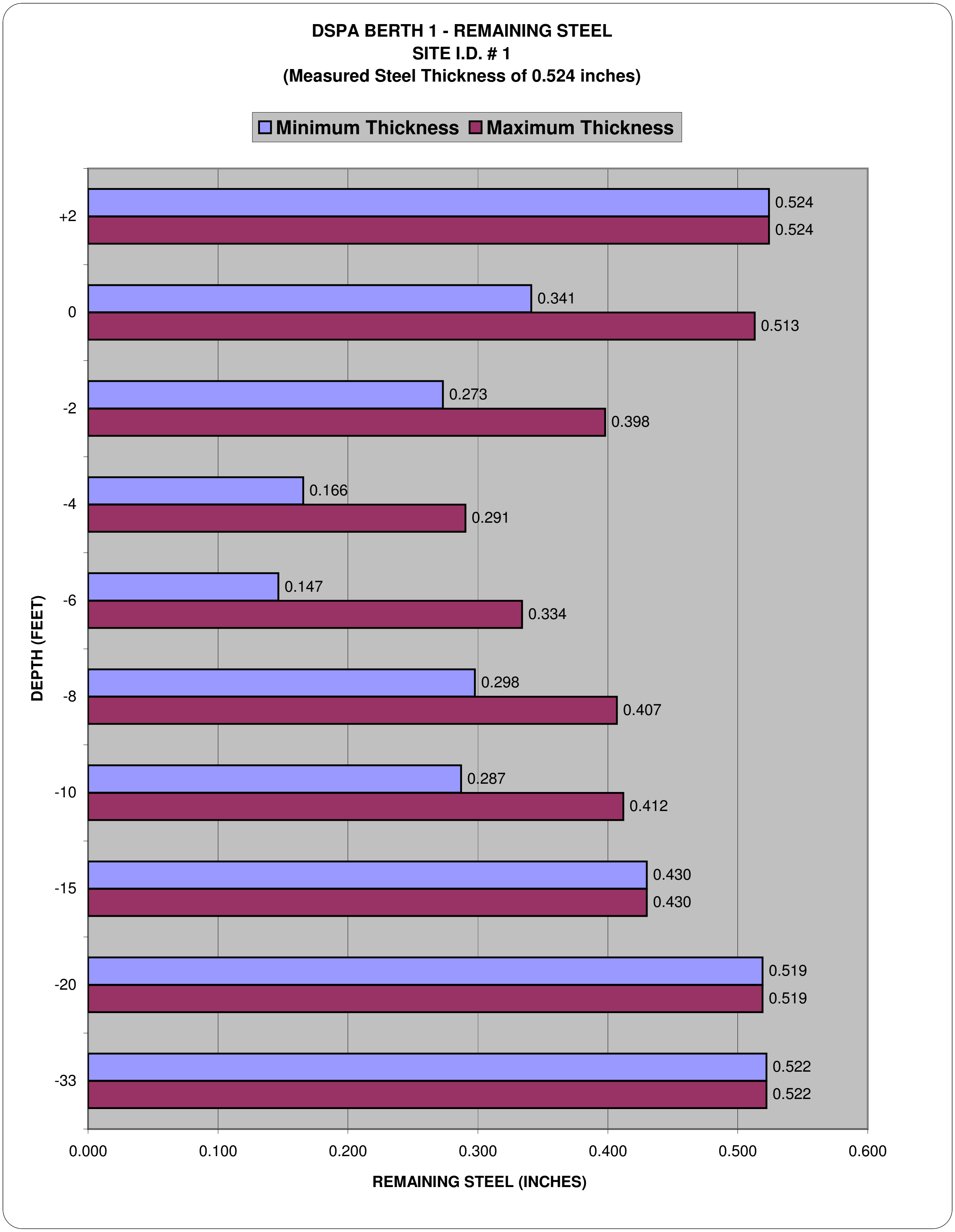
Corrosion Data Forms

FACILITY	Duluth Seaway Port Authority Berth 1	SITE I.D. NUMBER	1
DOCK CONFIGURATION	Southwest- Northeast	INSPECTION DATE	7/18/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	9:30
		WATER ELEVATION	601.62
		TEAM LEADER	C Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ38	0.5"	1957

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2									x			0.524					0					0	
2	0	X	Algae		Light					x	Pit	High	0.513	0.188	0.125	0.188	0.188	0.172	1.000	0.500	0.500	0.500	0.625	
3	-2	X	mussel	0.5	Sporatic					x	Pit	High	0.398	0.125	0.125	0.125	0.125	0.125	0.500	0.750	0.250	0.500	0.500	Pits Overlapped
4	-4	X	mussel	0.5	Sporatic					x	Pit	High	0.291	0.063	0.125	0.125	0.188	0.125	0.750	0.500	0.375	0.500	0.531	Pits Overlapped
5	-6	X	mussel	0.5	Sporatic					x	Pit	High	0.334	0.188	0.250	0.125	0.188	0.188	0.750	1.000	0.750	0.500	0.750	
6	-8	X	mussel	0.5	Sporatic					x	Pit	High	0.407	0.125	0.094	0.094	0.125	0.109	0.500	0.500	0.500	0.500	0.500	
7	-10	X	mussel	0.5	Full					x	Pit	Low	0.412	0.125	0.125	0.125	0.125	0.125	0.500	0.500	0.625	0.500	0.531	Deeper Pits More Sporadic
8	-15	X	mussel	0.5	Full					x	uniform	Low	0.430					0					0	Etched Overall Surface
9	-20	X	mussel	0.5	Full					x	uniform	Low	0.519					0					0	Etched Overall Surface
10	33	X	mussel	0.5	Full					x	uniform	Low	0.522					0					0	33 ft deep -2 Feet Below Mud Line Sheet Smooth


DSPA BERTH 1 - REMAINING STEEL
SITE I.D. # 1
(Measured Steel Thickness of 0.524 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-33
0.524
0.524
0.341
0.513
0.273
0.398
0.166
0.291
0.147
0.334
0.298
0.407
0.287
0.412
0.430
0.430
0.519
0.519
0.522
0.522
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

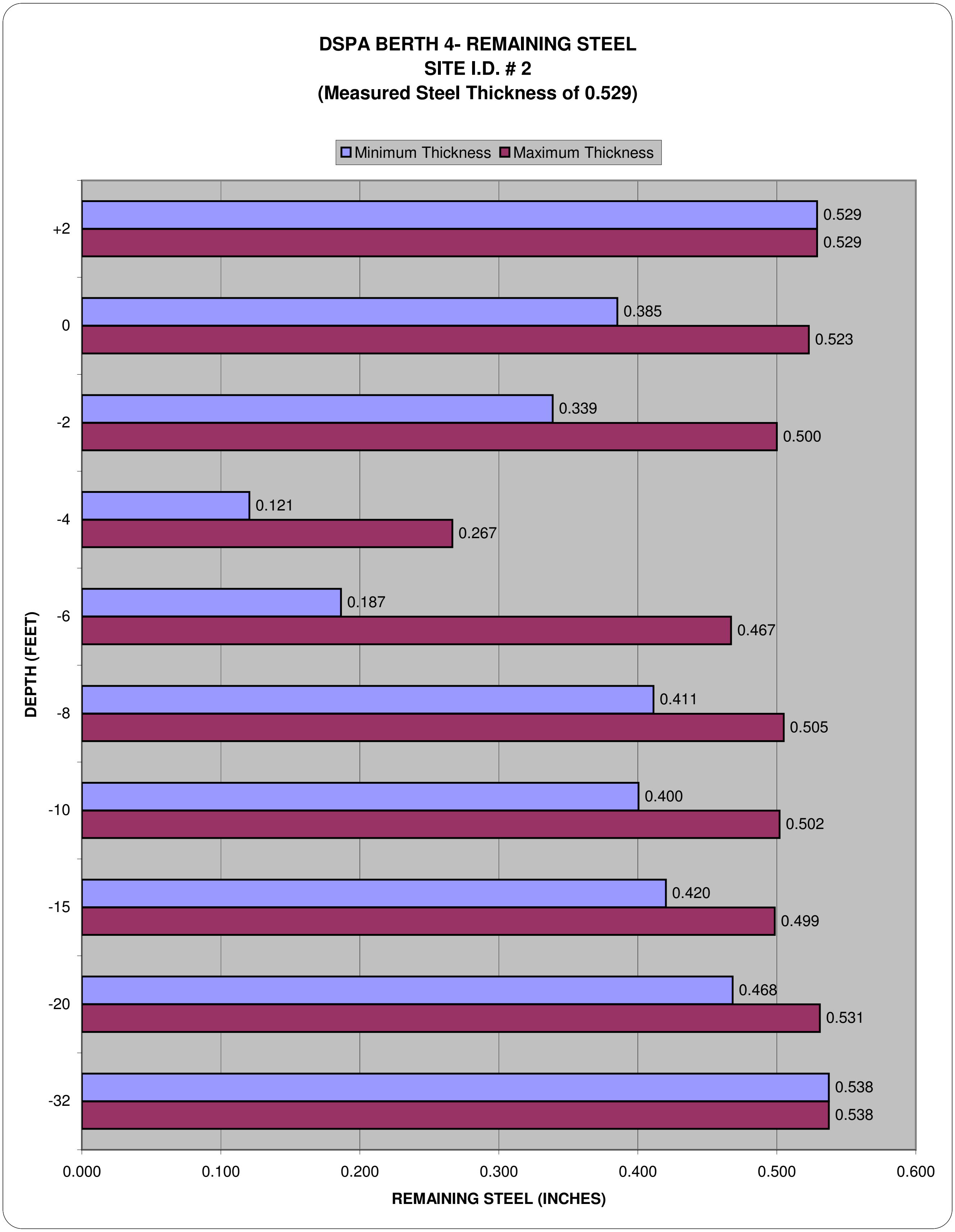
HARBOR STRUCTURES DATA

FACILITY	Duluth Seaway Port Authority Berth 4	SITE I.D. NUMBER	2
DOCK CONFIGURATION	Northwest-Southeast	INSPECTION DATE	7/18/2006
EXPOSURE DIRECTION	Northeast	INSPECTION TIME	14:10
		WATER ELEVATION	601.65
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ38	0.5"	1957

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings (remaining thickness)					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2	x											0.529					0.000					0.000	
2	0	x	Alge		Light					x	pit	High	0.523	0.148	0.132	0.123	0.148	0.138	0.750	0.750	0.750	0.750	0.750	Pits more significant than Berth 1
3	-2	x	Orange Nodules/Algae		Light					x	pit	High	0.500	0.155	0.132	0.233	0.125	0.161	0.500	0.750	0.500	0.500	0.563	Start of mussels on inpan
4	-4	x	Mussels		Sporatic					x	pit	High	0.267	0.155	0.148	0.126	0.155	0.146	0.500	0.375	0.500	0.500	0.469	More uniform pitting on inpan
5	-6	x	Mussels		Sporatic					x	pit	High	0.467	0.265	0.337	0.277	0.243	0.281	0.375	0.500	0.375	0.375	0.406	.09375 pits pen on inpan
6	-8	x	Mussels	0.75	Full					x	pit	High	0.505	0.063	0.094	0.125	0.094	0.094	0.250	0.250	0.250	0.250	0.250	.125 pits pen on inpan
7	-10	x	Mussels	1	Full					x	uniform	Mod	0.502	0.094	0.094	0.094	0.125	0.102	0.250	0.375	0.375	0.250	0.313	.0625 pits pen on inpan
8	-15	x	Mussels	1	Full					x	uniform	Mod	0.499	0.063	0.094	0.094	0.064	0.078	0.250	0.250	0.250	0.250	0.250	very small pits-high concentration
9	-20	x	Mussels	1	Full					x	uniform	Mod	0.531	0.063	0.063	0.063	0.064	0.063	0.125	0.125	0.125	0.125	0.125	1 - 0.375 by 4 inch long trough pit
10	-32	x	Mussels	1	Full					x	uniform	Low	0.538	0.000				0.000	0.125	0.125	0.125	0.125	0.125	Etched



DSPA BERTH 4- REMAINING STEEL
SITE I.D. # 2
(Measured Steel Thickness of 0.529)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-32
0.529
0.529
0.385
0.523
0.339
0.500
0.121
0.267
0.187
0.467
0.411
0.505
0.400
0.502
0.420
0.499
0.468
0.531
0.538
0.538
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

HARBOR STRUCTURES DATA

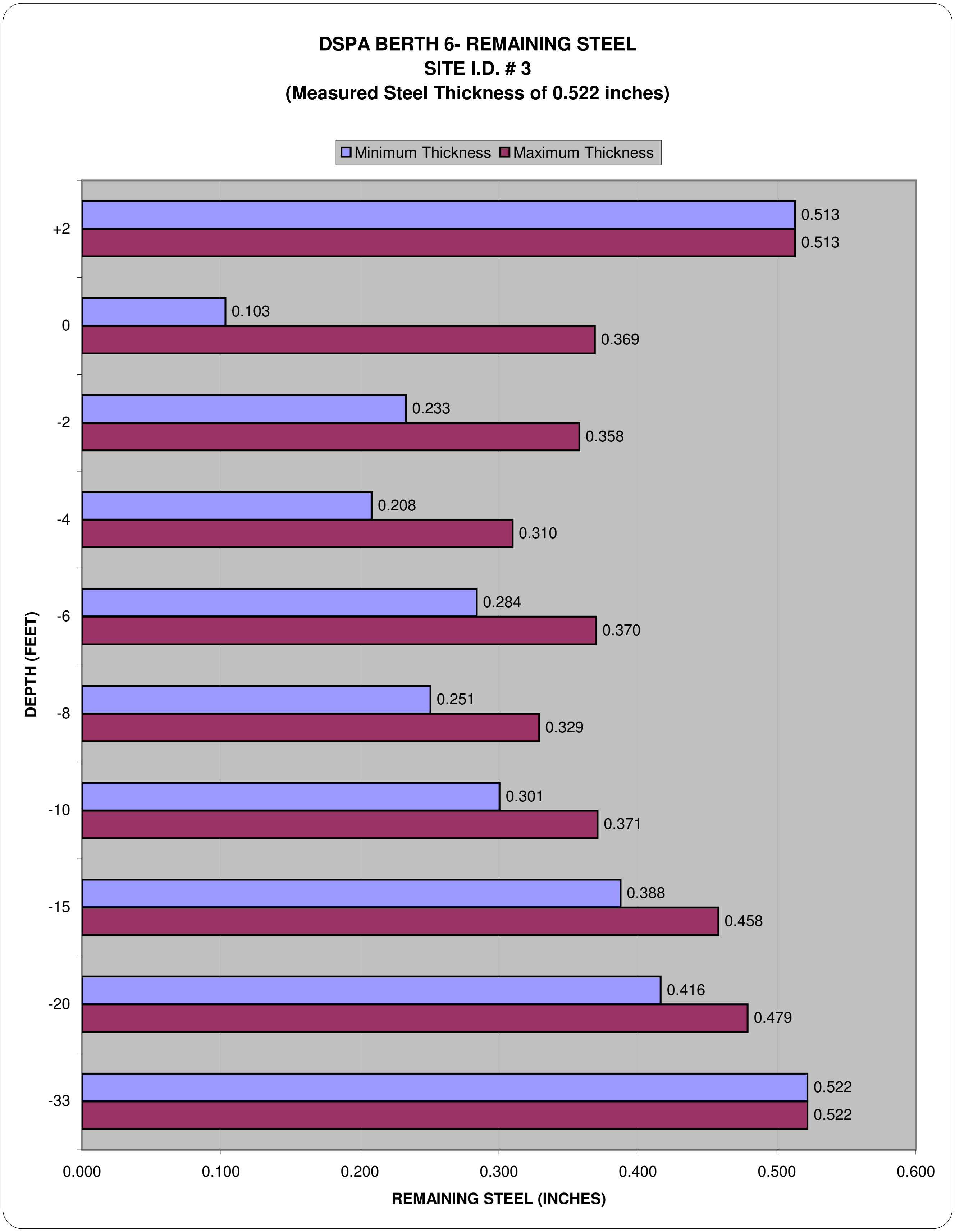
FACILITY	Duluth Seaway Port Authority Berth 6
DOCK CONFIGURATION	Southwest- Northeast
EXPOSURE DIRECTION	Southeast

SITE I.D. NUMBER	3
INSPECTION DATE	7/20/2006
INSPECTION TIME	13:31
WATER ELEVATION	601.6
TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ38	0.5"	1957

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.513					0.000					0.000	
2	0	X	Algae Orange Nodules		100					x	Pitting	High	0.369	0.250	0.313	0.250	0.250	0.266	0.750	0.750	0.625	0.500	0.656	1 foot below IGLD mussels begin
3	-2	x	Algae		100					x	Pitting	High	0.358	0.125	0.125	0.094	0.156	0.125	0.250	0.250	0.500	0.250	0.313	
4	-4	x	A, Zm Sponge		90%					x	Pitting	High	0.310	0.125	0.094	0.094	0.094	0.102	0.375	0.250	0.250	0.375	0.313	minor corrosion on inpan
5	-6	x	A, Zm Sponge		90%					x	Pitting	High	0.370	0.063	0.094	0.094	0.094	0.086	0.125	0.125	0.125	0.125	0.125	minor corrosion on inpan
6	-8	x	A, Zm Sponge		Zm 90%					x	Pitting	High	0.329	0.063	0.094	0.063	0.094	0.078	0.250	0.125	0.063	0.063	0.125	
7	-10	x	A, Zm Sponge		Zm 90%					x	Pitting	High	0.371	0.063	0.094	0.063	0.063	0.070	0.125	0.125	0.125	0.125	0.125	
8	-15	x	Zm		Zm 90%					x	Pitting	High	0.458	0.063	0.063	0.094	0.063	0.070	0.125	0.125	0.188	0.125	0.141	Etched Surface
9	-20	x	Zm Sponge		100%					x	Pitting	Mod	0.479	0.063	0.063	0.063	0.063	0.063	0.188	0.125	0.125	0.188	0.157	Etched Surface
10	-33	x	Zm		100%								0.522	No Pitting									0.000	33 feet deep- mussels end @ 29 ft


DSPA BERTH 6- REMAINING STEEL
SITE I.D. # 3
(Measured Steel Thickness of 0.522 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-33
0.513
0.513
0.103
0.369
0.233
0.358
0.208
0.310
0.284
0.370
0.251
0.329
0.301
0.371
0.388
0.458
0.416
0.479
0.522
0.522
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

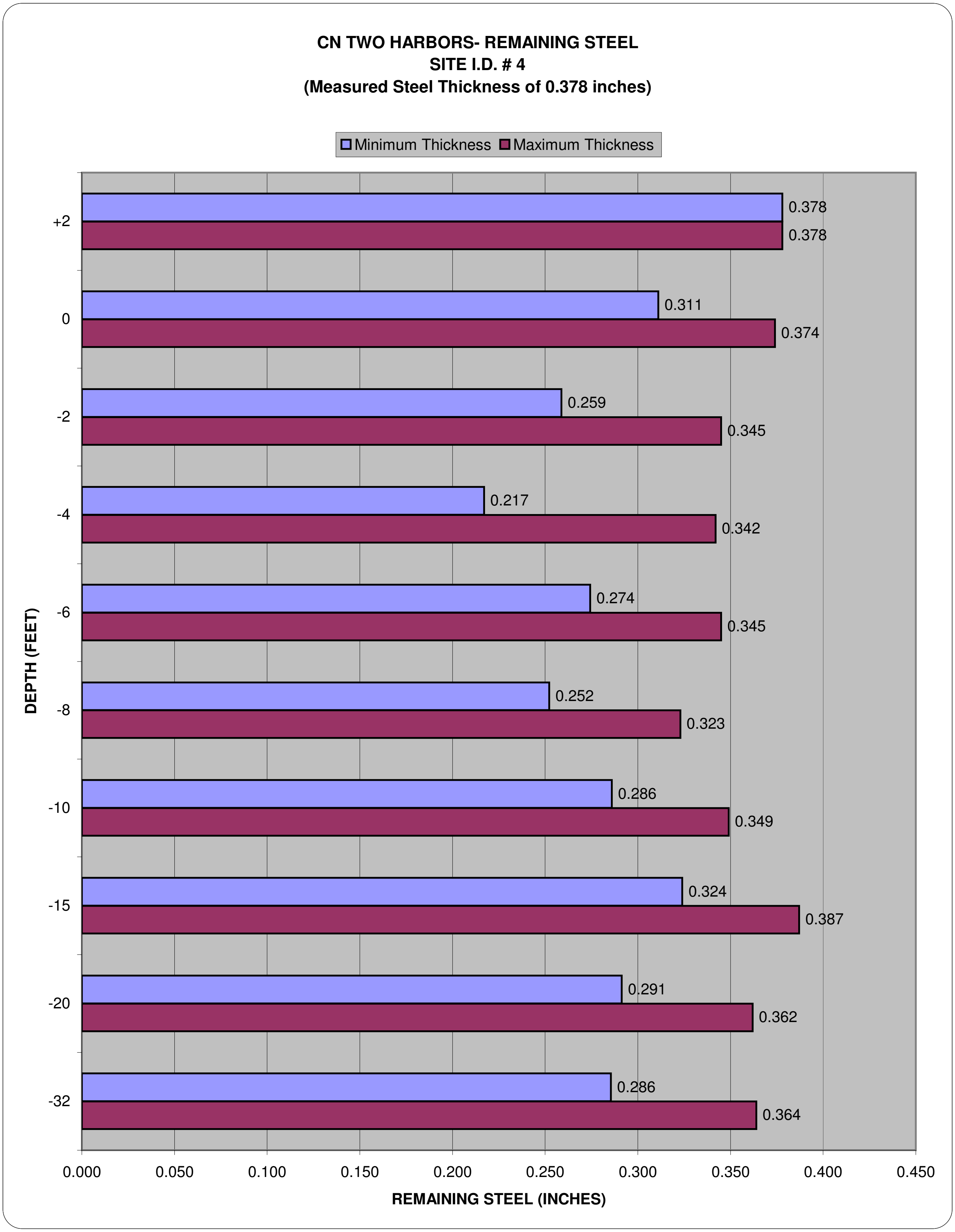
HARBOR STRUCTURES DATA

FACILITY	CN - Two Harbors
DOCK CONFIGURATION	West- East
EXPOSURE DIRECTION	North
SITE I.D. NUMBER	4
INSPECTION DATE	7/19/2006
INSPECTION TIME	13:37
WATER ELEVATION	601.62
TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MP-115	0.375"	1912

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.378					0.000					0.000	
2	0	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Low	0.374	0.063	0.063	0.063	0.063	0.063	0.125	0.125	0.125	0.125	0.125	Etched Appearance
3	-2	X	Orange Nods, Algae	.25 to .75	100%					x	Pit	Mod	0.345	0.125	0.063	0.063	0.094	0.086	0.375	0.125	0.125	0.125	0.188	Small pits within large pits
4	-4	X	Orange Nods, Algae	.25 to .75	100%					x	Pit	High	0.342	0.125	0.125	0.125	0.125	0.125	0.375	0.250	0.500	0.250	0.344	Small pits within large pits
5	-6	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Mod	0.345	0.063	0.063	0.094	0.063	0.071	0.250	0.125	0.125	0.125	0.156	Etched Appearance
6	-8	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Low	0.323	0.063	0.094	0.063	0.063	0.071	0.250	0.125	0.125	0.250	0.188	Etched Appearance
7	-10	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Low	0.349	0.063	0.063	0.063	0.063	0.063	0.125	0.125	0.125	0.125	0.125	Etched Appearance
8	-15	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Mod	0.387	0.063	0.063	0.063	0.063	0.063	0.250	0.125	0.250	0.125	0.188	Etched Appearance
9	-20	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Low	0.362	0.063	0.094	0.063	0.063	0.071	0.250	0.250	0.375	0.250	0.281	Etched Appearance
10	-32	X	Orange Nods, Algae	.25 to .75	100%					x	Uniform	Low	0.364	0.063	0.063	0.094	0.094	0.079	0.125	0.125	0.250	0.125	0.156	Etched Appearance

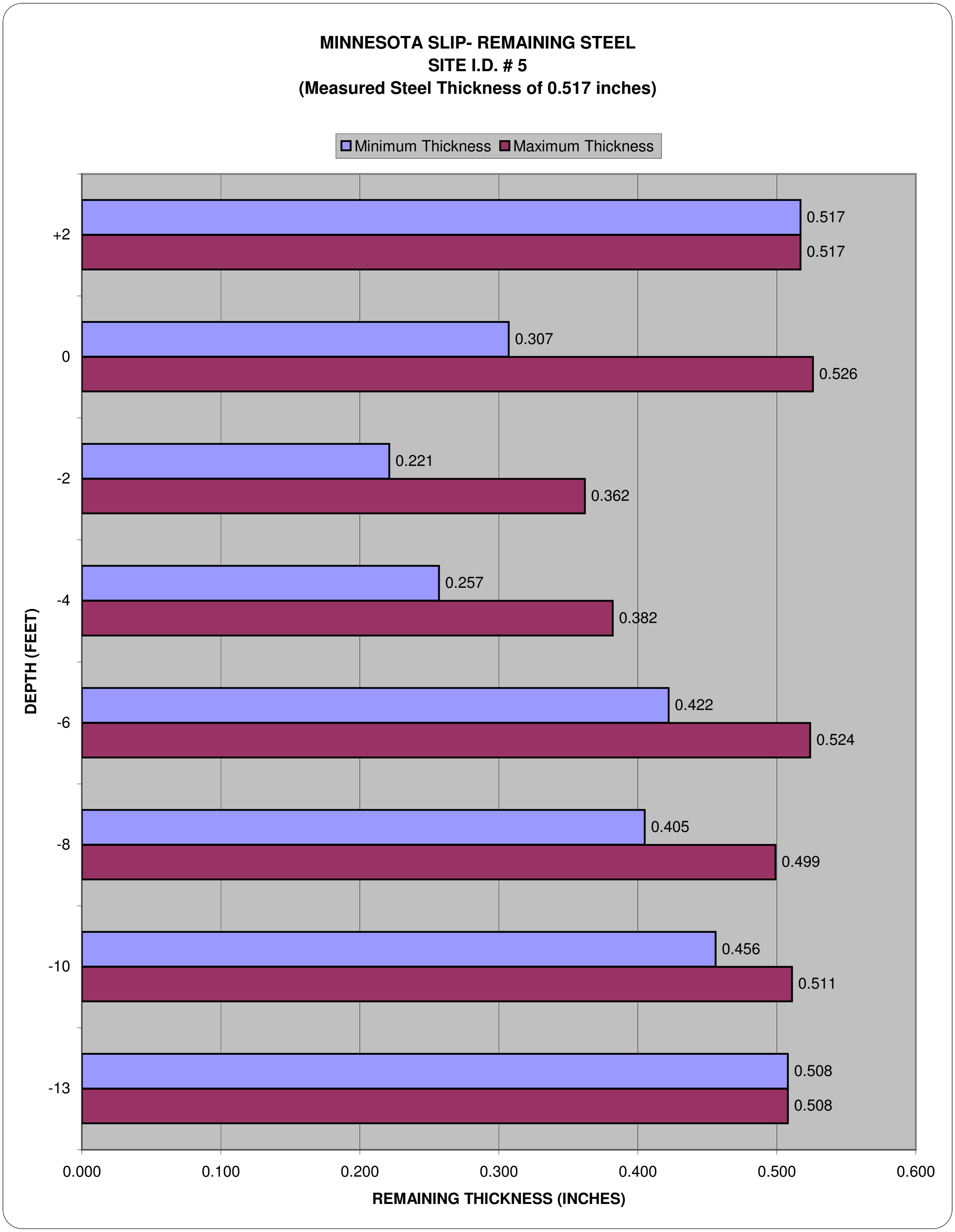

CN TWO HARBORS- REMAINING STEEL
SITE I.D. # 4
(Measured Steel Thickness of 0.378 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-32
0.378
0.378
0.311
0.374
0.259
0.345
0.217
0.342
0.274
0.345
0.252
0.323
0.286
0.349
0.324
0.387
0.291
0.362
0.286
0.364
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
REMAINING STEEL (INCHES)

FACILITY	Minnesota Slip	SITE I.D. NUMBER	5
DOCK CONFIGURATION	Southwest- Northeast	INSPECTION DATE	8/2/2006
EXPOSURE DIRECTION	Southeast	INSPECTION TIME	11:10
		WATER ELEVATION	601.7
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ 38	0.5"	unk

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.517					0.000					0.000	Storm sewer outfall by sample point
2	0	x	White Coating	0.125	100%					x	Pit	Mod	0.526	0.125	0.250	0.188	0.313	0.219	0.500	0.750	0.625	0.625	0.625	
3	-2	x	orange nod / Algae	.25 to .75	75%					x	Pit	Mod	0.362	0.125	0.125	0.125	0.188	0.141	0.375	0.500	0.500	0.500	0.469	Orange Nodules- Larger & Softer
4	-4	x	orange nod / Algae	.25 to .75	75%					x	Pit	Mod	0.382	0.094	0.125	0.125	0.156	0.125	0.125	0.250	0.250	0.250	0.219	Less Pitting on in Pan
5	-6	x	Mussels/ sponges	.5 to .75	75% 25%					x	Pit	Low	0.524	0.063	0.094	0.125	0.125	0.102	0.250	0.125	0.250	0.575	0.300	Sporadic Pitting
6	-8	x	Mussels/ sponges/O Nod	.5 to .75	70/20/10					x	Pit	Low	0.499	0.094	0.094	0.125	0.063	0.094	0.250	0.250	0.188	0.125	0.203	Etched surface / small pits
7	-10	x	Orange Nod - Z mussels	.5 to .75	50% 50%					x	Uniform	Low	0.511	0.063	0.063	0.031	0.063	0.055	0.125	0.125	0.063	0.125	0.110	Etched surface / small pits
8	-13	x	Orange Nod - Z mussels	.5 to .75	50% 50%								0.508					0.000					0.000	Mudline @13 ft, Soft Silty bottom / smooth steel
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	


MINNESOTA SLIP- REMAINING STEEL
SITE I.D. # 5
(Measured Steel Thickness of 0.517 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-13
0.517
0.517
0.307
0.526
0.221
0.362
0.257
0.382
0.422
0.524
0.405
0.499
0.456
0.511
0.508
0.508
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING THICKNESS (INCHES)

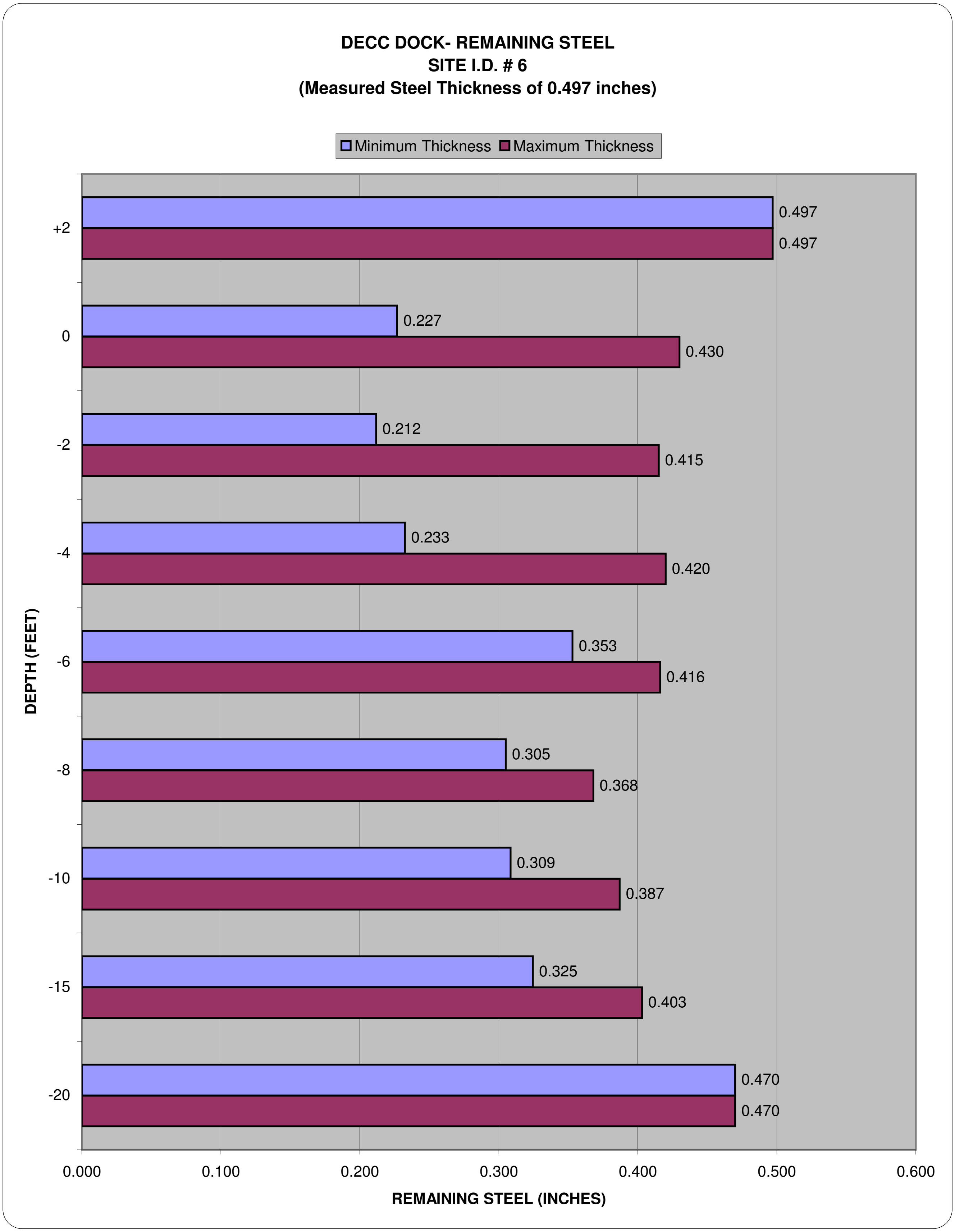
HARBOR STRUCTURES DATA

FACILITY	DECC	SITE I.D. NUMBER	6
DOCK CONFIGURATION	Southwest- Northeast	INSPECTION DATE	8/2/2006
EXPOSURE DIRECTION	Southeast	INSPECTION TIME	9:20
		WATER ELEVATION	601.71
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ 38	0.5"	1964

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth: Present	Marine Growth: Type	Marine Growth: Thickness	Marine Growth: Coverage	Protective Coating: Present	Protective Coating: Type	Protective Coating: Thickness	Protective Coating: Coverage	Corrosion: Present	Corrosion: Type	Corrosion: Concentration (High Mod. Low)	Steel Max. Remaining Thickness	Pit Penetration Readings: 1	2	3	4	AVG	Pit Diameter Readings: 1	2	3	4	AVG	Comments
1	+2					x	Coal / Tar	unk	unk				0.497					0.000					0.000	Present Above IGLD
2	0	x	Algae/orange nod / white	<.25	100%					x	Pit	High	0.430	0.125	0.250	0.188	0.250	0.203	0.500	0.750	0.500	0.750	0.625	Heavy Pits on both out & in pans
3	-2	x	Algae/ Mussels	.25 to 1.0	Sporadic					x	Pit	High	0.415	0.188	0.250	0.125	0.250	0.203	0.500	0.750	0.500	0.625	0.594	small pits within large pits
4	-4	x	Algae/mussels/sponges	.25 to 1.0	Sporadic					x	Pit	High	0.420	0.125	0.250	0.125	0.250	0.188	0.500	0.500	0.500	0.500	0.500	less pitting on in pans
5	-6	x	Algae/mussels/sponges	.25 to 1.0	Sporadic					x	Pit	Mod	0.416	0.063	0.063	0.063	0.063	0.063	0.188	0.250	0.250	0.125	0.203	pits on in &out pans similar
6	-8	x	Algae/mussels/sponges	.25 to 1.0	Sporadic					x	Pit	Mod	0.368	0.063	0.063	0.063	0.063	0.063	0.250	0.125	0.250	0.188	0.203	pits on in &out pans similar
7	-10	x	Less Algae more Mussels	1 to 1.5	80% 20%					x	Pit	Mod	0.387	0.063	0.063	0.094	0.094	0.079	0.188	0.125	0.188	0.250	0.188	pits on in &out pans similar
8	-15	x	Mussels	1 to 1.5	100%					x	Uniform	Low	0.403	0.094	0.063	0.000	0.000	0.079	0.500	0.250	0.000	0.000	0.375	Only 2 pits in sample area
9	-20	x	Mussels	1 to 1.5	100%					x	Uniform	Low	0.470					0.000					0.000	Etched surface / Mud line @ 20 ft
10	ML																							

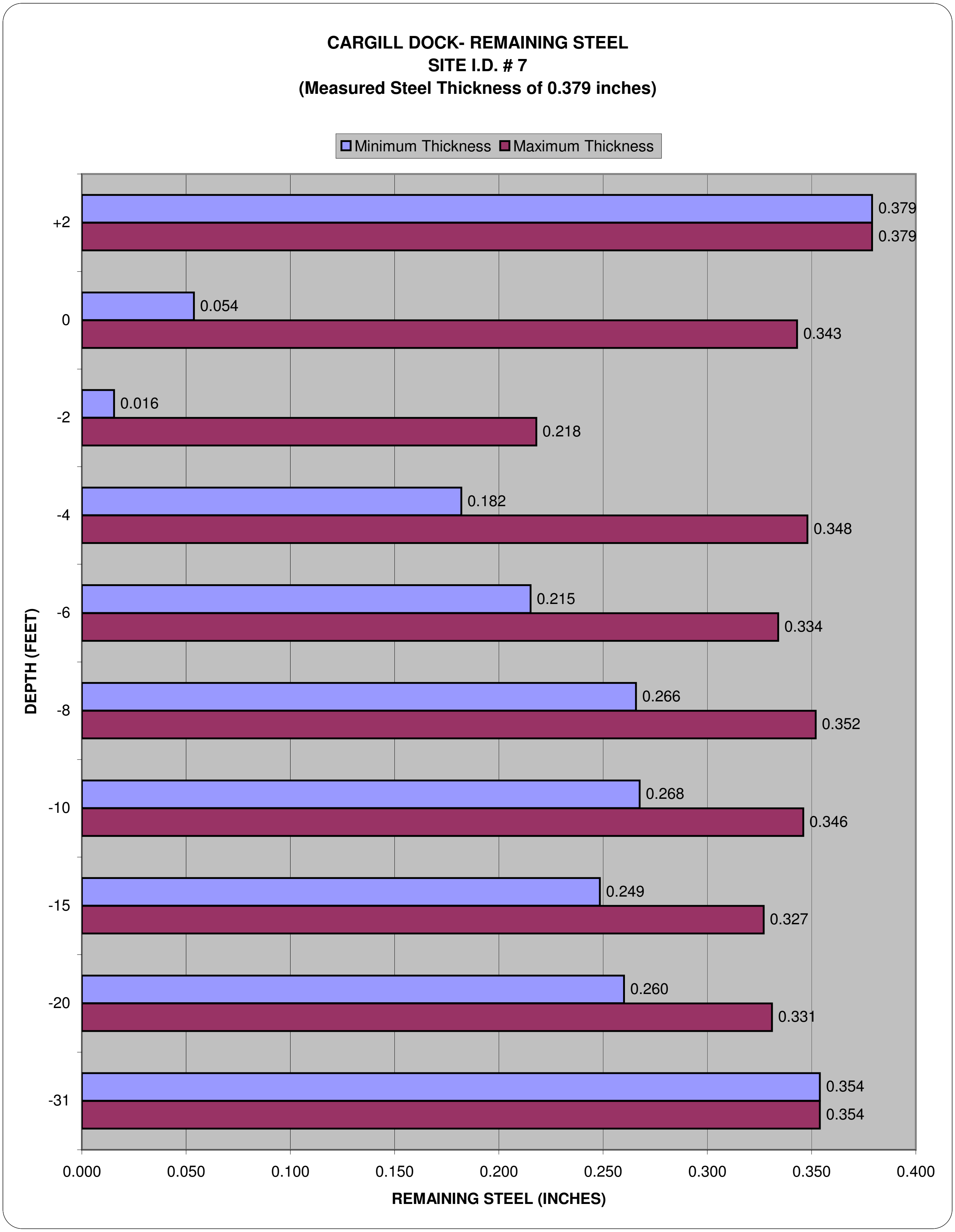

DECC DOCK- REMAINING STEEL
SITE I.D. # 6
(Measured Steel Thickness of 0.497 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
0.497
0.497
0.227
0.430
0.212
0.415
0.233
0.420
0.353
0.416
0.305
0.368
0.309
0.387
0.325
0.403
0.470
0.470
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

FACILITY	Cargill Berth 1	SITE I.D. NUMBER	7
DOCK CONFIGURATION	East - West	INSPECTION DATE	8/2/2006
EXPOSURE DIRECTION	North	INSPECTION TIME	13:15
		WATER ELEVATION	601.7
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MP116	0.375"	unk

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.379					0.000					0.000	
2	0	x	Algae, Orange Nod	<.25	75%					x	Pitting	High	0.343	0.250	0.375	0.188	0.344	0.289	0.625	0.250	0.500	0.375	0.438	Pits have perforated steel @-1'
3	-2	x	Mussels, Algae, Sponge	<.25	75%					x	Pitting	High	0.218	0.250	0.125	0.310	0.125	0.203	0.500	0.500	0.125	0.250	0.344	Less Pitting on in pan, pits have penetrated steel
4	-4	x	Mussels, Sponges	1.5 to 2	100%					x	Pitting	High	0.348	0.100	0.220	0.250	0.094	0.166	0.125	0.250	0.250	0.125	0.188	pits on in & out pans similar
5	-6	x	Sponges, Mussels, algae	1.5 to 2	100%					x	Pitting	Mod	0.334	0.125	0.125	0.125	0.100	0.119	0.250	0.125	0.250	0.125	0.188	pits on in & out pans similar
6	-8	x	Z Mussels, Sponges	1.5 to 2	100%					x	Pitting	Mod	0.352	0.063	0.094	0.094	0.094	0.086	0.250	0.125	0.125	0.125	0.156	pits on in & out pans similar
7	-10	x	Mussels, Sponges	1.5 to 2	100%					x	Pitting	Mod	0.346	0.063	0.094	0.063	0.094	0.079	0.125	0.125	0.375	0.250	0.219	pits on in & out pans similar
8	-15	x	Mussels, Sponges	1.5 to 2	100%					x	Pitting	Mod	0.327	0.094	0.094	0.063	0.063	0.079	0.125	0.250	0.125	0.250	0.188	pits on in & out pans similar
9	-20	x	Mussels, Orange Nod.	1.5 to 2	100%					x	Pitting	Mod	0.331	0.063	0.094	0.033	0.094	0.071	0.25	0.188	0.25	0.25	0.235	very small pits, in pan more pitted
10	-31	x	Mussels	1.5 to 2	100%					x	Uniform	Low	0.354					0.000					0.000	1ft of silt, Etched Surface


CARGILL DOCK- REMAINING STEEL
SITE I.D. # 7
(Measured Steel Thickness of 0.379 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-31
0.379
0.379
0.054
0.343
0.016
0.218
0.182
0.348
0.215
0.334
0.266
0.352
0.268
0.346
0.249
0.327
0.260
0.331
0.354
0.354
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
REMAINING STEEL (INCHES)

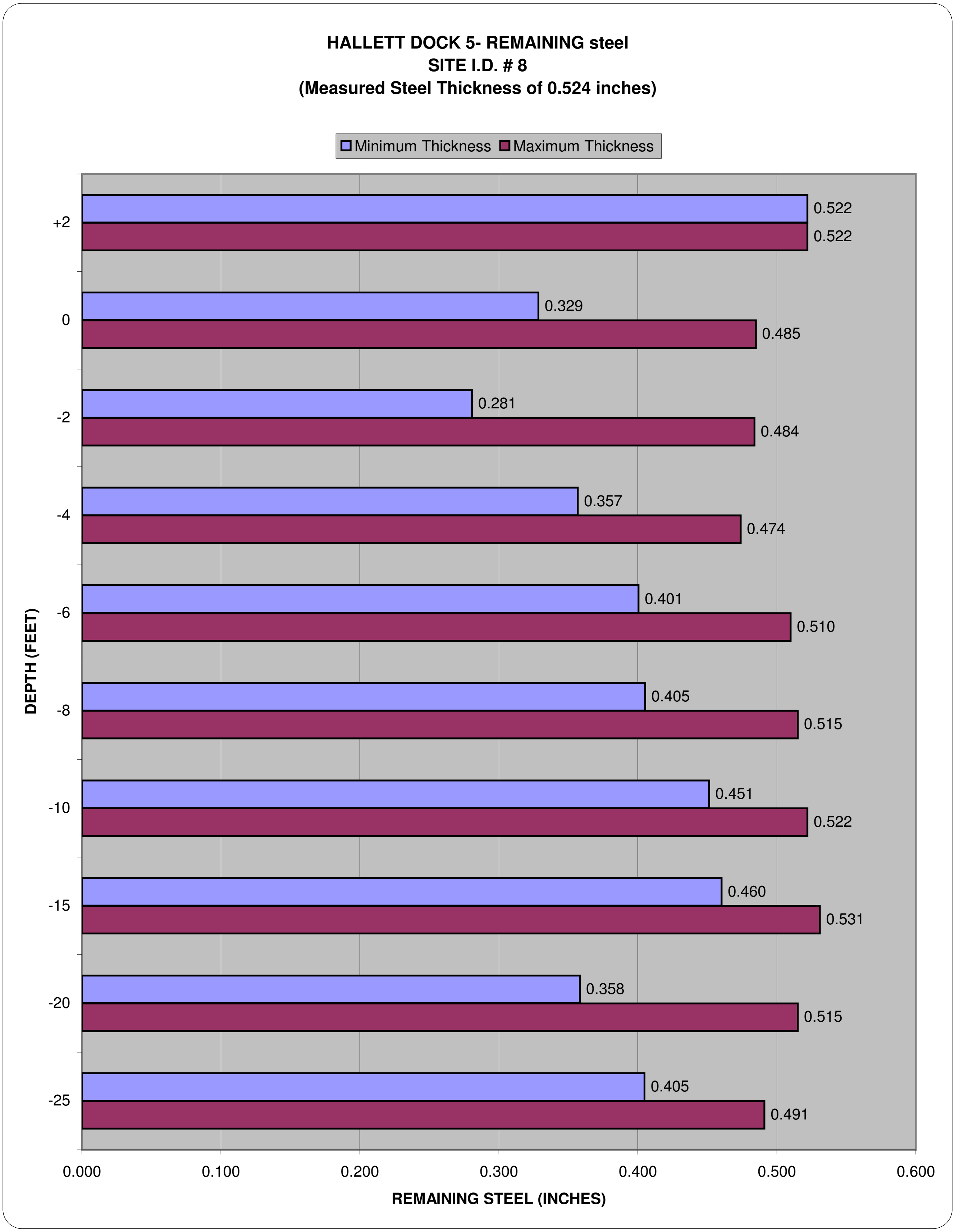
HARBOR STRUCTURES DATA

FACILITY	Hallett Dock 5	SITE I.D. NUMBER	8
DOCK CONFIGURATION	Northwest - Southeast	INSPECTION DATE	8/3/2006
EXPOSURE DIRECTION	Northeast	INSPECTION TIME	10:35
		WATER ELEVATION	601.56
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ 38	0.5"	1988?

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.522					0.000					0.000	
2	0	x	Algae Or. Nods.	.25 to .5	75%							Mod	0.485	0.125	0.125	0.188	0.188	0.157	0.250	0.375	0.375	0.625	0.406	In & Out Pan Similar
3	-2	x	Mussels Or. Nods.	.25 to .5	75%							High	0.484	0.188	0.125	0.188	0.313	0.203	0.625	0.500	0.750	0.500	0.594	Less severe pits on in pan
4	-4	x	Mussels	.25 to 1.0	100%							High	0.474	0.125	0.125	0.094	0.125	0.117	0.500	0.250	0.500	0.375	0.406	Less severe pits on in pan
5	-6	x	Mussels	1.5-2	100%							Mod	0.510	0.094	0.125	0.125	0.094	0.110	0.250	0.250	0.250	0.188	0.235	Less severe pits on in pan
6	-8	x	Mussels	1.5-2	100%							Low	0.515	0.125	0.063	0.188	0.063	0.110	0.250	0.375	0.250	0.375	0.313	Larger mussels, in & out pans similar pits
7	-10	x	Mussels	1.5-2	100%							Low	0.522	0.063	0.063	0.063	0.094	0.071	0.250	0.375	0.375	0.375	0.344	in & out pans similar pits, etched looking surface
8	-15	x	Mussels	1.5-2	100%							Low	0.531	0.063	0.063	0.063	0.094	0.071	0.125	0.125	0.125	0.250	0.156	more mussels on outpan, similar pitting, etched looking surface
9	-20	x	Mussels	1.5-2	100%							Low	0.515	0.188	0.063	0.188	0.188	0.157	0.250	0.125	0.250	0.125	0.188	more mussels on outpan, similar pitting, etched looking surface
10	-25		Mussels	1.5-2	100%							Low	0.491	0.094	0.063	0.125	0.063	0.086	0.250	0.125	0.250	0.125	0.188	silty layer(6") on top of clay, similar pits, etched looking surface


HALLETT DOCK 5- REMAINING steel
SITE I.D. # 8
(Measured Steel Thickness of 0.524 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-25
0.522
0.522
0.329
0.485
0.281
0.484
0.357
0.474
0.401
0.510
0.405
0.515
0.451
0.522
0.460
0.531
0.358
0.515
0.405
0.491
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

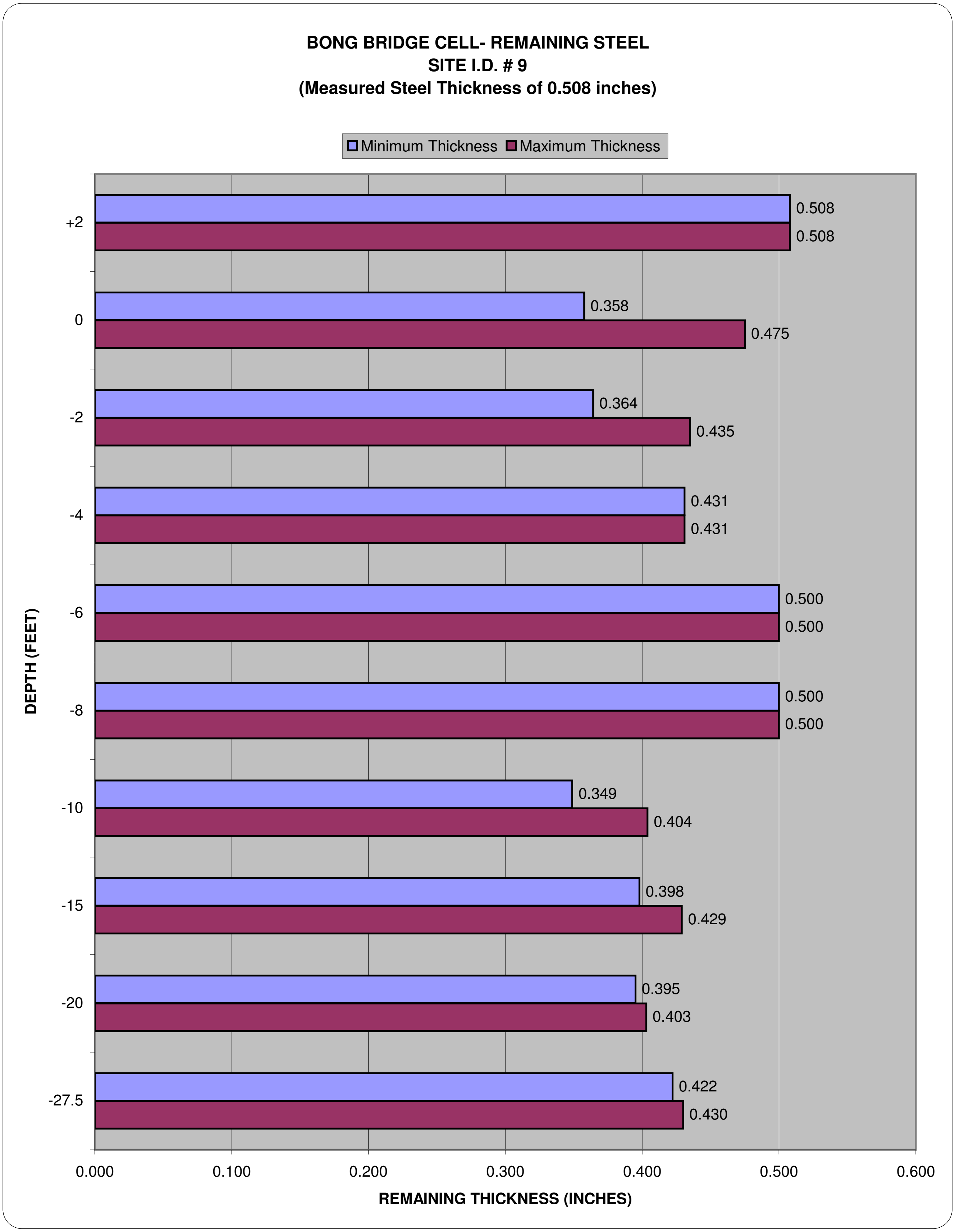
HARBOR STRUCTURES DATA

FACILITY	Bong Bridge Cell	SITE I.D. NUMBER	9
DOCK CONFIGURATION	Circular Cell	INSPECTION DATE	8/1/2006
EXPOSURE DIRECTION	South	INSPECTION TIME	8:15
		WATER ELEVATION	601.81
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	PSA 28	0.5"	1980's

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2					x	Coal - Tar	unk	100%				0.508					0.000					0.000	
2	0	x	slime	<.25						x	Pitting	Mod	0.475	0.125	0.063	0.156	0.125	0.117	0.500	0.500	0.500	0.750	0.563	start pitting @ 0ft, coating gone below igld
3	-2	x	mussels	.5 to .75	sporadic					x	Pitting	High	0.435	0.063	0.094	0.063	0.063	0.071	0.250	0.375	0.125	0.250	0.250	high concentration of small pits
4	-4	x	mussels	.5 to .75	sporadic	x	Coal - Tar	unk	50%				0.431					0.000					0.000	did not remove coating
5	-6	x	mussels, sponges	.75 to 1.5	100%	x	Coal - Tar	unk	100%				0.500					0.000					0.000	did not remove coating
6	-8	x	mussels	1.5 to 2	100%	x	Coal - Tar	unk	100%				0.500					0.000					0.000	coating ends
7	-10	x	mussels, sponges	1.5 to 2	100%					x	Pitting	High	0.404	0.031	0.063	0.063	0.063	0.055	0.125	0.125	0.125	0.063	0.110	steel in good condition, etched surface
8	-15	x	mussels	1.5 to 2	100%					x		High	0.429	0.031	0.031	0.031	0.031	0.031	0.500	0.375	0.750	0.750	0.594	ring pattern pits , etched surface
9	-20	x	mussels	1.5 to 2	100%					x		Mod	0.403	0.031				0.008	0.500	0.375	0.500	0.500	0.469	ring pattern pits, etched surface
10	-27.5	x	mussels	1.5 to 2	100%					x		Mod	0.430	0.031				0.008	0.250	0.125	0.250	0.125	0.188	27.5 feet deep, minor pitting, etched surface

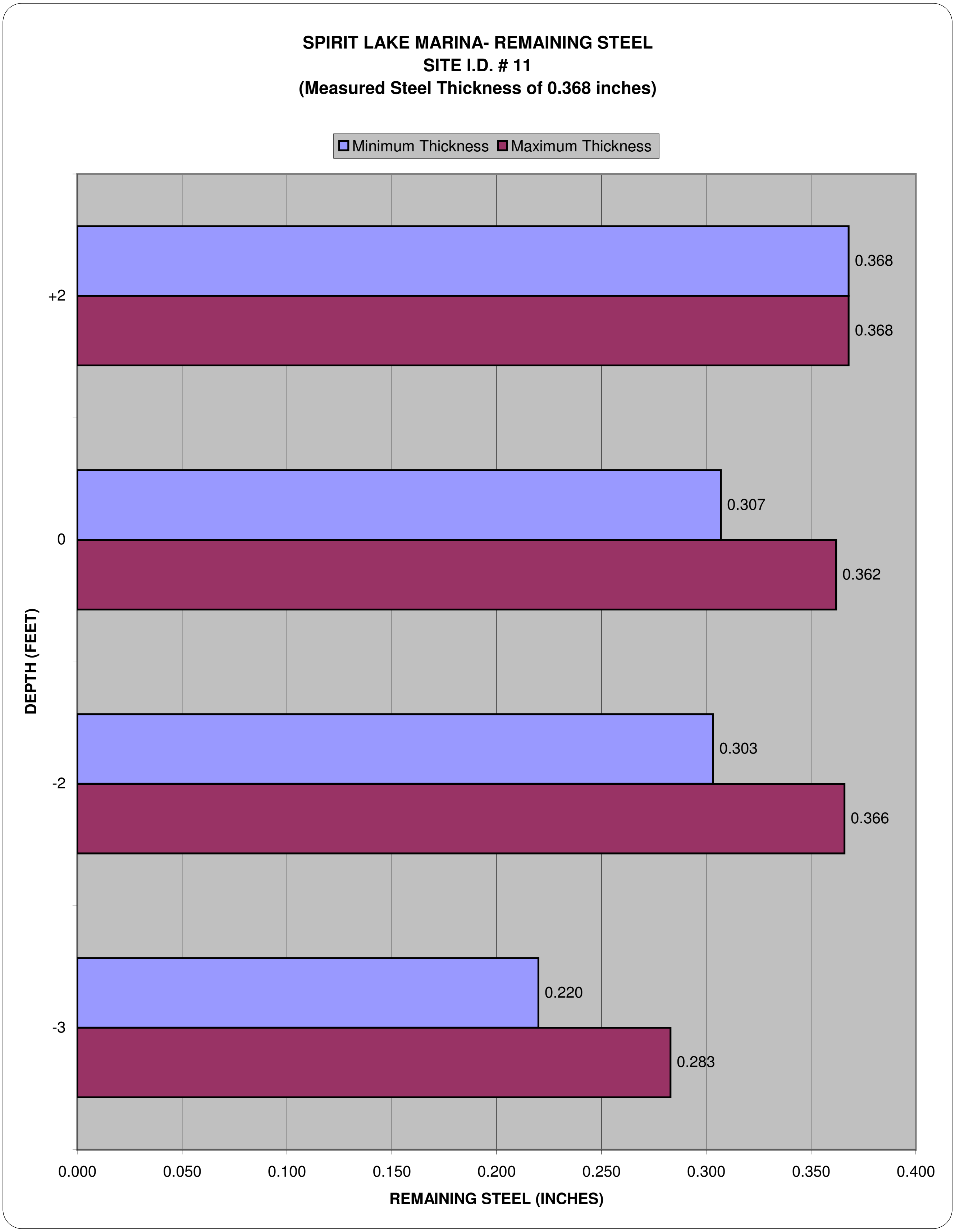

BONG BRIDGE CELL- REMAINING STEEL
SITE I.D. # 9
(Measured Steel Thickness of 0.508 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-27.5
0.508
0.508
0.358
0.475
0.364
0.435
0.431
0.431
0.500
0.500
0.500
0.500
0.349
0.404
0.398
0.429
0.395
0.403
0.422
0.430
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING THICKNESS (INCHES)

FACILITY	Spirit Lake Marina
DOCK CONFIGURATION	Pipe Pile/ Wood Pile/Wood Deck
EXPOSURE DIRECTION	South East
SITE I.D. NUMBER	11
INSPECTION DATE	7/31/2006
INSPECTION TIME	15:00
WATER ELEVATION	601.24
TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	12" schedule 40	0.375	Late 1980's

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.368					0.000					0.000	
2	0	x	Slime	<.25	15%					x	Pit	Low	0.362	0.031	0.063	0.063	0.063	0.055	0.125	0.375	0.250	0.250	0.250	
3	-2	x	Orange Nod. Mussels	.25 to .5	15%					x	Pit	High	0.366	0.031	0.094	0.063	0.063	0.063	0.250	0.250	0.250	0.250	0.250	
4	-3	x	Few Mussels	0.5	<25%					x	Pit	High	0.283	0.063	0.063	0.063	0.063	0.063	0.188	0.125	0.125	0.250	0.172	Steel jacket extends 3ft below WL
5	-6																	0.000					0.000	
6	-8																	0.000					0.000	
7	-10																	0.000					0.000	
8	-15																	0.000					0.000	
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	


SPIRIT LAKE MARINA- REMAINING STEEL
SITE I.D. # 11
(Measured Steel Thickness of 0.368 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-3
0.368
0.368
0.307
0.362
0.303
0.366
0.220
0.283
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
REMAINING STEEL (INCHES)

HARBOR STRUCTURES DATA

FACILITY: Oliver Bridge

DOCK CONFIGURATION: steel sheet pile cell around pier

EXPOSURE DIRECTION: South

SITE I.D. NUMBER: 12

INSPECTION DATE: 7/31/2006

INSPECTION TIME: 10:00

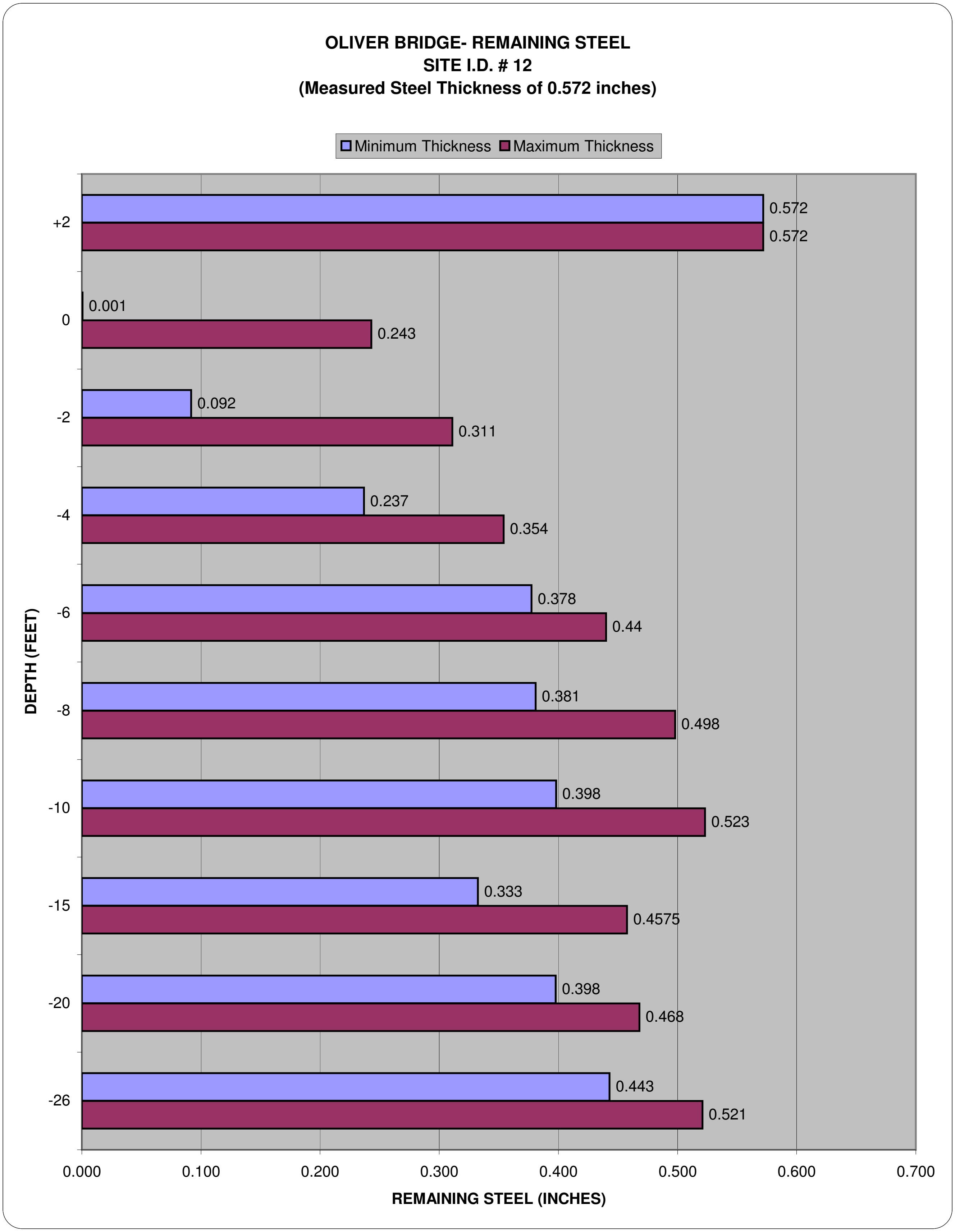
WATER ELEVATION: 602.05

TEAM LEADER: Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	SP Flat	0.625	

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth: Present	Marine Growth: Type	Marine Growth: Thickness	Marine Growth: Coverage	Protective Coating: Present	Protective Coating: Type	Protective Coating: Thickness	Protective Coating: Coverage	Corrosion: Present	Corrosion: Type	Corrosion: Concetration (High Mod. Low)	Steel Max. Remaining Thickness	Pit Penetration Readings: 1	2	3	4	AVG	Pit Diameter Readings: 1	2	3	4	AVG	Comments
1	+2									x			0.572					0.000					0.000	
2	0	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.243	0.240	0.313	0.188	0.230	0.243	1.000	0.625	0.625	0.750	0.750	1 to 1.5' below IGLD - holes in sheets
3	-2	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.311	0.156	0.173	0.290	0.258	0.219	0.500	0.250	0.625	0.500	0.469	Holes in sheets
4	-4	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.354	0.125	0.094	0.125	0.125	0.117	0.250	0.250	0.188	0.188	0.219	
5	-6	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.44	0.063	0.063	0.063	0.063	0.063	0.250	0.188	0.250	0.250	0.235	
6	-8	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.498	0.125	0.094	0.125	0.125	0.117	0.250	0.188	0.250	0.188	0.219	
7	-10	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.523	0.125	0.125	0.125	0.125	0.125	0.250	0.250	0.250	0.250	0.250	Orange nodules increase in size as depth increases
8	-15	x	Orange nodules	.25 to .50	75%					x	Pit	High	0.4575	0.188	0.125	0.063	0.125	0.125	0.375	0.250	0.250	0.250	0.281	
9	-20	x	Orange nodules	.25 to .50	75%					x	Pit	Mod	0.468	0.063	0.094	0.063	0.063	0.070	0.250	0.188	0.125	0.188	0.188	
10	-26	x	Orange nodules	.25 to .50	75%					x	Pit	Mod	0.521	0.125	0.063	0.063	0.063	0.078	0.063	0.500	0.094	0.250	0.227	


OLIVER BRIDGE- REMAINING STEEL
SITE I.D. # 12
(Measured Steel Thickness of 0.572 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-26
0.572
0.572
0.001
0.243
0.092
0.311
0.237
0.354
0.378
0.44
0.381
0.498
0.398
0.523
0.333
0.4575
0.398
0.468
0.443
0.521
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
REMAINING STEEL (INCHES)

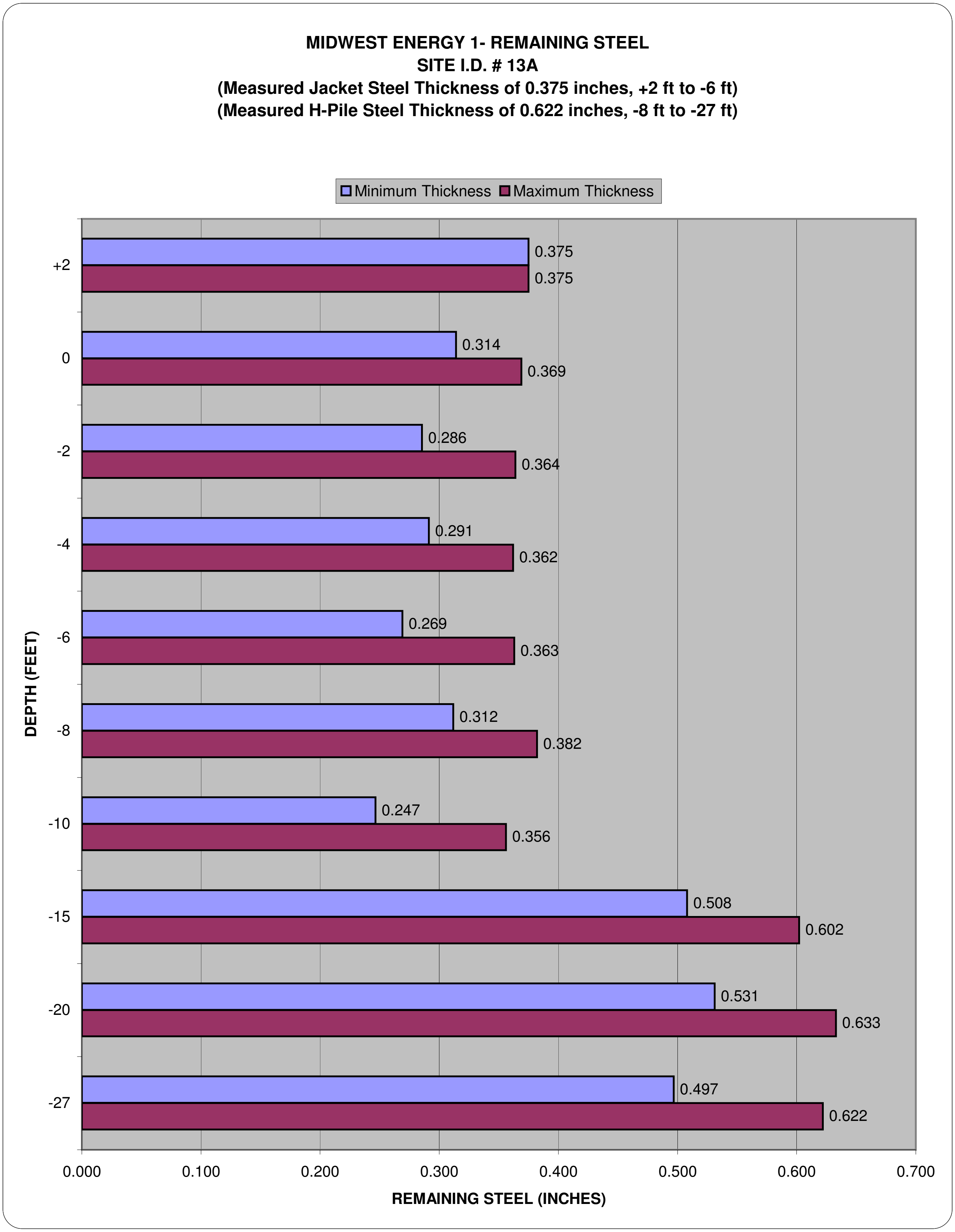
HARBOR STRUCTURES DATA

FACILITY	MERC	SITE I.D. NUMBER	13A
DOCK CONFIGURATION	East - West	INSPECTION DATE	8/3/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	12:30
		WATER ELEVATION	601.6
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	20" Sch 20 HP12x74 H-pile	0.375 / .625 FL	1975

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.375					0.000					0.000	
2	0	x	Or. Nod Algae	.25 to .5	50%					x	Pit	Low	0.369	0.063	0.031	0.063	0.063	0.055	0.250	0.375	0.375	0.250	0.313	
3	-2	x	Or. Nod Algae	.25 to .5	50%					x	Pit	Low	0.364	0.063	0.094	0.094	0.063	0.079	0.625	0.625	0.750	0.750	0.688	
4	-4	x	Or. Nod Algae	.25 to .5	50%					x	Pit	Low	0.362	0.094	0.063	0.063	0.063	0.071	0.625	0.625	0.625	0.375	0.563	
5	-6	x	Or. Nod	.25 to .5	75%					x	Pit	Low	0.363	0.125	0.094	0.094	0.063	0.094	0.375	0.375	0.500	0.500	0.438	Fewer nodules at this elevation
6	-8	x	Nods, Sponges, Mussels	.5 to 1.5	100%					x	Pit	Low	0.382	0.094	0.063	0.063	0.063	0.070	0.625	0.375	0.500	0.625	0.531	measurements on H-pile
7	-10	x	Mussels	.5 to 1.5	100%					x	Pit	High	0.356	0.125	0.094	0.125	0.094	0.110	0.625	0.750	0.500	0.500	0.594	
8	-15	x	Nods, Sponges, Mussels	.5 to 1.5	100%					x	Pit	High	0.602	0.094	0.125	0.094	0.063	0.094	0.750	0.350	0.500	0.500	0.525	very few mussels on front face- overlapping pits
9	-20	x	Nods, Sponges, Mussels	.5 to 1.5	100%					x	Pit	High	0.633	0.094	0.125	0.125	0.063	0.102	0.5	0.375	0.625	0.375	0.469	
10	-27	x	Or, Nod, Mussels	.5 to 1.5	100%					x	Pit	Mod	0.622	0.125	0.188	0.125	0.063	0.125	0.5	0.5	0.75	0.5	0.563	rip rap @ mud line



MIDWEST ENERGY 1- REMAINING STEEL
SITE I.D. # 13A
(Measured Jacket Steel Thickness of 0.375 inches, +2 ft to -6 ft)
(Measured H-Pile Steel Thickness of 0.622 inches, -8 ft to -27 ft)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-27
0.375
0.375
0.314
0.369
0.286
0.364
0.291
0.362
0.269
0.363
0.312
0.382
0.247
0.356
0.508
0.602
0.531
0.633
0.497
0.622
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
REMAINING STEEL (INCHES)

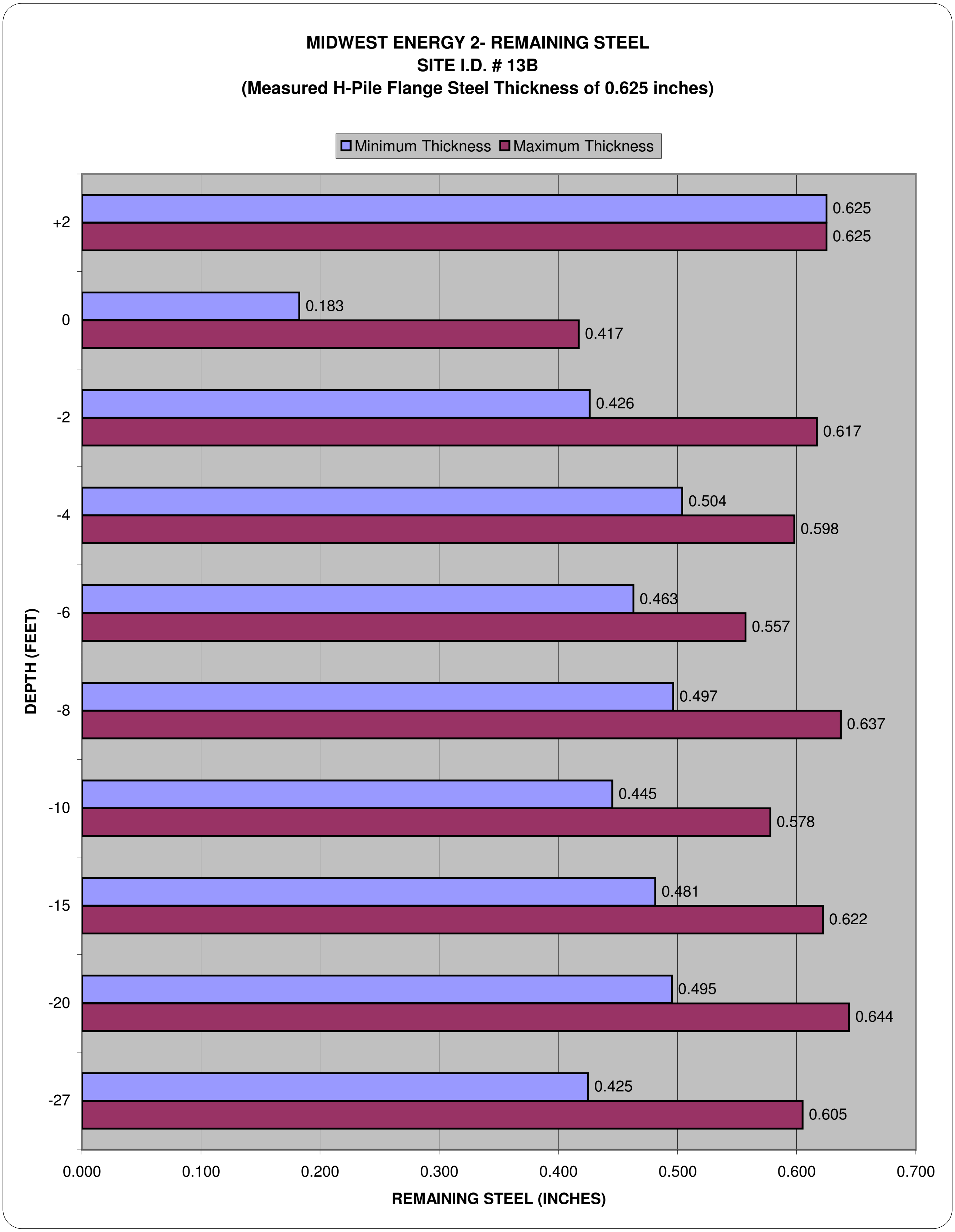
HARBOR STRUCTURES DATA

FACILITY	MERC	SITE I.D. NUMBER	13B
DOCK CONFIGURATION	East - West	INSPECTION DATE	8/3/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	13:06
		WATER ELEVATION	601.6
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	HP12x74	0.625 FL	1975

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth: Present	Marine Growth: Type	Marine Growth: Thickness	Marine Growth: Coverage	Protective Coating: Present	Protective Coating: Type	Protective Coating: Thickness	Protective Coating: Coverage	Corrosion: Present	Corrosion: Type	Corrosion: Concentration (High Mod. Low)	Steel Max. Remaining Thickness	Pit Penetration Readings 1	2	3	4	AVG	Pit Diameter Readings 1	2	3	4	AVG	Comments
1	+2												0.625					0.000					0.000	
2	0	x	nodules	.25 to .5	75%					x	Pit	High	0.417	0.188	0.250	0.250	0.250	0.235	0.750	0.625	0.750	0.625	0.688	Heavy pitting on all faces
3	-2	x	nodules	.25 to .5	75%					x	Pit	High	0.617	0.188	0.200	0.250	0.125	0.191	0.625	0.375	1.000	0.500	0.625	Edges of Flanges very pitted
4	-4	x	nodules	.25 to .5	75%					x	Pit	High	0.598	0.125	0.063	0.125	0.063	0.094	0.375	0.250	0.500	0.500	0.406	Edges of Flanges very pitted, web more pitted than below
5	-6	x	nodules	.25 to .5	75%					x	Pit	High	0.557	0.094	0.094	0.094	0.094	0.094	0.500	0.500	0.250	0.750	0.500	Web & Inner Flange more pitted than outer flange
6	-8	x	mussels, nodules	.5 to 1.5	100%					x	Pit	High	0.637	0.156	0.156	0.125	0.125	0.141	1.000	0.625	0.625	0.500	0.688	Piles spliced, lower pile more pitted
7	-10	x	mussels, nodules	.5 to 1.5	100%					x	Pit	High	0.578	0.125	0.125	0.156	0.125	0.133	0.750	1.000	0.500	1.000	0.813	smaller pits on web & inner flange
8	-15	x	mussels, nodules	.5 to 1.5	100%					x	Pit	Mod	0.622	0.156	0.094	0.188	0.125	0.141	1.000	0.625	0.188	0.250	0.516	smaller pits on web & inner flange
9	-20	x	mussels, nodules	.5 to 1.5	100%					x	Pit	Mod	0.644	0.188	0.094	0.125	0.188	0.149	0.625	0.750	0.250	0.500	0.531	
10	-27	x	mussels, nodules	.5 to 1.5	100%					x	Pit	Low	0.605	0.188	0.156	0.188	0.188	0.180	0.750	0.750	0.500	0.375	0.594	sporadic pits on web

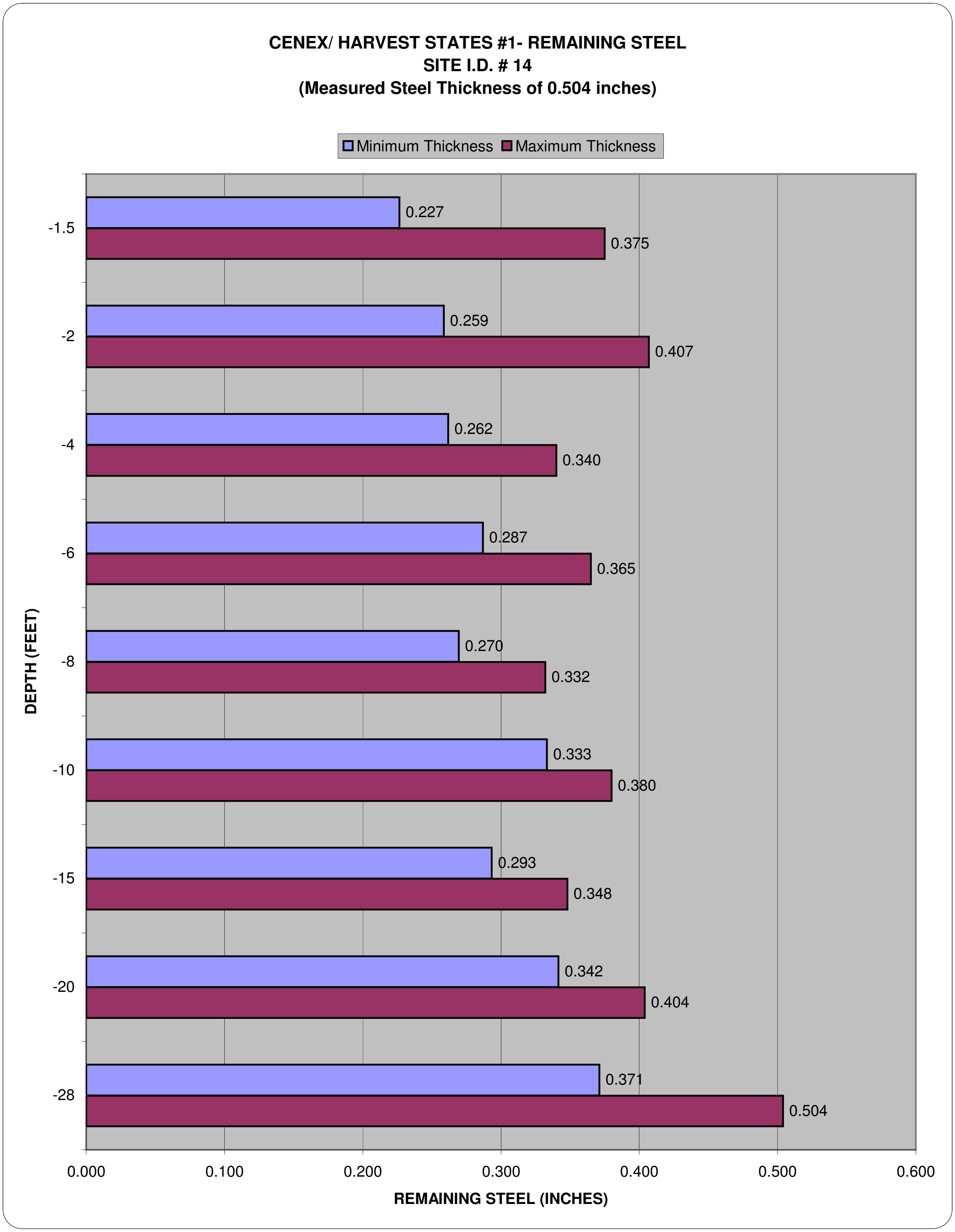

MIDWEST ENERGY 2- REMAINING STEEL
SITE I.D. # 13B
(Measured H-Pile Flange Steel Thickness of 0.625 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-27
0.625
0.625
0.183
0.417
0.426
0.617
0.504
0.598
0.463
0.557
0.497
0.637
0.445
0.578
0.481
0.622
0.495
0.644
0.425
0.605
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
REMAINING STEEL (INCHES)

FACILITY	Cenex Harvest States Loc #1	SITE I.D. NUMBER	14
DOCK CONFIGURATION	North- South	INSPECTION DATE	8/8/2006
EXPOSURE DIRECTION	East	INSPECTION TIME	12:00
		WATER ELEVATION	601.6
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MP 116	0.375"	1963

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2																	0.000					0.000	Concrete Cap Igld To -1.5ft
2	-1.5	x	ON , AL	.25 to .5	75-100					X	Pitting	High	0.375	0.125	0.125	0.156	0.188	0.148	0.625	0.750	0.625	0.750	0.688	Concrete Cap Igld To -1.5ft
3	-2	x	ON , AL	.25 to .5	75-100					X	Pitting	High	0.407	0.125	0.125	0.156	0.188	0.148	0.625	0.750	0.625	0.750	0.688	IP-OP SAME PIT
4	-4	x	ON, ZM, AL	.25 to .5	75-100					X	Pitting	High	0.340	0.125	0.063	0.063	0.063	0.078	0.500	0.500	0.500	0.375	0.469	IP SMALLER, OP LARGER PIT
5	-6	x	ON, ZM, AL	.25 to 1.5	75-100					X	Pitting	High	0.365	0.125	0.063	0.063	0.063	0.078	0.500	0.250	0.250	0.250	0.313	IP SMALLER, OP LARGER PIT
6	-8	x	ON, ZM, AL	.25 to 1.5	75-100					X	Pitting	High	0.332	0.063	0.063	0.063	0.063	0.063	0.250	0.250	0.188	0.250	0.234	IP SAME AS OP
7	-10	x	ON, ZM, AL	.25 to 1.5	50-50					X	Pitting	High	0.380	0.031	0.063	0.063	0.031	0.047	0.188	0.125	0.250	0.188	0.188	OP HIGHER PIT
8	-15	x	ON, ZM, AL	.25 to 1.5	50-50					X	Pitting	High	0.348	0.031	0.063	0.063	0.063	0.055	0.125	0.125	0.188	0.125	0.141	IP SAME AS OP
9	-20	x	ON, ZM, AL	.25 to 1.5	50-50					X	Pitting	Mod	0.404	0.063	0.063	0.063	0.063	0.063	0.250	0.250	0.125	0.125	0.188	IP SAME AS OP
10	-28	x	ON	.25 to .5	100-75					X	Pitting	Low	0.504	0.063	0.156	0.156	0.156	0.133	0.250	0.375	0.125	0.125	0.219	1' LIGHT SILT- IP SAME At ML AS OP



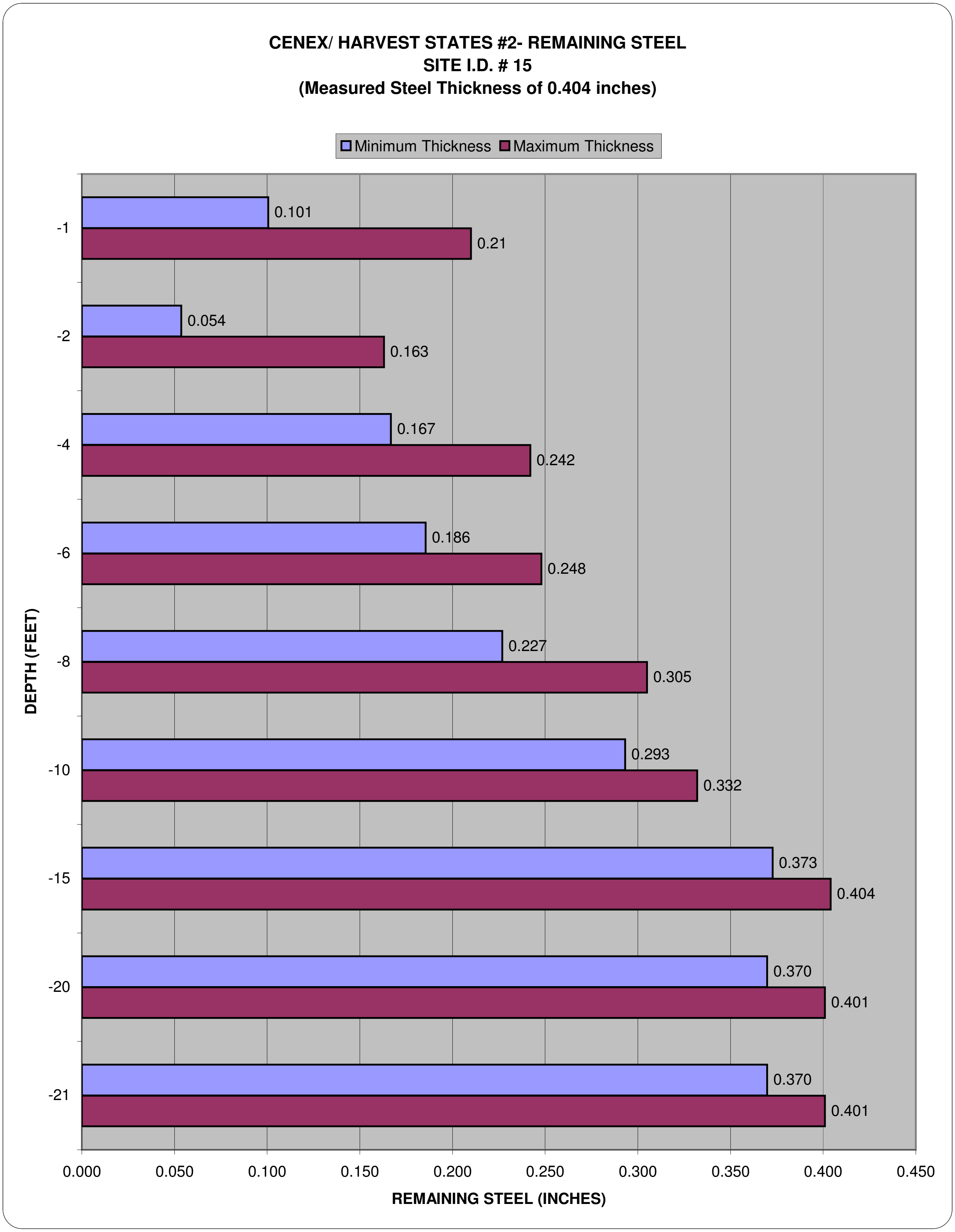
CENEX/ HARVEST STATES #1- REMAINING STEEL
SITE I.D. # 14
(Measured Steel Thickness of 0.504 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
-1.5
-2
-4
-6
-8
-10
-15
-20
-28
0.227
0.375
0.259
0.407
0.262
0.340
0.287
0.365
0.270
0.332
0.333
0.380
0.293
0.348
0.342
0.404
0.371
0.504
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

FACILITY	Cenex Harvest States Loc #2	SITE I.D. NUMBER	15
DOCK CONFIGURATION	Southwest- Northeast	INSPECTION DATE	8/8/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	14:30
		WATER ELEVATION	601.85
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MP 116	0.375"	1957

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2																	0.000					0.000	Concrete Cap
2	-1	X	ZM	1	100%					x	Pitting	High	0.21	0.125	0.125	0.125	0.063	0.109	0.375	0.250	0.250	0.375	0.313	Sheets Start 1ft Below IGLD
3	-2	X	ZM	1	100%					x	Pitting	High	0.163	0.125	0.125	0.125	0.063	0.109	0.375	0.250	0.250	0.375	0.313	IP of Same
4	-4	X	ZM, SP	1.5	100%					x	Pitting	High	0.242	0.063	0.082	0.094	0.063	0.075	0.250	0.500	0.500	0.375	0.406	IP OP Same
5	-6	X	ZM	1.5	100%					x	Pitting	High	0.248	0.063	0.063	0.063	0.063	0.063	0.250	0.250	0.250	0.250	0.250	IP OP Same
6	-8	X	ZM, SP	1.5	100%					x	Pitting	High	0.305	0.063	0.094	0.063	0.094	0.078	0.250	0.375	0.375	0.500	0.375	OP Heavy Pit thru IP
7	-10	X	ZM, SP	1.5	100%					x	Pitting	High	0.332	0.031	0.031	0.063	0.031	0.039	0.250	0.375	0.250	0.375	0.313	IP same as OP
8	-15	X	ZM	1.5	100%					x	Pitting	High	0.444	0.031	0.031	0.031	0.031	0.031	0.188	0.063	0.188	0.375	0.203	IP same as OP
9	-20	X	ZM	1.5	50%					x	Pitting	Low	0.401	0.031	0.031	0.031	0.031	0.031	0.188	0.063	0.188	0.063	0.125	IP same as OP
10	-21	X	ZM	1.5	50%					x	Pitting	Low	0.401	0.031	0.031	0.031	0.031	0.031	0.188	0.063	0.188	0.063	0.125	IP same as OP

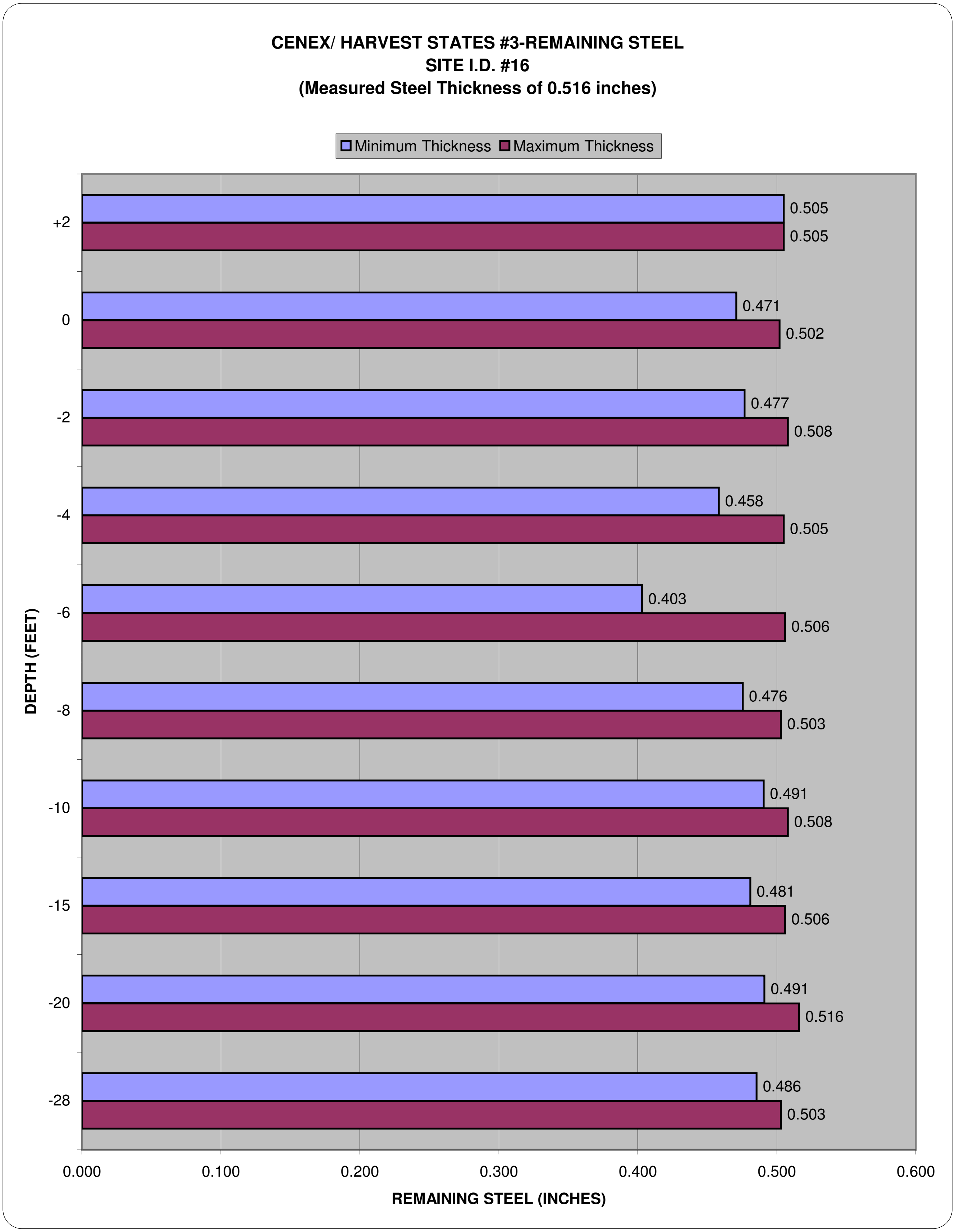

CENEX/ HARVEST STATES #2- REMAINING STEEL
SITE I.D. # 15
(Measured Steel Thickness of 0.404 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
-1
-2
-4
-6
-8
-10
-15
-20
-21
0.101
0.21
0.054
0.163
0.167
0.242
0.186
0.248
0.227
0.305
0.293
0.332
0.373
0.404
0.370
0.401
0.370
0.401
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
REMAINING STEEL (INCHES)

FACILITY	CHS #3
DOCK CONFIGURATION	Southwest- Northeast
EXPOSURE DIRECTION	Northwest
SITE I.D. NUMBER	16
INSPECTION DATE	8/8/2006
INSPECTION TIME	1600
WATER ELEVATION	601.85
TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	Hoesh 2500	0.5	2002

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.505					0.000					0.000	
2	0	x	ON	.25 to .50	75%					x	pitting	Low	0.502	0.031	0.031	0.031	0.031	0.031	0.250	0.250	0.250	0.250	0.250	
3	-2	x	AL, ZM, ON	.25 to 1	75%					x	pitting	high	0.508	0.031	0.031	0.031	0.031	0.031	0.250	0.250	0.250	0.250	0.250	
4	-4	x	ZM	1	90%					x	pitting	high	0.505	0.063	0.031	0.063	0.031	0.047	0.250	0.250	0.125	0.250	0.219	In pan out pan- similar pitting
5	-6	x	ZM, SP	1	100%					x	pitting	high	0.506	0.312	0.040	0.030	0.030	0.103	0.250	0.250	0.125	0.250	0.219	In pan out pan- similar pitting
6	-8	x	ZM, SP	1	100%					x	pitting	High	0.503	0.020	0.020	0.030	0.040	0.028	0.375	0.250	0.125	0.250	0.250	In pan out pan- similar pitting
7	-10	x	ZM, SP	1	100%					x	pitting	Low	0.508	0.010	0.030	0.020	0.010	0.018	0.128	0.125	0.125	0.125	0.126	In pan out pan- similar pitting
8	-15	x	ZM	1	100%					x	pitting	low	0.506	0.010	0.030	0.030	0.030	0.025	0.250	0.250	0.125	0.125	0.188	In pan out pan- similar pitting
9	-20	x	ZM, ON	1	100%					x	pitting	low	0.516	0.030	0.030	0.020	0.020	0.025	0.125	0.125	0.188	0.250	0.172	In pan out pan- similar pitting
10	-28	x	ON	.25 to .50	75%					x	pitting	low	0.503	0.010	0.030	0.020	0.010	0.018	0.188	0.250	0.188	0.250	0.219	In pan out pan- similar pitting


CENEX/ HARVEST STATES #3-REMAINING STEEL
SITE I.D. #16
(Measured Steel Thickness of 0.516 inches)
Minimum Thickness
Maximum Thickness
+2
0
-2
-4
-6
-8
-10
-15
-20
-28
0.505
0.505
0.471
0.502
0.477
0.508
0.458
0.505
0.403
0.506
0.476
0.503
0.491
0.508
0.481
0.506
0.491
0.516
0.486
0.503
0.000
0.100
0.200
0.300
0.400
0.500
0.600
DEPTH (FEET)
REMAINING STEEL (INCHES)

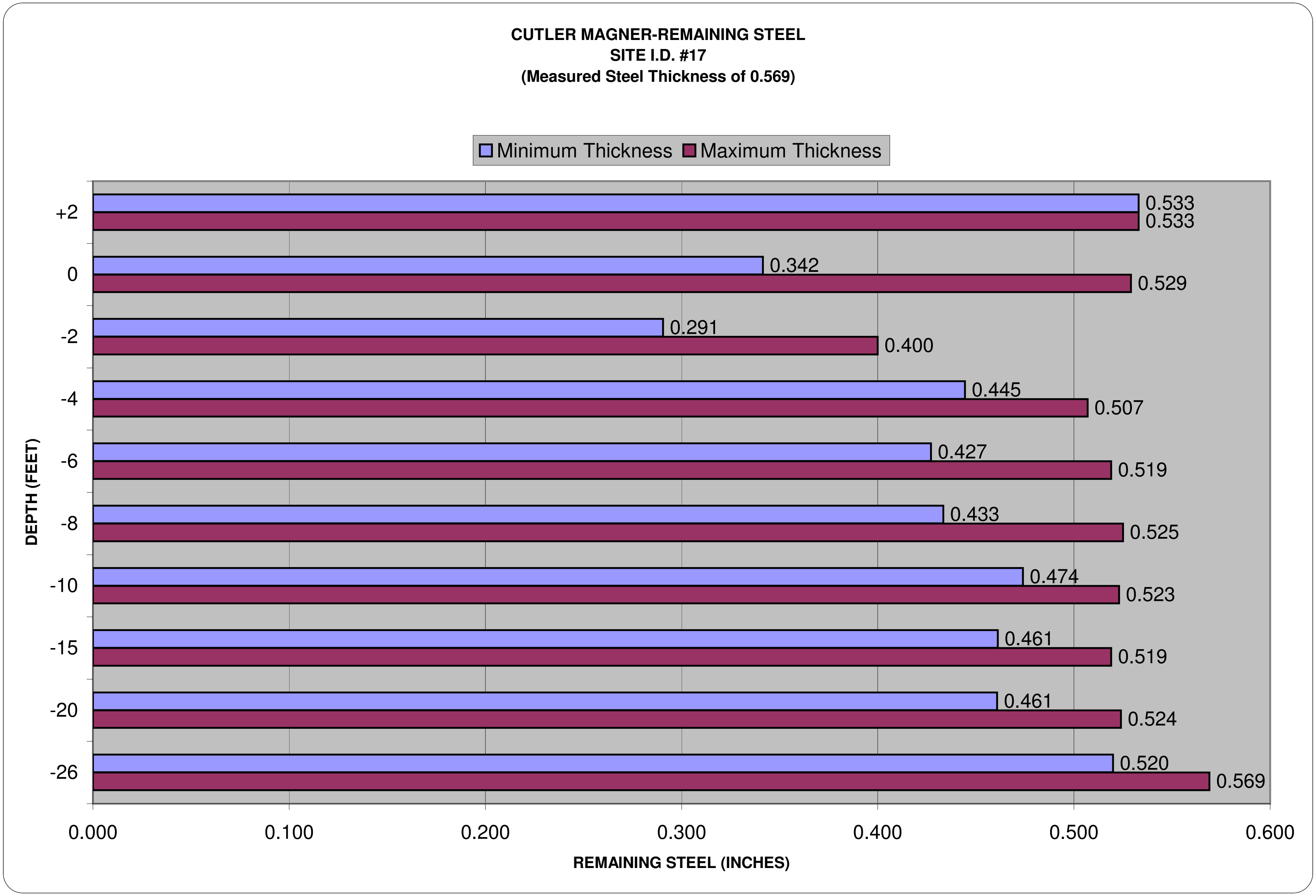
HARBOR STRUCTURES DATA

FACILITY	Cutler Magner	SITE I.D. NUMBER	17
DOCK CONFIGURATION	Southwest-Northeast	INSPECTION DATE	8/9/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	1045
		WATER ELEVATION	601.32
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	MZ-32	F1/2", W3/8"	1980's

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.533											
2	0	x	algae, or. nods	.25-.5	50%					x	scale	high	0.529	0.188	0.188	0.188	0.188	0.188	0.375	0.375	0.500	0.500	0.438	
3	-2	x	algae, or. nods	.25-.5	75%					x	pitting	high	0.400	0.125	0.125	0.063	0.125	0.109	0.375	0.375	0.250	0.375	0.344	In pan- Out Pan similar
4	-4	x	alg, nods, sponge	.25-.5	75%					x	pitting	high	0.507	0.063	0.063	0.063	0.063	0.063	0.250	0.375	0.375	0.250	0.313	In pan- Out Pan similar
5	-6	x	alg, nods, sponge	.25-.5	75%					x	pitting	mod	0.519	0.063	0.035	0.150	0.120	0.092	0.125	0.375	0.375	0.125	0.250	In pan- Out Pan similar
6	-8	x	mussel	1-2"	100%					x	pitting	mod	0.525	0.031	0.063	0.063	0.210	0.092	0.250	0.250	0.250	0.125	0.219	In pan- Out Pan similar
7	-10	x	sponge, mussel	1-2"	100%					x	pitting	low	0.523	0.040	0.063	0.031	0.063	0.049	0.375	0.250	0.250	0.375	0.313	In pan- Out Pan similar
8	-15	x	sponge, mussel	1-2"	100%					x	pitting	mod	0.519	0.031	0.045	0.090	0.065	0.058	0.125	0.500	0.375	0.250	0.313	In pan- Out Pan similar
9	-20	x	mussel	.75-1"	100%					x	pitting	low	0.524	0.063	0.120	0.040	0.030	0.063	0.250	0.188	0.188	0.250	0.219	In pan deeper pit
10	-26	x	mussel	small	<10%					x	pitting	low	0.569	0.063	0.063	0.040	0.031	0.049	0.250	0.250	0.250	0.500	0.313	Hard Clay w/ 1' light silt

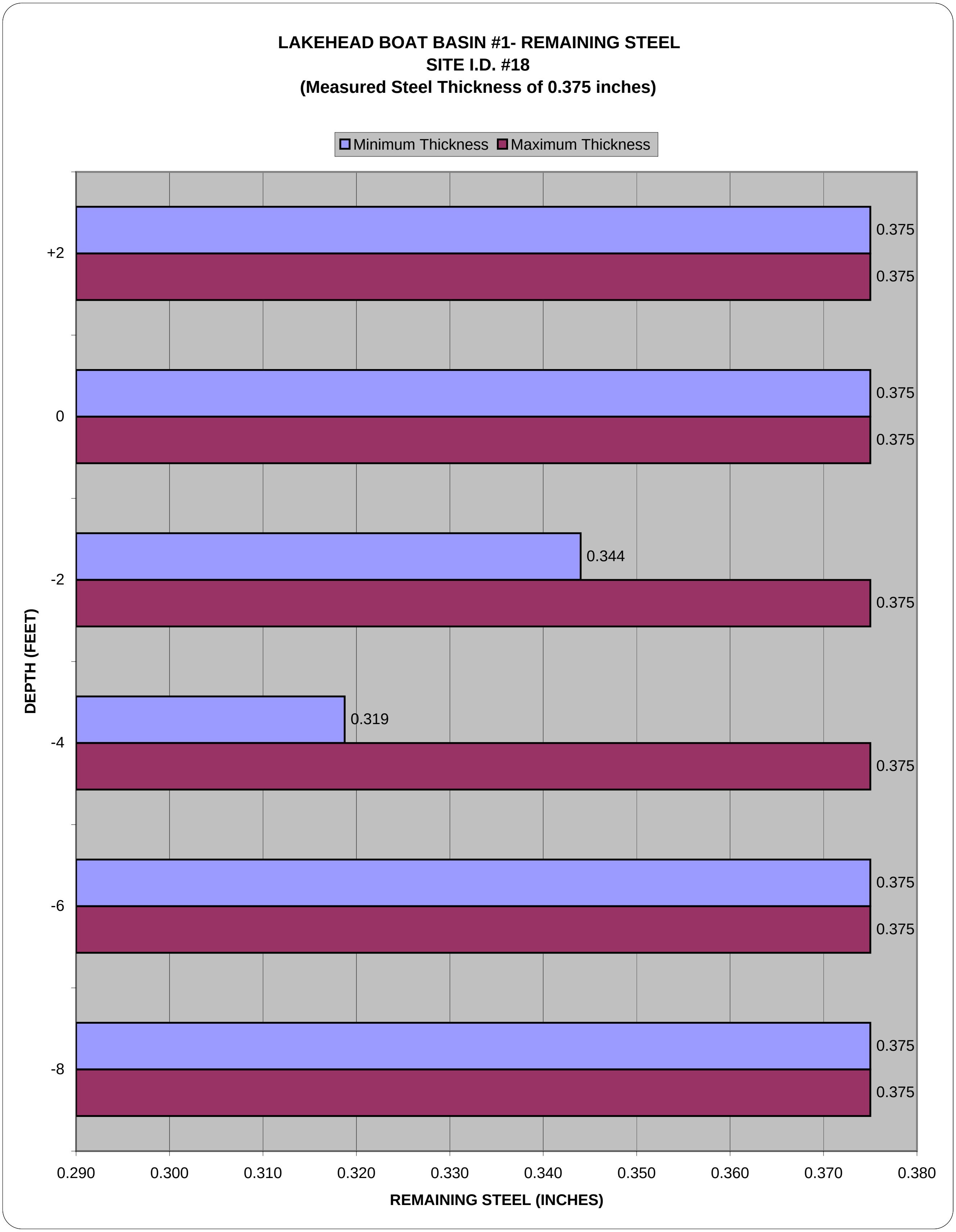

CUTLER MAGNER-REMAINING STEEL
SITE I.D. #17
(Measured Steel Thickness of 0.569)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
-10
-15
-20
-26
0.533
0.533
0.342
0.529
0.291
0.400
0.445
0.507
0.427
0.519
0.433
0.525
0.474
0.523
0.461
0.519
0.461
0.524
0.520
0.569
0.000
0.100
0.200
0.300
0.400
0.500
0.600
REMAINING STEEL (INCHES)

FACILITY	Lakehead Boat Basin Loc #1	SITE I.D. NUMBER	18
DOCK CONFIGURATION	Southwest- Northeast	INSPECTION DATE	8/9/2006
EXPOSURE DIRECTION	Northwest	INSPECTION TIME	
		WATER ELEVATION	
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	PZ27	0.375	2003

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2	0				x	ZG	unk	100%	NA			0.375					0.000					0.000	
2	0	x	AG	0.25	75-100	x	ZG	unk	100%	NA			0.375					0.000					0.000	
3	-2	x	AG	0.25	75-100	x	ZG	unk	99%	x	Blister Pit	3ea.	0.375	0.031	0.031	0.031	0.031	0.031	0.060	0.065	0.065	0.065	0.060	
4	-4	x	AG, SP	6x8 .5-.75		x	ZG	unk	99%	x	Corner Pitting	Low	0.375	0.063	0.050	0.063	0.050	0.056	0.375	0.375	0.500	0.500	0.438	Several small 3/8 pit dia @ .0625 pen
5	-6	x	AG, ON	3ea. .5-.75		x	ZG	unk	99%	x	Corner Pitting	Low	0.375					0.000					0.000	
6	-8	x	SP	1ea.4x6"2"		x	ZG	unk	95-98%	x	Blister	Low	0.375					0.000					0.000	Small blistering 3ea.
7	-10																	0.000					0.000	
8	-15																	0.000					0.000	
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	


LAKEHEAD BOAT BASIN #1- REMAINING STEEL
SITE I.D. #18
(Measured Steel Thickness of 0.375 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
-8
0.375
0.375
0.375
0.375
0.344
0.375
0.319
0.375
0.375
0.375
0.375
0.375
0.290
0.300
0.310
0.320
0.330
0.340
0.350
0.360
0.370
0.380
REMAINING STEEL (INCHES)

FACILITY: Lakehead Boat Basin Loc #2

DOCK CONFIGURATION: Southwest- Northeast

EXPOSURE DIRECTION: Northwest

SITE I.D. NUMBER: 19

INSPECTION DATE:

INSPECTION TIME: 10:30

WATER ELEVATION:

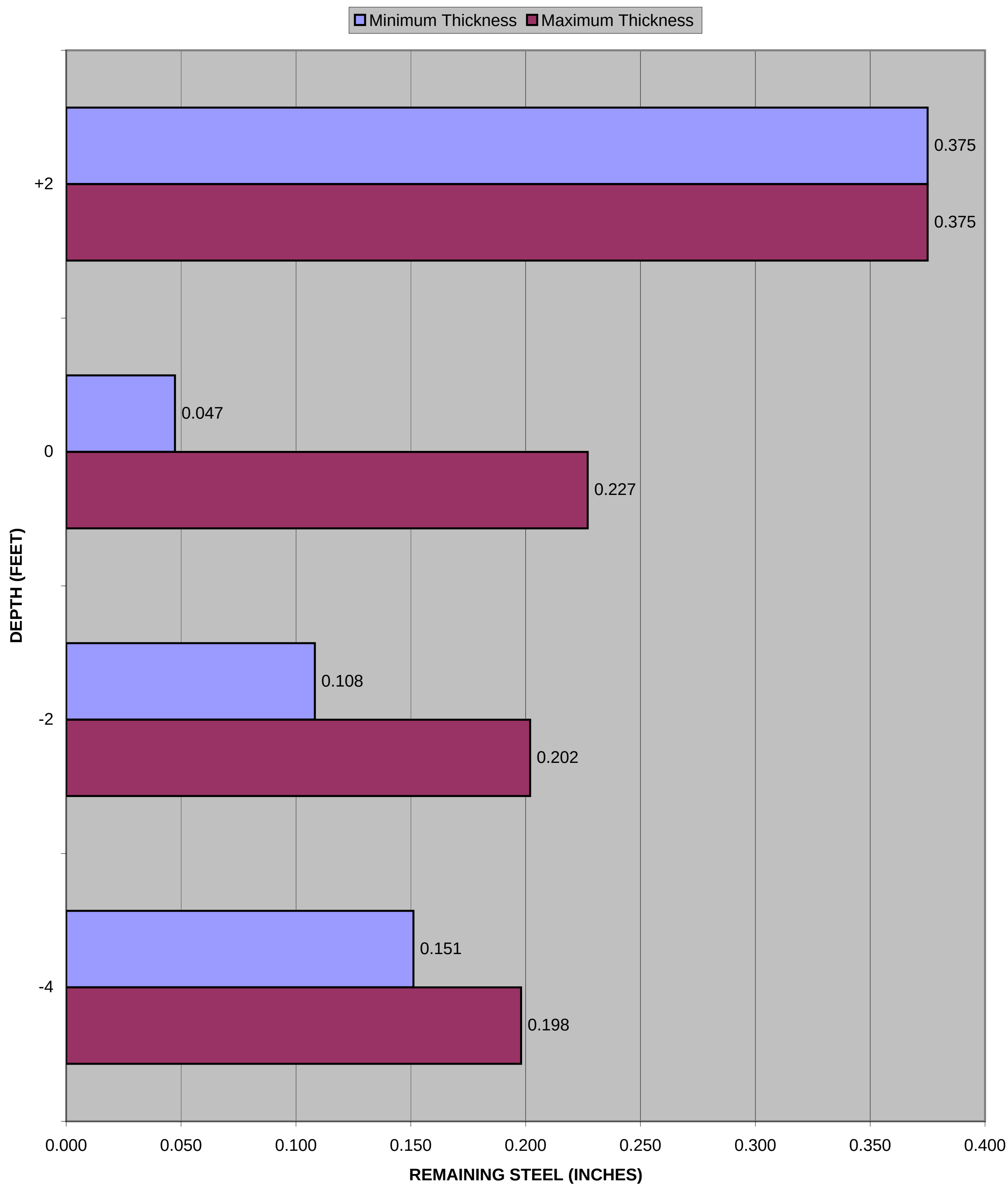
TEAM LEADER: Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	PSA23	0.375	1976

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2					0				X			0.375					0.000					0.000	
2	0	X	ALGAE, ON	0.25	100%AL, 20%ON	0				X	Pit	HIGH	0.227	0.250	0.125	0.156	0.188	0.180	0.625	0.500	0.625	0.625	0.594	a few holes present
3	-2	X	ALGAE, ON	.25,.25	100%AL, 50%ON	0				X	Pit	HIGH	0.202	0.125	0.125	0.063	0.063	0.094	0.375	0.250	0.375	0.500	0.375	
4	-4	X	AL,ZM	.25,LIGHT	10%	0				X	Pit	HIGH	0.198	0.063	0.063	0.031	0.031	0.047	0.125	0.250	0.250	0.250	0.219	Heavy pitting on edge, mud line at 4', silty bottom
5	-6																	0.000					0.000	
6	-8																	0.000					0.000	
7	-10																	0.000					0.000	
8	-15																	0.000					0.000	
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	

LAKEHEAD BOAT BASIN #2- REMAINING STEEL
SITE I.D. # 19
(Measured Steel Thickness of 0.375 inches)



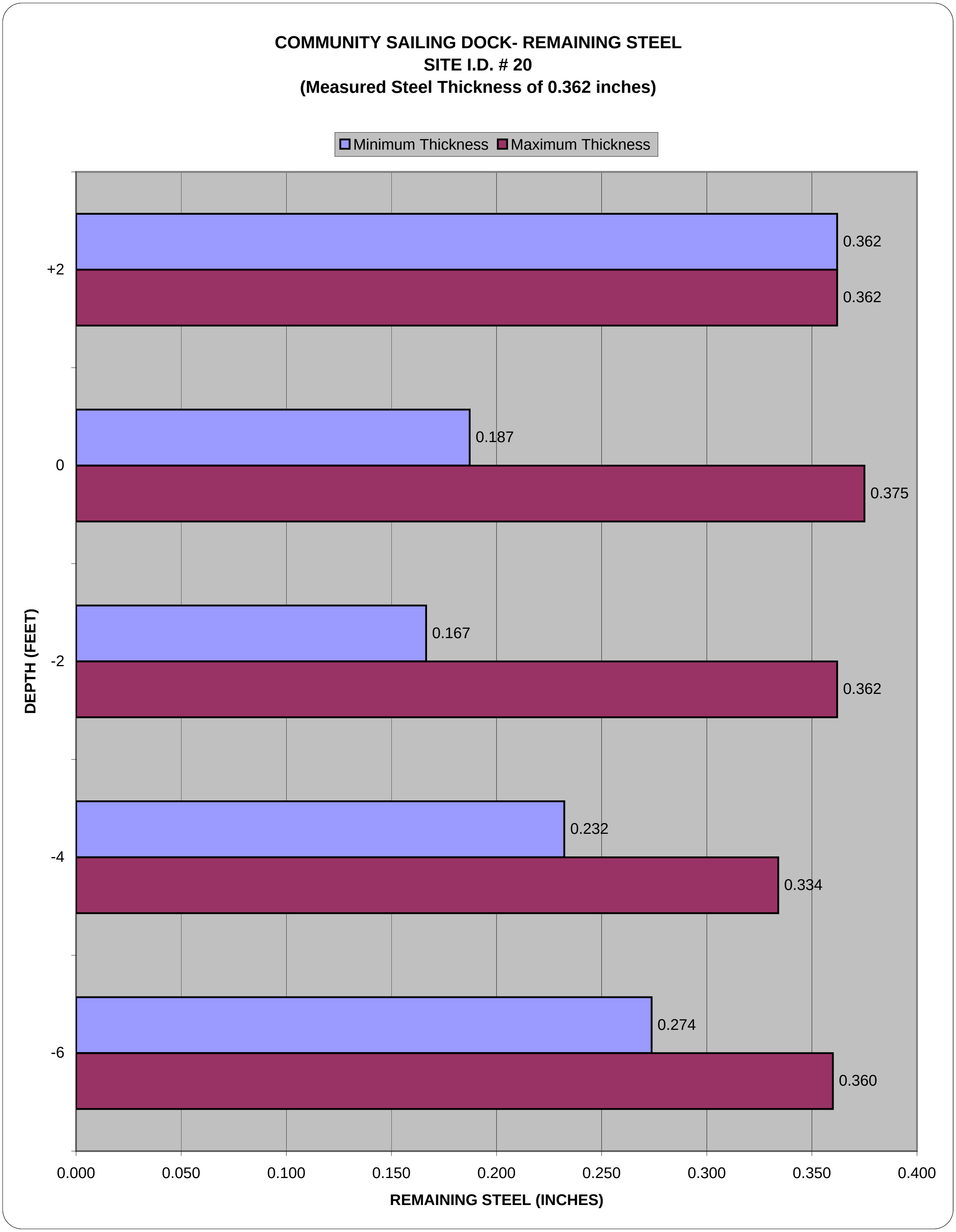
HARBOR STRUCTURES DATA

FACILITY	Community Sailing Dock	SITE I.D. NUMBER	20
DOCK CONFIGURATION	Northwest - Southeast	INSPECTION DATE	8/2/2006
EXPOSURE DIRECTION	Southwest	INSPECTION TIME	1455.00
		WATER ELEVATION	601.7
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	PMA 22	0.375"	1980's

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2												0.362					0.000					0.000	
2	0	x	Algae	<.25	100%					x	Pitting	High	0.375	0.250	0.188	0.125	0.188	0.188	0.750	0.625	0.625	0.750	0.688	Some pits almost perforating sheets
3	-2	x	ZM	1	25%					x	Pitting	High	0.362	0.188	0.250	0.188	0.156	0.196	0.500	0.625	0.500	0.500	0.531	
4	-4	x	ZM	1 to 1.5	50%					x	Pitting	High	0.334	0.125	0.094	0.094	0.094	0.102	0.250	0.375	0.500	0.250	0.344	
5	-6	x	ZM	1 to 1.5	50%					x	Pitting	High	0.360	0.063	0.094	0.094	0.094	0.086	0.125	0.250	0.250	0.250	0.219	Similar condition in/ out pan
6	-8																	0.000					0.000	
7	-10																	0.000					0.000	
8	-15																	0.000					0.000	
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	


COMMUNITY SAILING DOCK- REMAINING STEEL
SITE I.D. # 20
(Measured Steel Thickness of 0.362 inches)
Minimum Thickness
Maximum Thickness
DEPTH (FEET)
+2
0
-2
-4
-6
0.362
0.362
0.187
0.375
0.167
0.362
0.232
0.334
0.274
0.360
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
REMAINING STEEL (INCHES)

FACILITY	William A Irvin Ship	SITE I.D. NUMBER	21
DOCK CONFIGURATION	Ships Hull & Keel	INSPECTION DATE	8/16/2006
EXPOSURE DIRECTION	Northeast	INSPECTION TIME	14:57
		WATER ELEVATION	601.66
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	Vessel Hull		Built 1938

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concentration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2	x	Algae	<.25	20%	x	unk	unk										0.000					0.000	
2	0	x	Algae	<.25	20%	x	unk	unk		x	Lrg.pits	High		0.250	0.188	0.188	0.219	0.211	0.375	0.500	0.375	0.625	0.469	
3	-2	x	Algae	<.25	20%	x	unk	unk		x	pits	High		0.188	0.156	0.188	0.219	0.188	0.625	0.625	0.625	0.625	0.625	High pitting on keel, low on hull
4	-4	x	Algae	<.25	20%	x	unk	unk		x	pits	High Keel		0.156	0.156	0.125	0.125	0.141	1.000	0.750	0.750	0.625	0.781	High pitting on keel, low on hull
5	-6	x	Algae	<.25	20%	x	unk	unk		x	pits	Mod		0.125	0.156	0.156	0.188	0.156	0.625	0.500	0.625	0.625	0.594	Hull coating has failed in some areas
6	-8	x	Algae	<.25	20%	x	unk	unk		x	pits	Low		0.125	0.125	0.156	0.125	0.133	0.750	0.750	0.625	0.625	0.688	(See Video for Coatings Info)
7	-10	x	Algae	<.25	20%	x	unk	unk		x	pits	Low		0.125	0.188	0.156	0.250	0.180	0.500	0.750	0.750	0.750	0.688	
8	-15																	0.000					0.000	
9	-20																	0.000					0.000	
10	ML																	0.000					0.000	

FACILITY	John Sherwin Ship	SITE I.D. NUMBER	22
DOCK CONFIGURATION	Ship Hull	INSPECTION DATE	8/16/2006
EXPOSURE DIRECTION		INSPECTION TIME	16:10
		WATER ELEVATION	601.55
		TEAM LEADER	Chad Scott

SHEET PILE INFORMATION	TYPE	ORIG. THICK.	AGE
	Boat Hull		Built 1958

SAMPLE PILE ORIENTATION

STATION	Depth (IGLD +/-)	Marine Growth				Protective Coating				Corrosion			Steel Max. Remaining Thickness	Pit Penetration Readings					Pit Diameter Readings					Comments
		Present	Type	Thickness	Coverage	Present	Type	Thickness	Coverage	Present	Type	Concetration (High Mod. Low)		1	2	3	4	AVG	1	2	3	4	AVG	
1	+2																						0.000	
2	0	x	Or. Nods & algae	1/4"	100%					x	Pit	med		0.063	0.094	0.125	0.125	0.102	0.250	0.250	0.500	0.500	0.375	Rivets are covered with orange corrosion
3	-2	x	Or. Nods & algae	1/4"	100%					x	Pit	high		0.188	0.125	0.188	0.188	0.172	0.625	0.250	0.500	0.625	0.500	
4	-4	x	Or. Nods & algae	1/4"	100%					x	Pit	low		0.188	0.125	0.188	0.219	0.180	1.000	0.500	0.625	0.625	0.688	
5	-6	x	Or. Nods & algae	1/4"	100%					x	Pit	high		0.188	0.188	0.188	0.125	0.172	0.500	0.500	0.375	0.375	0.438	
6	-8	x	Or. Nods & algae	1/4"	100%					x	Pit	high		0.125	0.125	0.156	0.125	0.133	0.375	0.375	0.375	0.625	0.438	
7	-10																						0.000	
8	-15																						0.000	
9	-20																						0.000	
10	ML																						0.000	

APPENDIX D

Water Quality Data Forms

Facility	DSPA Berth 1
Site I.D. Number	1
Inspection Date	20-Jul-06
Inspection Time	9:24 AM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.79	8.7	0.142	3.1	67.2	320
3	-2	7.91	8.68	0.14	3.4	67.2	318
4	-4	7.94	8.68	0.14	3.4	67.2	315
5	-6	7.97	8.68	0.144	3.6	67.3	278
6	-8	7.98	8.68	0.144	3	67.3	275
7	-10	7.97	8.71	0.143	3.3	67.3	270
8	-15	7.94	8.74	0.14	3.5	66.4	258
9	-20	7.82	8.53	0.136	2.4	65.2	271
10	ML	7.62	8.9	0.122	23.1	60.6	220

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	DSPA Berth 4
Site I.D. Number	2
Inspection Date	20-Jul-06
Inspection Time	10:25

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.98	8.75	0.154	4.2	68.2	311
3	-2	7.98	8.65	0.155	4.1	68.1	310
4	-4	7.95	8.61	0.155	4.2	68	310
5	-6	7.94	8.51	0.154	4.1	67.8	310
6	-8	7.89	8.52	0.153	3.9	67.5	311
7	-10	7.89	8.49	0.153	3.9	67.6	312
8	-15	7.7	8.13	0.141	2.5	66.8	317
9	-20	7.8	8.88	0.139	4.6	64.2	317
10	ML	7.91	10.08	0.116	4.4	57.7	313

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	3.914954
Date ICR Measured	9/7/2006

Facility	DSPA Berth 6
Site I.D. Number	3
Inspection Date	20-Jul-06
Inspection Time	11:50

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.86	8.43	0.159	5.5	68.3	319
3	-2	7.86	8.42	0.161	4.3	68.1	319
4	-4	7.82	8.51	0.162	5.2	67.8	319
5	-6	7.8	8.42	0.162	5	67.5	319
6	-8	7.79	8.37	0.162	5	67.5	317
7	-10	7.78	8.37	0.159	5.2	67	317
8	-15	7.77	8.34	0.158	5.6	66.8	318
9	-20	7.69	8.41	0.152	6.8	65.6	321
10	ML	7.66	8.41	0.137	14	63	297

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	CN Two Harbors
Site I.D. Number	4
Inspection Date	19-Jul-06
Inspection Time	2:30 PM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.84	10.34	0.103	1.3	60.3	266
3	-2	8.04	10.46	0.102	2.1	58.8	263
4	-4	8.04	10.49	0.103	2	57.9	269
5	-6	7.96	10.58	0.103	2.1	57.9	274
6	-8	7.96	10.63	0.103	3.2	57.8	274
7	-10	7.98	10.68	0.102	1.9	57.2	274
8	-15	8.06	10.79	0.102	2.4	56	270
9	-20	8.07	10.97	0.102	2.7	55.1	267
10	ML	8.04	11.68	0.102	5.6	49.4	257

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Minnesota Slip
Site I.D. Number	5
Inspection Date	8/2/2006
Inspection Time	11:35

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.71	6.3	0.185	19	74.5	454
3	-2	7.81	6.27	0.189	16.4	74.1	456
4	-4	7.8	6.34	0.19	17.2	73.7	456
5	-6	7.78	6.14	0.18	22.3	73.3	455
6	-8	7.74	5.76	0.169	30.1	72.5	454
7	-10	7.63	5.63	0.164	33.2	72.8	453
8	-15	7.64	5.69	0.155	30.4	71.5	453
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Water Data

Facility	DECC
Site I.D. Number	6
Inspection Date	8/2/2006
Inspection Time	8:05 AM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.93	7.32	0.151	10.9	73.2	448
3	-2	7.96	7.24	0.151	10.7	73.2	448
4	-4	7.96	7.07	0.151	9.6	73.2	450
5	-6	7.95	6.99	0.143	9.3	73	451
6	-8	7.99	7.14	0.137	9.9	72.7	451
7	-10	7.99	7.12	0.137	9.4	72.7	451
8	-15	8.02	7.4	0.126	9.7	71.9	454
9	-20	8.05	7.4	0.126	10.3	71.8	454
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Water Data

Facility	Cargill Berth 1
Site I.D. Number	7
Inspection Date	8/2/2006
Inspection Time	12:50

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.97	7.08	0.145	9.4	73.9	
3	-2	8	7.07	0.144	9.5	73.8	
4	-4	8.04	7.16	0.145	9.8	73.8	
5	-6	8.04	7.18	0.145	9.8	73.8	
6	-8	8.06	7.21	0.145	9.9	73.8	
7	-10	8.03	7.06	0.143	8.9	73.6	
8	-15	7.95	7.06	0.121	10.2	71.8	
9	-20	7.86	7.07	0.121	9.5	71.7	
10	ML	7.96	7.64	0.111	9.5	70.5	

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Hallet Dock 5
Site I.D. Number	8
Inspection Date	8/1/2006
Inspection Time	1:45 PM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.79	6.62	0.192	9.8	77.2	462
3	-2	7.98	6.21	0.189	9.6	77	463
4	-4	7.95	6.12	0.187	9.8	76.9	462
5	-6	7.96	6.15	0.186	9.9	76.6	462
6	-8	7.93	6.02	0.186	9.2	76.6	462
7	-10	7.92	5.99	0.186	9	76.5	462
8	-15	7.92	5.96	0.184	10.1	76.4	462
9	-20	7.92	5.96	0.186	10.7	76.2	461
10	ML	7.89	5.86	0.208	15.8	75.2	422

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	6.357016
Date ICR Measured	9/7/2006

Facility	Bong Bridge Cell
Site I.D. Number	9
Inspection Date	8/1/2006
Inspection Time	2:15 PM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	8.11	6.3	0.166	14.8	77.8	449
3	-2	8.1	6.18	0.166	16.4	77.8	449
4	-4	8.1	6.2	0.166	14.4	77.9	450
5	-6	8.1	6.24	0.166	15.2	77.9	450
6	-8	8.09	6.22	0.166	15.2	77.9	450
7	-10	8.08	6.22	0.165	14	77.9	450
8	-15	8.08	6.23	0.166	14.3	77.8	451
9	-20	8.09	6.24	0.166	14.3	77.9	451
10	ML	8.1	6.28	0.166	15.1	77.9	451

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Spirit Lake Marina
Site I.D. Number	11
Inspection Date	31-Jul-06
Inspection Time	2:34 PM

Quanta Water Quality Data

Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	8.2	6.8	0.175	9.1	84.8	442
3	-2	8.26	7.11	0.174	10.2	80.6	449
4	-4	8.22	7.05	0.174	10.1	78.8	454
5	-6	8.24	6.78	0.174	10.2	78.7	457
6	-8	8.25	6.68	0.174	10.6	78.7	459
7	-10	8.25	6.44	0.174	14.9	78.6	459
8	-15						
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD

Sample Taken			Sample Tested	
Date	Time		Date	Time

Chloride Ions	
Total Suspended Solids	
Hardness	
Total Iron	
Alkalinity	

Instantaneous Corrosion Information

Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Oliver Bridge
Site I.D. Number	12
Inspection Date	7/31/2006
Inspection Time	1:15 PM

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (ºF)	ORP (mV)
2	0	8.14	6.62	0.193	14	79.3	498
3	-2	8.23	6.62	0.193	14.2	79.1	494
4	-4	8.24	6.62	0.193	14.5	79.2	493
5	-6	8.24	6.67	0.193	14.6	79.1	493
6	-8	8.25	6.81	0.193	14.4	79.1	493
7	-10	8.26	6.66	0.193	14.6	79.0	493
8	-15	8.24	6.67	0.193	14.8	79.0	494
9	-20	8.24	6.7	0.193	15.3	78.8	493
10	ML	8.26	6.64	0.193	16.1	78.8	491

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Corrosion Rate (mpy)	5.748697
Date ICR Measured	9/7/2006

Facility	MERC
Site I.D. Number	13
Inspection Date	8/3/2006
Inspection Time	12:05

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen	Conductivity	Turbidity	Temperature	ORP
2	0	7.86	6.27	0.183	11.9	76.3	444
3	-2	7.91	6.29	0.182	12.4	76.3	442
4	-4	7.91	6.31	0.182	12.5	76.2	442
5	-6	7.91	6.33	0.183	12.5	76.2	443
6	-8	7.91	6.34	0.183	12.6	76	443
7	-10	7.91	6.35	0.184	12.3	76	444
8	-15	7.9	6.31	0.184	12.7	75.6	445
9	-20	7.88	6.33	0.178	12.8	75	447
10	ML	7.86	6.63	0.157	11.1	73.5	449

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	6.093998
Date ICR Measured	9/7/2006

Facility	CHS East Dock
Site I.D. Number	14
Inspection Date	8/4/2006
Inspection Time	14:50

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.78	5.58	0.179	13	77.5	423
3	-2	7.76	5.58	0.178	13.5	77.5	425
4	-4	7.66	5.31	0.181	12.7	75.9	430
5	-6	7.66	5.28	0.179	13.3	75.2	431
6	-8	7.66	5.27	0.178	12.9	75	432
7	-10	7.59	4.44	0.173	14.2	74.4	438
8	-15	7.62	5	0.164	15.1	73.6	439
9	-20	7.58	4.74	0.162	20.8	73.4	440
10	ML	7.55	5.63	0.155	48.6	73	402

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	CHS West Dock (inner end)
Site I.D. Number	15
Inspection Date	8/4/2006
Inspection Time	15:30

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (ºF)	ORP (mV)
2	0	7.89	6.05	0.182	17.9	78	426
3	-2	7.87	5.81	0.182	17	77.9	426
4	-4	7.85	5.84	0.183	16.7	77.6	426
5	-6	7.84	5.45	0.183	16.2	77.4	426
6	-8	7.75	5.22	0.19	17.3	75.4	430
7	-10	7.75	4.9	0.192	20.7	75.3	431
8	-15	7.74	4.63	0.186	28.6	74.1	432
9	-20	7.68	4.46	0.215	30.6	73.6	434
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Water Data

Facility	CHS (New Sheets)
Site I.D. Number	16
Inspection Date	8/4/2006
Inspection Time	15:50

Quanta Water Quality Data

Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (ºF)	ORP (mV)
2	0	7.9	5.87	0.182	19.2	78.3	444
3	-2	7.89	5.87	0.182	18.6	78	443
4	-4	7.88	5.84	0.182	18.4	77.9	442
5	-6	7.86	5.37	0.185	17.3	76	442
6	-8	7.76	4.97	0.19	19.3	75.4	444
7	-10	7.75	5.15	0.181	17.3	74.8	444
8	-15	7.71	4.95	0.191	19.4	73.9	446
9	-20	7.69	4.65	0.224	27.4	73.6	447
10	ML	7.71	5.09	0.258	23.1	73.4	448

Bulk Water Sample Data @ -4 ft LWD

Sample Taken			Sample Tested	
Date	Time		Date	Time

Chloride Ions	
Total Suspended Solids	
Hardness	
Total Iron	
Alkalinity	

Instantaneous Corrosion Information

Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Cutler Magner
Site I.D. Number	17
Inspection Date	8/9/2006
Inspection Time	935

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	7.99	7.99	0.161	11.8	73.9	486
3	-2	8.01	7.55	0.161	10.4	73.9	484
4	-4	8.02	7.4	0.161	10.8	73.7	483
5	-6	8.02	7.09	0.161	11	73.3	483
6	-8	7.97	7.13	0.161	11.5	73	483
7	-10	7.95	6.81	0.16	10.7	72.9	483
8	-15	7.82	6.36	0.15	8.9	72.1	484
9	-20	7.82	6.61	0.146	9.8	71.7	484
10	ML	7.81	6.16	0.135	12.2	70.7	478

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Lakehead Boat Basin 1
Site I.D. Number	18
Inspection Date	8/4/2006
Inspection Time	13:50

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	8.03	7.83	0.134	8.7	72.4	459
3	-2	8.01	7.82	0.132	9.1	72.7	458
4	-4	7.99	7.9	0.124	11.2	71.5	456
5	-6	8.02	7.99	0.122	12.2	71.3	454
6	-8	8.09	7.96	0.122	12.6	71.2	445
7	-10						
8	-15						
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	Lakehead B. Basin 2
Site I.D. Number	19
Inspection Date	8/4/2006
Inspection Time	2:15

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (ºF)	ORP (mV)
1	2	8.08	7.72	0.135	14.7	73.5	453
2	0	7.91	7.76	0.134	15.0	73.4	457
3	-2	7.93	7.83	0.134	19.2	73.4	457
4	-4						
5	-6						
6	-8						
7	-10						
8	-15						
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Water Data

Facility	Community Sailing Dock
Site I.D. Number	20
Inspection Date	8/2/2006
Inspection Time	1520

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	8.13	7.5	0.145	17	77.4	468
3	-2	8.17	7.51	0.145	15.7	76.7	464
4	-4	8.11	7.26	0.146	16	76.4	463
5	-6						
6	-8						
7	-10						
8	-15						
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

Facility	John Sherwin
Site I.D. Number	21
Inspection Date	8/16/2006
Inspection Time	1640

Quanta Water Quality Data							
Station	Depth (IGLD +/-)	pH	Dissolved Oxygen Mg/L	Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°F)	ORP (mV)
2	0	9.41	10.86	2.17	17	77	493
3	-2	9.31	10.5	0.217	17	76.4	498
4	-4	8.49	8.16	0.217	14.4	73	497
5	-6	8.28	7.71	0.218	14.4	71.6	503
6	-8	8.19	7.48	0.218	14.8	71.3	504
7	-10	8.06	7.05	0.218	15.6	70.9	506
8	-15	8.01	6.82	0.219	15.6	70.8	489
9	-20						
10	ML						

Bulk Water Sample Data @ -4 ft LWD				
Sample Taken			Sample Tested	
Date	Time		Date	Time
Chloride Ions				
Total Suspended Solids				
Hardness				
Total Iron				
Alkalinity				

Instantaneous Corrosion Information	
Instantaneous Corrosion Rate	
Date ICR Measured	

APPENDIX E

Linear Polarization Resistance Results & Report

BUSHMAN & Associates, Inc.
CORROSION CONSULTANTS
P.O. Box 425, Medina, OH 44258 • Phone 330/769-3694, Fax 330/769-2197

September 10, 2006

AMI Consulting Engineers
1 East 1st Street, Suite 403
Duluth, MN 55802

Attn: Mr. Chad W. Scott

Re: Duluth Harbor Corrosion Rate Testing

Dear. Mr. Scott.

This letter report is intended to provide a summary of the test data and information obtained during our corrosion rate testing work performed on September 7, 2006 in Duluth Harbor. The methodology used is commonly referred to as Linear Polarization Resistance (LPR) Corrosion Rate Measurement which is defined in ASTMs Standard G59-97(2003), “Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements”.

The method used in this study follows the ASTM procedure using a Gamry Reference 600 Potentiostat, Galvanostat, and Zero Resistance Ammeter combined in a portable instrument package which is designed for both laboratory and field testing work. The unit requires a PC computer running under Windows 2000 or XP using Gamry’s DC-105 Corrosion Measurement and Analysis software.

LPR is probably the most common test method used in assessing the corrosivity of an environment with respect to a metal. It is both relatively simple to perform, given the right computer driven test equipment, and provides reproducible results. At the end of each computer controlled scan, it automatically calculates the average corrosion rate over the surface area of the metal sample being testing in the water or soil being evaluated. Since underground and submerged metal corrosion is almost always of the pitting type, it is common practice to multiply this average rate by a factor of 5, 10 or 20 to determine the pitting or perforation rate that can be expected. B&A often uses a rate of 7.5 times the average rate as a reasonable approximation of the pitting rate.

LPR, as performed by B&A in this as well as most studies, involves the use of extremely small amounts of current (generally in the micro-ampere level) applied from a small metallic rod (commonly called the “counter electrode”) to a prepared metal test specimen (commonly called the “working electrode”) of the same metal alloy of that of the structure being evaluated when it is immersed in water or soil obtained from the environment in which the structure is or will be installed. The entire test is controlled by a microcomputer controlled DC power supply called a potentiostat. During the entire LPR scan, the energy level (or potential) of the metal specimen is measured in millivolts by a reference electrode. The applied current is controlled to vary the potential of the metal specimen in a series of steps form a value of 20 millivolt less than the free corrosion potential to a value 20 millivolt more positive than the free corrosion potential.

The test scan parameter from **Scan #4 at Midwest Energy Dock** using the insitu probe with Serial. No. 06-08-1008 installed approximately 1½ weeks ago were as follows;

Initial E (V): -0.02 vs. Eoc
Final E (V): 0.02 vs. Eoc
Test Setup: Linear Polarization Resistance
Date: 9/7/2006
Time: 13:37:18
Scan Rate (mV/s): 0.2
Sample Period (s): 2
Sample Area (cm^2): 5
Steel Density (gm/cm^3): 7.87
Steel Equiv. Wt: 27.92
Conditioning: Off
Init. Delay: On
Time for stabilization before starting scan (s): 100
Stab.(mV/s): 0.1
Open Circuit (V): 0.006856

When this data is plotted on a semi-log graph, a linear relationship between the change in potential versus the applied test current is observed.

Figure 1 - B&A Computer Running Gamry LPR Software in Duluth Harbor

Once the experiment is complete, the data generated is sent to the Gamry Analysis Package which permits calculation of the average corrosion rate based on the slope and axis intercept point of the line developed during the LPR scan. The program then displays the analysis determinations as follows:

EXPERIMENTAL DETERMINATIONS **(from Scan #4 at Midwest Energy Dock)**
Beta An.(V/Dec): 0.12
Beta Cat.(V/Dec): 0.12
Icorr (A): 6.599473E-05
Ecorr (V): 5.72136E-03
Corrosion Rate (mpy): 6.031089

Since pitting corrosion is visibly occurring; B&A calculates a real corrosion penetration rate of 45.2 mils per year (mpy) or penetration of a 1/2" plate in 11 years.

Figure 2 - LPR Test Probe Junction Box

Figure 3 – LPR Probe after 1 week exposure

Figure 4 - LPR Test Probe Tips after 2 weeks exposure

Fig. 5 - Gamry 600 LPR Instrument Supported by Ladder

Fig. 6 – Test Setup with Computer on Boat

Fig 7 – AMI Inspection Boat used for all tests

Fig 8 – All tests were controlled from this location

Fig 9 – AMI performing water chemistry tests

Fig 10 – AMI Hach Water Chemistry Probe

Fig. 11 – Hach Water Chemistry Display

LPR Scans were measured at the 7 sites with 3 scans per site. Results are summarized in the following table:

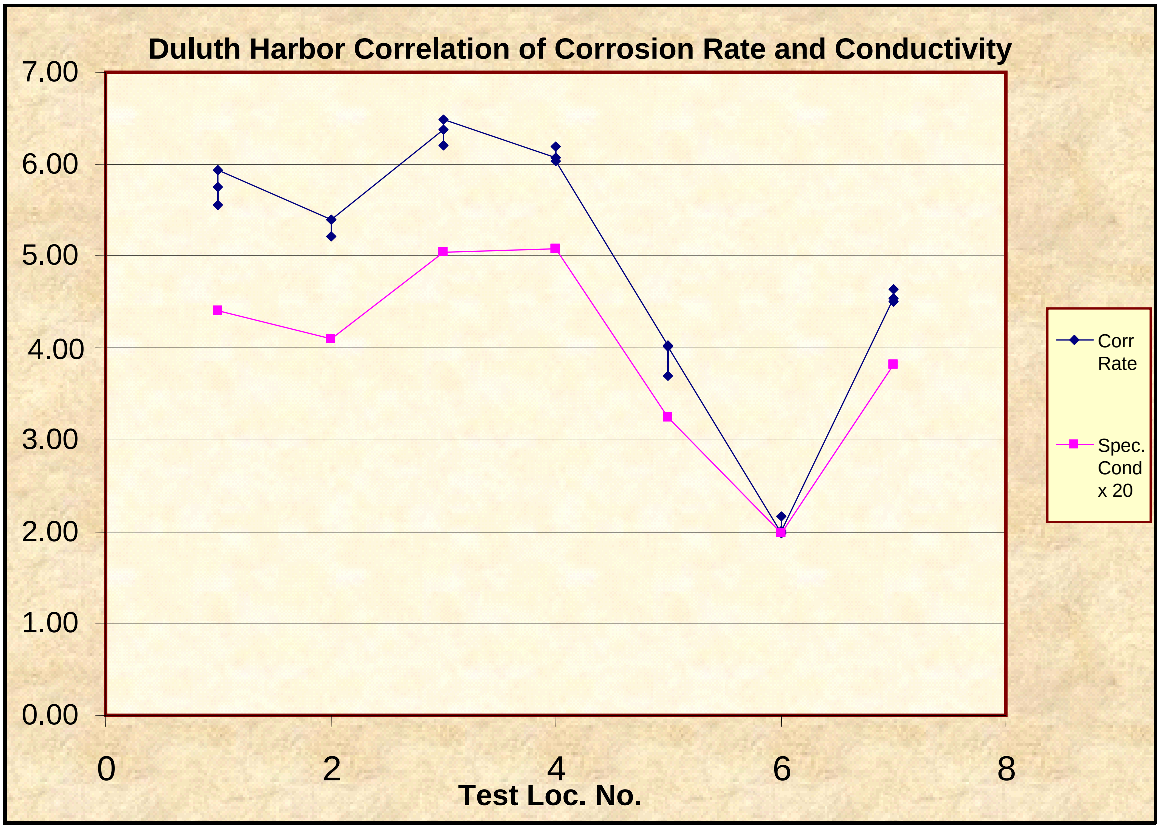
Table No. 1 – Corrosion Rate Test Results – Duluth Harbor

Location Description	Test Locate No.	Scan No.	LPR Probe Ser. No.	Corrosion Rate (mpy)
Oliver Bridge	1	B	Ser. No. 06-98-1005	**5.750072**
Oliver Bridge	1	C	Ser. No. 06-98-1005	**5.554085**
Oliver Bridge	1		Ser. No. 06-98-1005	**5.941934**
Hallett 7 Dock	2	A	Ser. No. 06-08-1003	**5.400351**
Hallett 7 Dock	2	B	Ser. No. 06-08-1003	**5.207576**
Hallett 7 Dock	2		Ser. No. 06-08-1003	**5.403211**
Hallett 5 Dock	3	A	Ser. No. 06-08-1007	**6.367826**
Hallett 5 Dock	3	B	Ser. No. 06-08-1007	**6.209100**
Hallett 5 Dock	3		Ser. No. 06-08-1007	**6.494123**
Midwest Energy Dock	4	A	Ser. No. 06-08-1008	**6.065133**
Midwest Energy Dock	4	B	Ser. No. 06-08-1008	**6.185771**
Midwest Energy Dock	4		Ser. No. 06-08-1008	**6.031089**
DSPA Berth 4	5	A	Ser. No. 06-08-1004	**4.030746**
DSPA Berth 4	5	B	Ser. No. 06-08-1004	**3.699939**
DSPA Berth 4	5		Ser. No. 06-08-1004	**4.014178**
US Army COE Duluth Entry	6	A	Ser. No. 06-08-1006	**1.977549**
US Army COE Duluth Entry	6	B	Ser. No. 06-08-1006	**2.165742**
US Army COE Duluth Entry	6		Ser. No. 06-08-1006	**2.012401**
Superior Cutler Magner	7	A	Ser. No. 06-08-1009	**4.541889**
Superior Cutler Magner	7	B	Ser. No. 06-08-1009	**4.641087**
Superior Cutler Magner	7		Ser. No. 06-08-1009	**4.496408**

The above rates are considerably higher than normally measured by B&A in potable waters. More typically, we would have expected values in the 0.5 to 1.5 mil/year corrosion rate. We then decided to analyze the probable correlation between the measured water conductivity and the measured corrosion rates. To show these on the same graph, the specific conductivity values were all multiplied by 20 to produce numeric values that would be in the same range as those provided by the Corrosion Rate Values. There is an obvious close relationship between the values as would be expected. None-the-less, the corrosion rates are so high that they can only be explained by some other over-riding factor accelerating the rate such as micro-biologically influenced corrosion (MIC).

We have attached copies of all LPR scans, thumbnail prints of all photos taken (including CDs with high resolution copies thereof) as well as a tabulation of the above with the additional water chemistry data measured by AMI Consulting Engineers.

Graph 1 – Correlation between Corrosion Rate and Conductivity



Recommendations:

- It is imperative that another set of readings be made in approximately 1 month to see if there is any measurable decline in these corrosion rates.
- Test for MIC using several available techniques to determine if this is a principal impactor on the unusually high corrosion rates being experience in the Duluth Harbor.
- Test for Stray DC Currents including those that might be emanating from the nearby HVDC system and from DC powered ship loading conveyors.
- Develop and implement a remediation plan for saving that piling which has not already suffered excessive corrosion. This plan needs to be "trialed" as soon as possible.

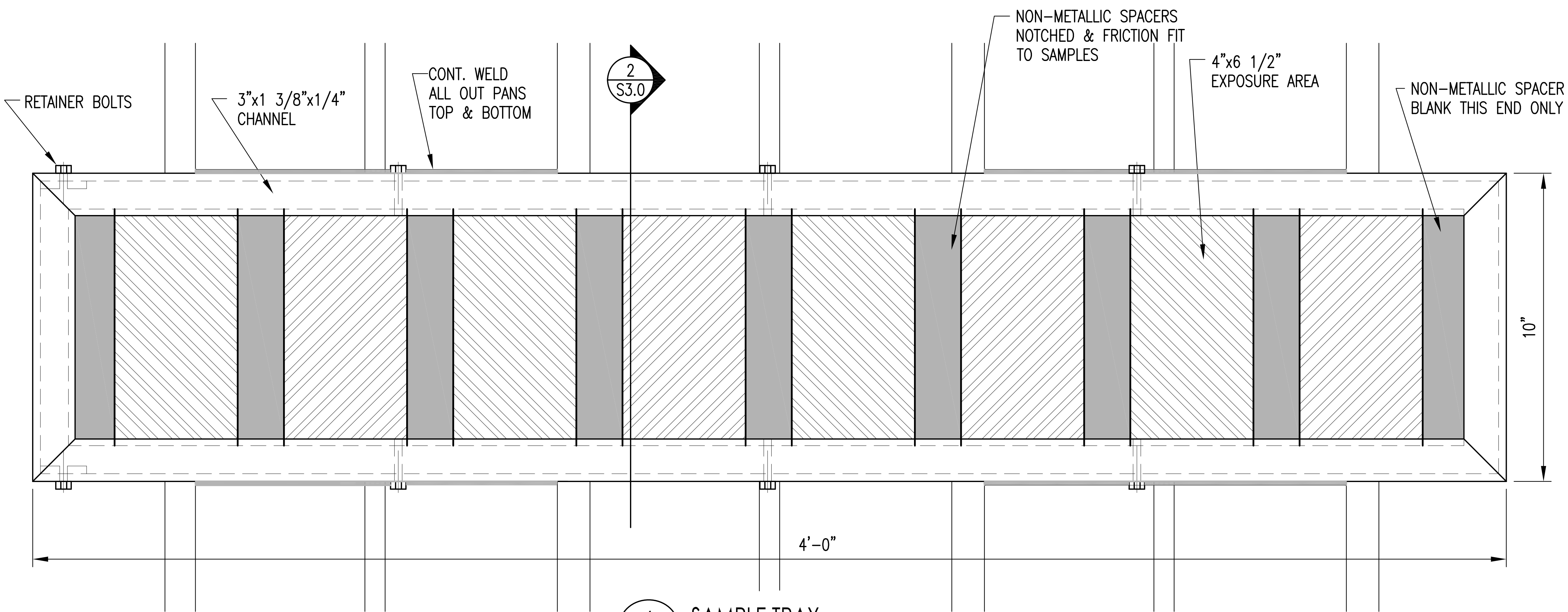
We sincerely appreciate having the opportunity of working with you on this project and the support and assistance provided by you and your staff at every step. If you have any questions or need further information from me, please call or write.

Sincerely,
Bushman & Associates, Inc.

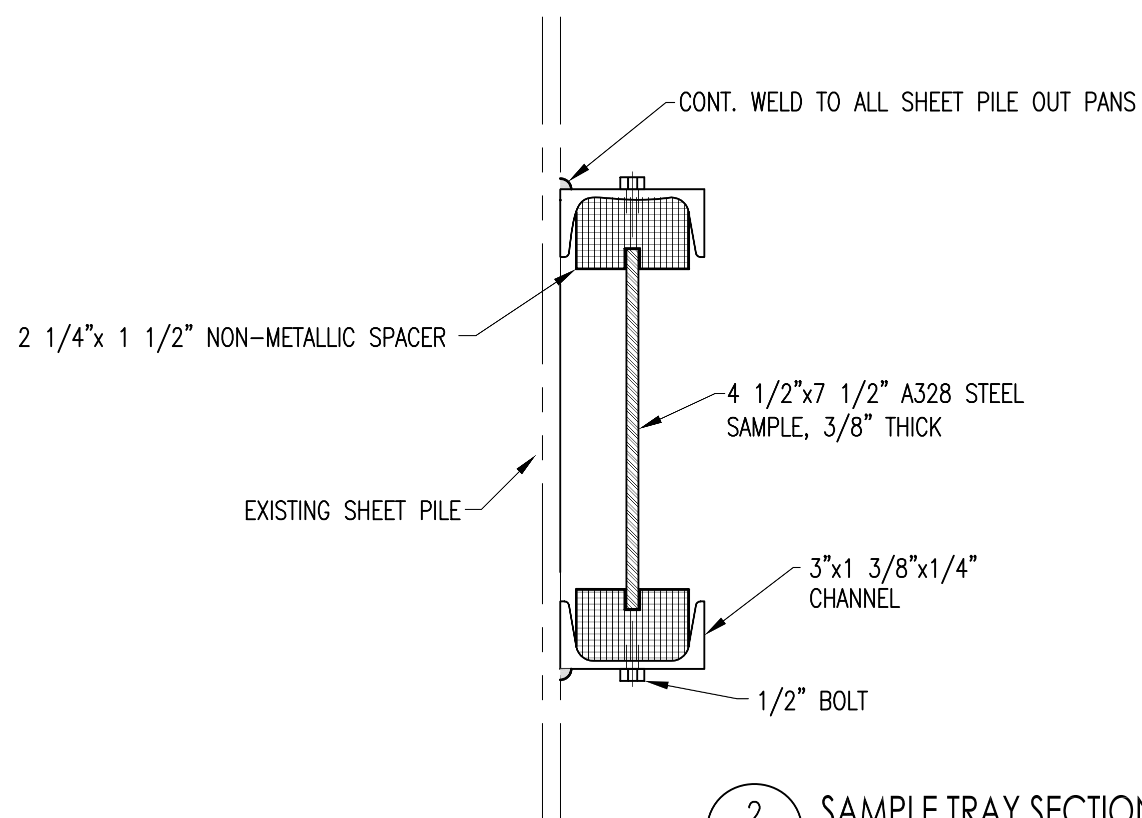
James B. Bushman, P.E., C.P.S., S.C.T.
President and Principal Corrosion Engineer

APPENDIX F

Sample Tray Plans and Data



1 S1.0 SAMPLE TRAY
3"= 1'-0"



2 S1.0 SAMPLE TRAY SECTION
3"= 1'-0"

AMI CONSULTING ENGINEERS P.A.
1 East 1st Street Suite 403
Duluth, MN 55802
PH 218.727.1206 Fax 218.727.3961

DATE:	REV:	DESCRIPTION	BY:

USACE
HARBOR CORROSION INVESTIGATION
DULUTH, MINNESOTA

STEEL COUPON
SAMPLE TRAY #2

JOB No: 061036
DATE: 10/20/06
DRAWN BY: SAJ
DESIGNED BY: CWS

SHEET:
S1.0

Feb 07, 2007 - 2:11pm
Z:\2006\061035 DSPA Sheet Pile Sample Tray Installation\drawings\sample tray as built.dwg

CORROSION SAMPLE TRAY INFORMATION				
Sample Tray Location	Dimensions (cm)		Weight	Installation
Steel Plate I.D.	Length	Width	(grams)	Date
DPSA BERTH 4				
B4- 1	19.3	11.6	1878.2	10/17/2006
B4- 2	19.4	11.7	1896.8	10/17/2006
B4- 3	19.4	11.4	1869.1	10/17/2006
B4- 4	19.3	11.6	1894.9	10/17/2006
B4- 5	19.3	11.7	1866.5	10/17/2006
B4- 6	19.3	11.6	1886.1	10/17/2006
B4- 7	19.4	11.7	1891.5	10/17/2006
B4- 8	19.2	11.5	1855.9	10/17/2006
AVERAGES	19.325	11.6	1879.88	
HALLETT DOCK 5				
H5- 1	19.3	11.7	1861	10/17/2006
H5- 2	19.4	11.5	1787.5	10/17/2006
H5- 3	19.3	11.5	1870.1	10/17/2006
H5- 4	19.7	11.7	1872.9	10/17/2006
H5- 5	19.4	11.8	1881.6	10/17/2006
H5- 6	19.3	11.8	1893.1	10/17/2006
H5- 7	19.5	11.6	1870.2	10/17/2006
H5- 8	19.4	11.6	1875.3	10/17/2006
AVERAGES	19.41	11.65	1863.96	
HALLETT DOCK 7				
H7- 1	19.5	11.5	1871.4	10/3/2006
H7- 2	19.4	11.6	1884.2	10/3/2006
H7- 3	19.3	11.7	1864.7	10/3/2006
H7- 4	19.4	11.6	1860.6	10/3/2006
H7- 5	19.4	11.8	1900.7	10/3/2006
H7- 6	19.5	11.6	1788.6	10/3/2006
H7- 7	19.4	11.7	1854	10/3/2006
H7- 8	19.2	11.5	1956.2	10/3/2006
AVERAGES	19.39	11.63	1872.55	
OLIVER BRIDGE				
OB- 1	19.4	11.6	1866.7	10/4/2006
OB- 2	19.4	11.6	1813.5	10/4/2006
OB- 3	19.3	11.5	1854.1	10/4/2006
OB- 4	19.2	11.7	1885.3	10/4/2006
OB- 5	19.3	11.5	1899.9	10/4/2006
OB- 6	19.2	11.4	1817.6	10/4/2006
OB- 7	19.3	11.5	1895	10/4/2006
OB- 8	19.3	11.4	1866.7	10/4/2006
AVERAGES	19.30	11.53	1862.35	

Sample Tray Location	Dimensions (cm)		Weight	Installation
Steel Plate I.D.	Length	Width	(grams)	Date
MIDWEST ENERGY				
MW- 1	19.3	11.5	1860.8	10/17/2006
MW- 2	19.3	11.6	1871.5	10/17/2006
MW- 3	19.3	11.5	1883.8	10/17/2006
MW- 4	19.3	11.5	1835.7	10/17/2006
MW- 5	19.2	11.5	1864	10/17/2006
MW- 6	19.3	11.7	1916.3	10/17/2006
MW- 7	19.4	11.7	1908.8	10/17/2006
MW- 8	19.2	11.6	1892.6	10/17/2006
AVERAGES	19.29	11.58	1879.19	
CUTLER MAGNER				
CM- 1	19.3	11.5	1862.3	10/3/2006
CM- 2	19.2	11.7	1890.8	10/3/2006
CM- 3	19.4	11.6	1884.9	10/3/2006
CM- 4	19.3	11.6	1903.7	10/3/2006
CM- 5	19.2	11.7	1964.3	10/3/2006
CM- 6	19.4	11.6	1901.3	10/3/2006
CM- 7	19.3	11.6	1890.6	10/3/2006
CM- 8	19.3	11.5	1866.1	10/3/2006
AVERAGES	19.30	11.60	1895.50	
Balance used: NBS Serial #F54470 calibrated-4/19/06				