Engineering Evaluation Relative to Concrete Condition and Steel Sheet Pile Wing Walls
Moss Bluff Lock and Dam/Spillway Structures
Marion County, Florida

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St. Johns River Water Management District  
P.O. Box 1429  
Palatka, Florida 32178

Attention: Mr. Wayne Dempsey, P.E.

Subject: Engineering Evaluation Relative to Concrete Condition and  
Steel Sheet Pile Wing Walls  
Moss Bluff Lock and Dam/Spillway Structures  
Marion County, Florida

Dear Mr. Dempsey:

As authorized by you, Ardaman & Associates, Inc. has completed an engineering evaluation of the subject lock and dam/spillway structures relative to the concrete condition and steel sheet pile wing walls. The purposes of our evaluation were to observe and evaluate the condition of the concrete within the water fluctuation zones for the lock and dam/spillway structures, observe and evaluate the condition of the existing steel sheet pile wing walls, and to provide recommendations for remediation as needed. This report documents our findings and presents our engineering recommendations.

SITE LOCATION AND DESCRIPTION

The Moss Bluff lock and dam/spillway structures are located on the southern edge of the Ocala National Forest, along the Ocklawaha River in Marion County, Florida. The GPS coordinates obtained from St. Johns River Water Management District website, indicate that the Moss Bluff structures are located at latitude 29°04'43.910", longitude 81°52'53.141".

We understand that the existing structures were constructed in or around 1967. The dam structure and the steel sheet pile walls have not been modified except for periodic painting of the steel sheet pile wing walls. In 2004, the lock structure underwent a complete rehabilitation which included foundation pressure grouting, contraction joint repair, concrete crack and surface repairs, repair and painting of lock gates and sheet piling walls. The structures are constructed primarily of reinforced concrete with the metal gates and anchored steel sheet pile wing walls located at the upstream and downstream ends of the structures.

Based on review of “As-Built” record drawings, the lock structure (including the lock chamber, gate monoliths and the lock inlet and outlets) is approximately 228 feet in length. The interior lock chamber is 30 feet wide and 35 feet deep from the top of wall to top of chamber slab. According to the “As-Built” drawings, the upstream sheet pile wing walls consist of 26 sections of Type Z-27 sheet pile having a total wall length of 39 feet and the downstream sheet pile wing walls consist of 48 sections of Type Z-38 sheet pile having a total wall length of 72 feet. Type Z-27 (now known as PZ-27) sheet pile has a nominal web and flange thickness of 0.375 inch and Type Z-38 (now known as PZ-38) sheet pile has a nominal web and flange thickness of 0.500 inches.
Based on review of “As Built” record drawings on the dam/spillway structures, the double gate hydraulic control structure is 40 feet in width. The concrete gate monolith is 112.3 feet in length having an upstream top of crest weir elevation of +48.1 feet dropping over an approximate horizontal distance of 38 feet to the downstream top of slab elevation of +30.0 feet. According to the “As-Built” drawings, the upstream sheet pile wing walls consist of 28 sections of Type Z-27 sheet pile having a total wall length of 42.0 feet and the downstream sheet pile wing walls consist of 24 sections of Type Z-27 sheet pile having a total length of 18.0 feet. Type Z-27 (now known as PZ-27) sheet pile has a nominal web and flange thickness of 0.375 inch.

SITE OBSERVATIONS

Site observations of the structures were made on August 7, 2014 by Ardaman and Associates engineer Mr. Jason Parker, P.E. In general, observations of the structures and wingwalls were limited to the portions above the water level at the time of our observations, except for inside the lock structure, where the water level was lowered approximately 20 feet during our observations. Based on the visual water staining marks, the water levels appear to typically fluctuate approximately 1 foot on the upstream and downstream sides of the lock and dam/structures. However, on the downstream side of the dam/spillway, the visible erosion zone (based on concrete pitting) is estimated to be 6 to 8 feet above the normal water fluctuation zone. It is generally known that water levels during extreme hydrological events fluctuate more than typical.

Lock Structure Observations

For the lock structure, our observations indicated that the concrete walls appeared to be in “good” general condition. Concrete pitting within the water fluctuation zone was observed to be minimal (i.e; less than ¼ inch) with no significant loss of aggregate. Below the water fluctuation zone, pitting was even less apparent. The portions of the lock walls below the normal water level were exhibiting less pitting and were coated with a uniform layer of algae growth. Almost no pitting above the normal water level was observed. No spalling, significant cracking, rust staining or other indicators of potential structural defects or corrosion relative to the concrete were observed.

Relative to the steel sheet pile wing walls, the upstream walls appeared to be in “very good” condition. No evidence of corrosion or seepage between the joints was observed. On the downstream side, the wingwalls appeared to be in “good” general condition; however significant seepage staining and surficial corrosion through the joints and tie-back anchor plates were observed. We note that only portions of the first 12 sections of sheet piles on the upstream side of the lock and 46 sections on the downstream side of lock were observed. The remaining portions of the steel sheet pile walls were below the water surface and could not be observed relative to their condition.
Dam/Spillway Structure Observations

For the upstream side of the dam/spillway structure, our observations indicated that the concrete appeared to be in “good” general condition and experiencing moderate concrete pitting within the approximate 1-foot water fluctuation zone with typical surficial loss of aggregate on the order of ¼ to ½ inch. Minimal pitting, if any, was observed above the water fluctuation zone. On the downstream side of the structure, our observations indicated that the concrete also appeared to be in “good” general condition. Concrete pitting within the normal water fluctuation zone was observed to be slightly less advanced than the upstream portion. While pitting was observed up to 8 feet above the normal water fluctuation zone, the degree of pitting was considered to be minimal with no significant loss of aggregate. We were unable to observe the concrete structure below a depth relative to the water level of approximately 6 inches due to water clarity. No spalling, significant cracking, rust staining or other indicators of potential structural defects or corrosion were observed.

Relative to the steel sheet pile wing walls, the upstream walls appeared to be in “very good” condition. No evidence of corrosion or seepage between the joints was observed. On the downstream side, the wingwalls appeared to be in “good” condition; however minor seepage staining and surficial corrosion through the joints and tie-back anchor plates were observed. We note that only portions of the first 12 sections of the sheet piles on the upstream side of the dam/spillway and 24 sections on the downstream side were observed. The remaining portions of the steel sheet pile walls were below the water surface and could not be observed relative to their condition.

Representative photographs of our observations are included in Appendix I.

FIELD EXPLORATION PROGRAM

The field exploration program consisted of performing a series of non-destructive and destructive testing/sampling at selected locations to evaluate the concrete condition and the steel sheet pile wing walls. The following describes the field exploration program in detail.

Rebound Hammer Readings

Rebound hammer testing was performed in general accordance with ASTM C 805, “Standard Test Method for Rebound Number of Hardened Concrete”. A rebound hammer is a non-destructive device that consists of a plunger rod and an internal spring loaded steel hammer and a latching mechanism. When the extended plunger rod is pushed against a hard surface, the spring connecting the hammer is stretched to an internal limit and then released, causing the energy stored in the stretching spring to propel the hammer against the plunger tip. The hammer strikes the shoulder of the plunger rod and rebounds a certain distance. On the outside of the unit is a slide indicator which records the distance traveled during the rebound. This indication is known as the rebound number (R-number).
At selected locations, rebound hammer readings were obtained to assess the uniformity of the in-place concrete within and above the water fluctuation zone and to delineate regions of potentially deteriorated concrete for further testing. In general, a set of readings were obtained within the water fluctuation zone to represent the visual zone of erosion, and a second set of readings were obtained above the water fluctuation zone to represent the less-eroded concrete.

Within the lock structure, the rebound hammer testing was performed approximately 2 feet above the water level at the time of our evaluation and a second set of readings was obtained approximately 4 feet below the water level (after the lock water level was pumped down approximately 6 feet). For the dam/spillway structure, rebound hammer testing was performed approximately 1 foot above the water level at the time of our exploration and a second set of readings were obtained approximately 4 feet above the normal water fluctuation zone. One test was also performed on each of the two spillways.

A total of 10 rebound hammer readings were obtained at each of the selected test locations. The average of the rebound hammer readings obtained from each test location is presented on Table 1. The approximate locations where the readings were obtained are presented on Figures 1 and 2.

As shown on Table 1, the average value of the rebound number within the zone of typical water fluctuation inside the lock structure is 2.5. The average value of the rebound number within the zone of typical water fluctuation for the dam/spillway structure is 2.4 and 2.5 for the upstream and downstream walls respectively. The spillway readings were considerably lower with readings of 1.0 and 1.1. The average rebound number value above the zone of typical water fluctuation inside the lock structure is 4.0. The average rebound number value above the zone of typical water fluctuation for the dam/spillway is 4.4 and 3.4 for the upstream and downstream walls, respectively. Though the average rebound number readings obtained above the water typical fluctuation zone are higher than the average rebound number within the typical fluctuation zone, it is our opinion that the lower rebound numbers in the zone of typical fluctuation are primarily due to the surface condition (i.e., the concrete pitting present within the zone of typical water level fluctuation). No obvious areas of “softer” or “harder” concrete were distinguishable.

Concrete Coring

The field exploration program also included obtaining a series of concrete cores for evaluation. For the lock structure, six selected locations on the inside chamber walls were selected for coring (designated as L-1 through L-6). For the dam/spillway structure, two locations were selected from the upstream portion of the structure, one location from each of the spillways and six locations from the downstream walls for a total of ten locations (designated as D-1 through D-10). At each lock and dam/spillway core location, two (2) 2.5-inch diameter core samples were obtained for testing. The cores were obtained from approximately 4 feet below the normal water level in the lock structure and from approximately 1.0 foot above the water level at the time of our exploration for the dam/spillway structure. The cores were drilled horizontally to a depth of at least 3.5 inches. Reinforcing steel was not encountered during coring at any sample
location. The core samples were visually inspected and measured for length in the field and transported to our laboratory for additional testing. Upon completion of the coring program, all core holes were patched with high strength, rapid setting concrete patch.

A summary of the concrete core data including their length and general observations is presented as Table 2. The approximate core locations are schematically illustrated on the lock and dam/spillway core location plans presented as Figures 1 and 2.

**Ultrasonic Thickness Readings**

Non-destructive ultrasonic thickness readings were performed at selected locations along the upstream and downstream steel sheet pile wing walls for both the lock and dam/spillway structures. At each of the sheet pile wing walls, evenly spaced locations were tested and readings were obtained across the sheet pile section. The readings were obtained approximately 0.5 foot above the water level at the time of the readings. When corrosion was present at a test location, the corrosion was removed using a hand-held battery operating grinder and the remaining section measured for thickness. The thickness readings were obtained utilizing a Krautkramer DMS Ultrasonic Thickness Gauge. A summary of the readings for the sheet pile wing walls is included as Table 3A through 3D.

In general, the average thickness readings for the Type Z-27 sheet pile sections were slightly above the nominal sectional thickness of 0.375 inch. The average thickness readings for the Type Z-38 sheet pile sections were close to the nominal sectional thickness of 0.500 inch.

**Water Sampling**

A sample of the creek water was obtained on August 7, 2014 upstream of the weir within the stilling basin and near the north wall. This sample was transported to our laboratory for analysis relative to corrosive properties (i.e.; pH, conductivity, chlorides and sulfates).

**LABORATORY PROGRAM**

**Petrographic Evaluation of Concrete Core Samples**

Selected core samples were chosen for petrographic examination to assess the depth of the erosion and examine for evidence of corrosion of embedded reinforcing steel (if present). The selected core samples were saw-cut longitudinally and polished for examination.

In general, evidence of erosion (pitting) was measured to be on the order of 1/8 to 1/4 inch on both the upstream and the downstream portions of the structures. Within the cores we observed no evidence of rust bleeding (as would be expected from corroding reinforcing steel) or leaching of paste due to acid attack. These results also are consistent with our field observations.
Petrographic evaluation reports and representative photographs depicting the polished core samples are included in Appendix II.

**Chemical Evaluation of Concrete Core Samples**

Selected core samples were also tested for carbonation and pH to assess the potential for corrosion. The pH of new concrete is typically within the range of 12 to 13 mostly due to calcium hydroxide, which is a normally occurring by-product of cement hydration. As a concrete surface reacts with carbon dioxide in air or water, the pH of the surface gradually is reduced to about 7 to 8 through a process called carbonation. Gradually the process penetrates deeper into the concrete. Once the internal pH drops below 10, the reinforcing steel passivation is dissolved, promoting corrosion.

To verify the pH, the top 2 inches of selected cores were cut horizontally in 1-inch sections from the core samples. Each 1-inch section was then crushed into a powder and mixed with distilled water and tested with a pH meter.

The affected depth of carbonation from the surface can be readily shown by the use of phenolphthalein indicator solution. The phenolphthalein indicator solution is applied to the fresh cut surface of the concrete core. If the indicator solution turns purple, the pH is above 10.

The following Table summarizes the results of the pH and Carbonation testing.

<table>
<thead>
<tr>
<th>Location</th>
<th>Tested pH 0”-1”</th>
<th>Tested pH 1”-2”</th>
<th>Depth of Carbonation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core L-1</td>
<td>11.5</td>
<td>11.3</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core L-2</td>
<td>11.4</td>
<td>11.4</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core L-4</td>
<td>11.0</td>
<td>11.4</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core L-6</td>
<td>10.9</td>
<td>11.0</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core D-1</td>
<td>11.2</td>
<td>11.3</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core D-3</td>
<td>11.0</td>
<td>11.2</td>
<td>¼” to ½”</td>
</tr>
<tr>
<td>Core D-4</td>
<td>9.2</td>
<td>11.2</td>
<td>½”</td>
</tr>
<tr>
<td>Core D-5</td>
<td>9.7</td>
<td>10.1</td>
<td>½” to ¾”</td>
</tr>
<tr>
<td>Core D-7</td>
<td>10.8</td>
<td>11.0</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core D-8</td>
<td>10.3</td>
<td>10.7</td>
<td>Surficial</td>
</tr>
<tr>
<td>Core D-9</td>
<td>9.7</td>
<td>10.2</td>
<td>Surficial to ½”</td>
</tr>
<tr>
<td>Core D-10</td>
<td>11.0</td>
<td>10.7</td>
<td>Surficial</td>
</tr>
</tbody>
</table>

The results of the indicator solution suggest that carbonation is minor and ranges from surficial to ½-inch from the surface of the concrete. Beneath the minor zone of carbonation, the pH of the concrete cores remains high and consistent with depth. These characteristics indicate that concrete within the areas explored has not undergone significant chemical attack.

Representative photographs depicting the carbonation testing using the phenolphthalein are included in Appendix II.
Concrete Compressive Strength Testing

The core samples were trimmed and capped in accordance with ASTM C-42 for compressive strength testing. The results of the compressive strength testing are presented in the following table:

<table>
<thead>
<tr>
<th>Location</th>
<th>Original Length (in)</th>
<th>Trimmed and Capped Length (in)</th>
<th>Corrected Compressive Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core L-1</td>
<td>4.60</td>
<td>3.90</td>
<td>4345</td>
</tr>
<tr>
<td>Core L-2</td>
<td>4.49</td>
<td>3.95</td>
<td>4558</td>
</tr>
<tr>
<td>Core L-3</td>
<td>4.75</td>
<td>4.29</td>
<td>3568</td>
</tr>
<tr>
<td>Core L-4</td>
<td>4.44</td>
<td>2.69</td>
<td>4334</td>
</tr>
<tr>
<td>Core L-5</td>
<td>5.24</td>
<td>4.55</td>
<td>3303</td>
</tr>
<tr>
<td>Core L-6</td>
<td>3.96</td>
<td>3.40</td>
<td>3406</td>
</tr>
<tr>
<td>Core D-1</td>
<td>5.25</td>
<td>4.77</td>
<td>4673</td>
</tr>
<tr>
<td>Core D-2</td>
<td>5.15</td>
<td>4.67</td>
<td>4243</td>
</tr>
<tr>
<td>Core D-3</td>
<td>4.61</td>
<td>4.12</td>
<td>3505</td>
</tr>
<tr>
<td>Core D-4</td>
<td>4.98</td>
<td>4.17</td>
<td>2870</td>
</tr>
<tr>
<td>Core D-5</td>
<td>4.78</td>
<td>4.29</td>
<td>2253</td>
</tr>
<tr>
<td>Core D-6</td>
<td>4.74</td>
<td>4.33</td>
<td>3380</td>
</tr>
<tr>
<td>Core D-7</td>
<td>4.59</td>
<td>4.23</td>
<td>4421</td>
</tr>
<tr>
<td>Core D-8</td>
<td>4.90</td>
<td>4.21</td>
<td>3864</td>
</tr>
<tr>
<td>Core D-9</td>
<td>4.33</td>
<td>3.90</td>
<td>4449</td>
</tr>
<tr>
<td>Core D-10</td>
<td>5.31</td>
<td>4.62</td>
<td>3693</td>
</tr>
</tbody>
</table>

The results indicate that the minimum and maximum compressive strengths range from 2,253 to 4,673 psi. Cores D-4 and D-5 are from the spillways and are lower strength than the wall cores.

Chemical Analyses of Water

A water sample collected from the downstream stilling basin was tested for its corrosion properties. Properties tested included pH, resistivity, chloride and sulfate content. The properties and their classification according to the FDOT Structures Design Manual are presented below.
<table>
<thead>
<tr>
<th>Tested Property</th>
<th>Environmental Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride (ppm)</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>Resistivity (ohm-cm)</td>
<td></td>
</tr>
<tr>
<td>Sulfate (ppm)</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>Moderately Aggressive</td>
</tr>
<tr>
<td>Concrete</td>
<td>Slightly Aggressive</td>
</tr>
</tbody>
</table>

40 6.9 3400 <2.4

The environmental classification criteria are based on Table 1.3.2-1 for Substructure Environmental Classification from the Florida Department of Transportation Structural Design Manual dated January, 2012. It is noted that the Florida Department of Transportation Substructures Environmental Classification system includes three categories (i.e.; slightly aggressive, moderately aggressive and extremely aggressive).

CONCLUSIONS AND RECOMMENDATIONS

Based on our visual observations and the results of our field exploration and laboratory testing programs, it is our opinion that the structural integrity of the concrete element of the lock and dam/spillway structures are in “good” general condition and are exhibiting normal physical erosion characteristics typical of hydraulic structures of this age and use. Remediation of the concrete within the water fluctuation zone is not required at this time. The condition of the concrete, considering the years of service, suggests that the concrete should continue to perform for many years before remediation is required. We note that the spillways and then the upstream portion of the dam structure will likely need remediation prior to the downstream dam walls and lock chamber walls which are in considerably better condition relative to pitting and corrosion.

Our observations and testing relative to the steel sheet pile wing walls indicate that the upstream wing walls for both structures are in “very good” condition and that remediation is not needed at this time. However, while the downstream wingwalls are in overall “good” general condition, there are varying degrees of corrosion occurring at the wall joints and tie-back anchor plates due to seepage. The corrosion is surficial now and has not affected the section thickness, but it will over time. Budget should be established for routine, periodic maintenance (corrosion removal and painting). The frequency of the maintenance should be determined based on the recurrence of the corrosion of the joints and tie-back anchor plates.

CLOSURE

The analyses and recommendations submitted herein are based on our observations and on the data obtained from our field and laboratory programs. This report does not reflect any variations which may occur adjacent to or between the test locations, or in the areas that could not be observed.

This report has been prepared for the exclusive use of St. Johns River Water Management District in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.
We are pleased to be of assistance to you on this phase of the project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

[Signature]
Charles H. Cunningham, P.E.
Orlando Branch Manager
Florida License No. 38189

[Signature]
Christopher May, E.I.T.
Assistant Project Engineer

CS/JMP/CHC/ksb
14-6428 Moss Bluff Lock and Dam-Spillway Structures (2014 Geo)
TABLE 1
Summary of Rebound Hammer Data
Moss Bluff Lock and Dam/Spillway
SJRWMD, Marion County, Florida

<table>
<thead>
<tr>
<th>Number Location</th>
<th>Description</th>
<th>Average R-Number</th>
<th>Within Zone of Typical Water Fluctuation</th>
<th>Above Zone of Typical Water Fluctuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-1</td>
<td>Lock - South Wall</td>
<td>2.7</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>L-2</td>
<td>Lock - South Wall</td>
<td>2.5</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>L-3</td>
<td>Lock - South Wall</td>
<td>2.9</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>L-4</td>
<td>Lock - North Wall</td>
<td>2.4</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>L-5</td>
<td>Lock - North Wall</td>
<td>2.3</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>L-6</td>
<td>Lock - North Wall</td>
<td>2.4</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>D-1</td>
<td>Dam Downstream - North Wall</td>
<td>3.4</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>D-2</td>
<td>Dam Downstream - North Wall</td>
<td>2.5</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>D-3</td>
<td>Dam Downstream - North Wall</td>
<td>2.6</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>D-4</td>
<td>Dam Downstream - Spillway</td>
<td>1.0</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>D-5</td>
<td>Dam Downstream - Spillway</td>
<td>1.1</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>D-6</td>
<td>Dam Downstream - South Wall</td>
<td>1.3</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>D-7</td>
<td>Dam Downstream - South Wall</td>
<td>3.4</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>D-8</td>
<td>Dam Downstream - South Wall</td>
<td>1.8</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>D-9</td>
<td>Dam Upstream - South Wall</td>
<td>2.2</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>D-10</td>
<td>Dam Upstream - North Wall</td>
<td>2.3</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lock Average</td>
<td>2.5</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dam Average (Upstream/Downstream)*</td>
<td>2.4/2.5</td>
<td>4.4/3.4</td>
<td></td>
</tr>
</tbody>
</table>

* Does not include spillway cores (D-4 & D-5)
### TABLE 2
Summary of Rebound Hammer Data
Moss Bluff Lock and Dam/Spillway
SJRWMD, Marion County, Florida

<table>
<thead>
<tr>
<th>Location</th>
<th>Core Designation</th>
<th>Length (in)</th>
<th>Rebar Encountered</th>
<th>General Condition/Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lock - South Wall</td>
<td>L-1 A</td>
<td>4.60</td>
<td>No</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td>L-1 B</td>
<td>4.50</td>
<td>No</td>
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Note 1 - Other than surficial erosion, concrete was in good general condition.  No evidence of corrosion observed.
**TABLE 3A**
Ultrasonic Thickness Readings
Steel Sheet Pile Wing Walls
Moss Bluff Lock and Dam/Spillway - Lock Structure (Upstream)
SJRWMD, Marion County, Florida

<table>
<thead>
<tr>
<th>Reading Designation</th>
<th>Wing Wall Average Thickness Reading (inches)</th>
<th>North Lock Wing Wall (Upstream)</th>
<th>South Lock Wing Wall (Upstream)</th>
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<td></td>
<td>1</td>
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<td>A</td>
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<tr>
<td>B</td>
<td>0.392</td>
<td>0.375</td>
<td>0.392</td>
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<tr>
<td>C</td>
<td>0.375</td>
<td>0.382</td>
<td>0.386</td>
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<tr>
<td>D</td>
<td>0.394</td>
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<tr>
<td>E</td>
<td>0.381</td>
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<tr>
<td>F</td>
<td>0.412</td>
<td>0.386</td>
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<td>Maximum Value</td>
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<td>0.424</td>
<td>0.411</td>
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<tr>
<td>Minimum Value</td>
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<td>0.373</td>
<td>0.375</td>
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**PZ-27 Steel Sheet Piling**

**ASTM A572 Grade 50**

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<th>Section</th>
<th>Width (in)</th>
<th>Height (in)</th>
<th>Thickness (in)</th>
<th>Cross Sectional Area (in²/ft)</th>
<th>Pile Weight (lb/ft)</th>
<th>Wall Weight (lb/ft²)</th>
<th>Section Modulus (in³/ft)</th>
<th>Moment of Inertia (in⁴/ft)</th>
<th>Coating Area Both Sides (in²/ft)</th>
<th>Coating Area (in²/m²)</th>
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</thead>
<tbody>
<tr>
<td>PZ-27</td>
<td>18.00</td>
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Approximate Reading Designation Location
TABLE 3B
Ultrasonic Thickness Readings
Steel Sheet Pile Wing Walls
Moss Bluff Lock and Dam/Spillway -Lock Structure (Downstream)
SJRWMD, Marion County, Florida

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PZ-27 Steel Sheet Piling

ASTM A572 Grade 50

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<th>Width w (mm)</th>
<th>Height h (mm)</th>
<th>Thickness tw (mm)</th>
<th>Cross Sectional Area (cm²/m)</th>
<th>Weight Pile (lb/ft)</th>
<th>Wall (lb/ft²)</th>
<th>Section Modulus (in⁴/ft)</th>
<th>Moment of Inertia (in⁶/ft)</th>
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### TABLE 3C
**Ultrasonic Thickness Readings**
**Steel Sheet Pile Wing Walls**
**Moss Bluff Lock and Dam/Spillway - Dam Structure (Upstream)**
**SJRWMD, Marion County, Florida**

<table>
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<th>Reading Designation</th>
<th>Wing Wall Average Thickness Reading (inches)</th>
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<td>North Dam Wing Wall (Upstream)</td>
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### Diagram:

**PZ-27 Steel Sheet Piling**

**ASTM A572 Grade 50**

<table>
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<tr>
<th>Section</th>
<th>Width w (in)</th>
<th>Height h (in)</th>
<th>Thickness tw (in)</th>
<th>Cross Sectional Area (in²/ft)</th>
<th>Pile Weight lb/ft</th>
<th>Wall Weight lb/ft²</th>
<th>Section Modulus in²/ft</th>
<th>Moment of Inertia in⁴/ft</th>
<th>Coating Area Both Sides ft²/m²</th>
<th>Coating Area ft²/m²</th>
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<tbody>
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<td>0.375</td>
<td>11.91</td>
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<td>27.00</td>
<td>36.20</td>
<td>184.20</td>
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<td>1.40</td>
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TABLE 3D
Ultrasonic Thickness Readings
Steel Sheet Pile Wing Walls
Moss Bluff Lock and Dam/Spillway - Dam Structure (Downstream)
SJRWMD, Marion County, Florida

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<th>North Dam Wall (Downstream)</th>
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PZ-27 Steel Sheet Piling

ASTM A572 Grade 50

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<th>Section</th>
<th>Width (in)</th>
<th>Height (in)</th>
<th>Thickness (in)</th>
<th>Cross Sectional Area (in²/ft)</th>
<th>Weight</th>
<th>Pile Exponent (kN/m)</th>
<th>Wall Exponent (kN²/m²)</th>
<th>Section Modulus (in⁴/ft)</th>
<th>Moment of Inertia (in⁴)</th>
<th>Coating Area Both Sides (m²)</th>
<th>Coating Area (m²/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZ-27</td>
<td>18.00</td>
<td>12.00</td>
<td>0.375</td>
<td>11.91</td>
<td>40.50</td>
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<td>30.20</td>
<td>184.20</td>
<td>4.48</td>
<td>1.40</td>
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Approximate Reading Designation Location
APPENDIX I

Photographs Taken August 7, 2014
APPENDIX I
Moss Bluff Lock Structure
SJRWMD, Marion County

Upstream - North Lock Wing Wall.

Upstream - South Lock Wing Wall.
APPENDIX I
Moss Bluff Lock Structure
SJRWMD, Marion County

Downstream - North Lock Wing Wall.

Downstream - South Lock Wing Wall.
APPENDIX I
Moss Bluff Lock Structure
SJRWMD, Marion County

Downstream - South Lock Wing Wall.

Downstream - North Lock Wing Wall.
APPENDIX I
Moss Bluff Lock Structure
SJRWMD, Marion County

Inside Lock - Normal Water Level

Inside Lock - Lowered Water Level.
APPENDIX I
Moss Bluff Lock Structure
SJRWMD, Marion County

Inside Lock - Lowered Water Level

Inside Lock - North Side of Wall at Lowered Water Level
APPENDIX I
Moss Bluff Dam/Spillway Structure
SJRWMD, Marion County

Upstream - North Dam Wing Wall.

Upstream - South Dam Wing Wall.
APPENDIX I
Moss Bluff Dam/Spillway Structure
SJRWMDD, Marion County

Upstream - View of Dam.

Upstream - Dam Center Pier Between Gates.
APPENDIX I
Moss Bluff Dam/Spillway Structure
SJRWMD, Marion County

Downstream - North Dam Wing Wall.

Downstream - South Dam Wing Wall.
APPENDIX I
Moss Bluff Dam/Spillway Structure
SJRWMD, Marion County

Downstream - Spillways.

Downstream - South Dam Wall.
APPENDIX II

Petrographic and Carbonation Examination Photographs
Coarse Aggregate

- White to tan crushed fossiliferous limestone and siliceous limestone.
- Nominal maximum particle size is ¾ inch graded down to ⅛ inch.
- The particles are equidimensional with a sub-rounded to sub-angular texture.
- Volume of coarse aggregate appears reasonable.
- Coarse aggregate relatively well distributed.
- Aggregate paste bond is good.
- No indications of cement-aggregate reactions were noted within the coarse aggregate.

Fine Aggregate

- Natural sand, gray, white and clear quartz.
Report of Petrographic Examination of Concrete (Cont’d.)
Moss Bluff Lock and Dam
Core Sample L3
Page 2 of 6

- Maximum particle size 3/8 inch, graded down to fine sand sizes.
- Particles have sub-rounded texture.
- No indications of cement-aggregate reactions were noted within the fine aggregate.

Matrix (cement paste)
- Paste is light gray in color. Core has a light tan layer at the surface which can be attributed to carbonation which was measured to be <0.01 inch deep at the surface as determined by the application of a phenolphthalein indicator solution.
- Paste moderately hard when scratched with steel point.
- Paste to aggregate bond appears good.

Air Voids
- Air voids are spherical to irregular in shape and are not well distributed, visually estimated at 1.5 ± 1 percent.

Surface
- The surface of the samples is coarse and eroded.

Cracking
- A crack was observed extending longitudinally through one side of the core for approximately 2 inches. Near the surface of the core the crack transitions to a transverse direction.

Embedded Items
- No embedded reinforcing steel was observed in the sample.

Conclusions:
1. Quality of concrete is relatively good.
2. The paste is moderately hard to hard when scratched with a steel point.
3. Concrete is not air entrained but does contain entrapped air.
4. The exposed surface of the core is showing signs of erosion.

William R. Goodson, PE
Senior Materials Engineer
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Photo 2 – End view. Note eroded surface of concrete.

Photo 3 – Sample as cut longitudinally and polished for observation. Note crack extending longitudinally through samples and transitioning to transverse direction.
Photo 4 – Close-up view of crack.

Photo 5 – Magnified view of crack, note crack does not extend through coarse aggregate.
Photo 6 – Magnified view of crack, note crack. Crack transitioning from longitudinal to transverse direction within core sample

Photo 7 – Polished section showing zone of tan colored paste at surface. Application of a phenolphthalein indicator solution confirms the tan zone to be carbonated.
Photo 8 – Entrapped air voids at side of core sample.
Core L5

Coarse Aggregate
- White to tan crushed fossiliferous limestone and siliceous limestone.
- Nominal maximum particle size is ¾ inch graded down to ¼ inch.
- The particles are equidimensional with a sub-rounded to sub-angular texture.
- Volume of coarse aggregate appears reasonable.
- Coarse aggregate relatively well distributed.
- Aggregate paste bond is good.
- No indications of cement-aggregate reactions were noted within the coarse aggregate.

Fine Aggregate
- Natural sand, gray, white and clear quartz.
• Maximum particle size ⅛ inch, graded down to fine sand sizes.
• Particles have sub-rounded texture.
• No indications of cement-aggregate reactions were noted within the fine aggregate.

Matrix (cement paste)
• Paste is light gray in color. Core has a surficial layer of carbonation as determined by the application of a phenolphthalein indicator solution.
• Paste moderately hard when scratched with steel point.
• Paste to aggregate bond appears good.

Air Voids
• Air voids are spherical to irregular in shape and are not well distributed, visually estimated at 2.0 ± 1 percent.

Surface
• The surface of the samples is coarse and eroded.

Cracking
• No cracking was observed in the sample.

Embedded Items
• No embedded reinforcing steel was observed in the sample.

Conclusions:
1. Quality of concrete is relatively good.
2. The paste is moderately hard to hard when scratched with a steel point.
3. Concrete is not air entrained but does contain entrapped air.
4. The exposed surface of the core is showing signs of erosion.

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Ardaman & Associates, Inc.
Photo 2 – End view. Note eroded surface of concrete.

Photo 3 – Sample as cut longitudinally and polished for observation. Note crack extending longitudinally through samples and transitioning to transverse direction.
Photo 4 – Polished section with application of a phenolphthalein indicator solution. Carbonation is negligible.

Photo 5 – Magnified view of surface.
Photo 6 – Entrapped air voids.

Photo 7 – Polished section showing zone of tan colored paste at surface. Application of a phenolphthalein indicator solution confirms the tan zone to be carbonated.
Report of Petrographic Examination of Concrete

ASTM C-856

Project: Moss Bluff Lock and Dam
Date: August 21, 2014

Location: Jacksonville
Client: SJRWMD
Project No. 14-60-6428

Sample Nos. D2
Sample Size: 2½ in. wide, 5 in. long

Core D2

Coarse Aggregate
- White to tan crushed fossiliferous limestone and siliceous limestone.
- Nominal maximum particle size is ¾ inch graded down to ¼ inch.
- The particles are equidimensional with a sub-rounded to sub-angular texture.
- Volume of coarse aggregate appears reasonable.
- Coarse aggregate relatively well distributed.
- Aggregate paste bond is good.
- No indications of cement-aggregate reactions were noted within the coarse aggregate.

Fine Aggregate
- Natural sand, gray, white and clear quartz.
Maximum particle size ⅛ inch, graded down to fine sand sizes.
- Particles have sub-rounded texture.
- No indications of cement-aggregate reactions were noted within the fine aggregate.

Matrix (cement paste)
- Paste is light gray with some isolated zones of darker gray paste surrounding some coarse aggregate pieces. The darker paste may be a result of retempering of the mix or the intermixing of two loads of concrete during the placement. Core has a light tan layer at the surface which can be attributed to carbonation which was measured to be on the order of 0.2 inch deep at the surface as determined by the application of a phenolphthalein indicator solution.
- Paste moderately hard when scratched with steel point.
- Paste to aggregate bond appears good.

Air Voids
- Air voids are spherical to irregular in shape and are not well distributed, visually estimated at 1.5 ± 1 percent.

Surface
- The surface of the samples is coarse and eroded.

Cracking
- No cracking observed.

Embedded Items
- No embedded reinforcing steel was observed in the sample.

Conclusions:
1. Quality of concrete is relatively good.
2. The paste is moderately hard to hard when scratched with a steel point.
3. Concrete is not air entrained but does contain entrapped air.
4. The exposed surface of the core is showing signs of erosion and loss.

William R. Goodson, PE
Senior Materials Engineer
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Photo 2 – End view. Note eroded surface of concrete.

Photo 3 – Sample as cut longitudinally and polished for observation. Note zones of darker paste observed around some aggregate pieces.
**Photo 4** – Magnified view of darker paste as it transition into lighter paste.

**Photo 5** – Magnified view of core surface, scale = 0.01 inch. It appears that at least 0.1 inches of surface loss has occurred. Note tan paste below exposed aggregate piece indicating carbonated paste.
Photo 6 – Magnified view of core surface, scale = 0.01 inch. It appears that surface on the order of 0.2 inches has occurred.

Photo 7 – Entrapped air void.
Photo 8 – Polished section showing zone of tan colored paste at surface. Application of a phenolphthalein indicator solution confirms the tan zone to be carbonated.
Project: Moss Bluff Lock and Dam  
Date: August 21, 2014  
Location:  
Client: SJRWMD  
Project No. 14-60-6428  
Sample Nos. D6  
Sample Size: 2 ½ in. wide, 4 ½ in. long  

**Coarse Aggregate**
- White to tan crushed fossiliferous limestone and siliceous limestone.
- Nominal maximum particle size is ¾ inch graded down to ¼ inch.
- The particles are equidimensional with a sub-rounded to sub-angular texture.
- Volume of coarse aggregate appears reasonable.
- Coarse aggregate relatively well distributed.
- Aggregate paste bond is good.
- No indications of cement-aggregate reactions were noted within the coarse aggregate.

**Fine Aggregate**
- Natural sand, gray, white and clear quartz.
Maximum particle size ⅛ inch, graded down to fine sand sizes.
- Particles have sub-rounded texture.
- No indications of cement-aggregate reactions were noted within the fine aggregate.

Matrix (cement paste)
- Paste is light gray in color. Core has a light tan layer at the surface which can be attributed to carbonation which was measured to be on the order of 0.2 inch deep at the surface as determined by the application of a phenolphthalein indicator solution.
- Paste moderately hard when scratched with steel point.
- Paste to aggregate bond appears good.

Air Voids
- Air voids are spherical to irregular in shape and are not well distributed, visually estimated at 1.5 ± 1 percent.

Surface
- The surface of the samples is coarse and eroded.

Cracking
- No cracking observed.

Embedded Items
- No embedded reinforcing steel was observed in the sample.

Conclusions:
1. Quality of concrete is relatively good.
2. The paste is moderately hard to hard when scratched with a steel point.
3. Concrete is not air entrained but does contain entrapped air.
4. The exposed surface of the core is showing signs of erosion.

William R. Goodson, PE
Senior Materials Engineer
Florida License 37935
Photo 2 – End view. Note eroded surface of concrete.

Photo 3 – Sample as cut longitudinally and polished for observation.
Photo 4 – Typical coarse aggregate piece. Scale at bottom of photo = 0.01 inch.

Photo 5 – Magnified view of core surface, scale = 0.01 inch. Tan paste directly at surface is carbonated.
Photo 6 – Magnified view of core surface, scale = 0.01 inch. Tan paste directly at surface is carbonated.

Photo 7 – Polished section showing zone of tan colored paste at surface. Application of a phenolphthalein indicator solution confirms the tan zone to be carbonated.
Entrapped Air Voids

Photo 8 – Entrapped air voids at side of core sample.

Entrapped Air Void

Photo 9 – Entrapped air void.