From:	Michael Ellis
To:	Mark Miller; Lynn Werkheiser
Cc:	Derek Davis; Erika Addison; Ross Stuart; Chris J. Carbone; Nathan M. Cline; Matthew McAloon; Ridley STP Lab; SCOTT TOWLER
Subject:	DRAFT SBR Tank #1 Inspection Report
Date:	Thursday, August 7, 2025 11:45:31 PM
Attachments:	ATT00001.png EGMAU25001 SBR Tank #1 Structural Assessment Draft compressed.pdf

Hi Mark and Lynn,

Attached is the subject report from our recent tank inspection for your review and for inclusion in the MA packet for Monday. It includes copies of prior Tank #1 inspection reports over the past several years to provide background reference also so it is a large document.

I suggest we set up a call or field visit with Mark and Matthew Mullin and/or Scott to discuss recommended repairs. We can then determine how to proceed with repairs and we can finalize the report accordingly. I'll reach out to see everyone's availability for next week.

In the meantime, I will provide a quick overview of the observations and recommendations to the MA at Monday's meeting.

Mike

Michael Ellis, PE
Municipal Division Manager

Pennoni
Christiana Executive Campus, 121 Continental Drive, Suite 207 | Newark, DE 19713
Direct: +1 302-351-5236 | **Mobile:** +1 302-561-4235
www.pennoni.com | MEllis@Pennoni.com

What's Possible Podcast Episode 2

Memorandum DRAFT

TO:	Michael Ellis
FROM:	Chris J. Carbone, P.E. Ross E. Stuart, P.E., S.E.
DATE:	July 9, 2025
RE:	East Goshen Municipal Authority Sequencing Batch Reactor (SBR) Tank #1
SUBJECT:	**Structural Assessment Memo**

The following memo summarizes the structural assessment of the existing Sequencing Batch Reactor (SBR) Tank #1 located at the Ridley Creek Sewage Treatment Plant (RCSTP) in East Goshen Township, Pennsylvania. The assessment was performed as part of semi-yearly structural condition assessments that are performed to document the interior conditions of the tank drained for maintenance purposes at the time of the site visit. Pennoni performed a site visit on June 25th, 2025 to conduct a visual condition assessment of the exterior and interior of SBR Tank #1, as part of a semi-yearly structural assessment of the SBR tanks. Pennoni has performed semi-yearly assessments since the construction of the tanks in 2009. Initial structural assessments for each tank have been issued in report format, while additional assessments have been documented in memo format. The previous assessment documents issued by Pennoni are listed below.

Date Issued	SBR Tank Assessed	Report Type
5/26/2021	Tank #1	SBR Tank Assessment Memo
10/12/2020	Tank #3	SBR Tank Assessment Report
10/28/2019	Tank #2	SBR Tank Assessment Memo
8/21/2018	Tank #2	SBR Tank Assessment Report
11/10/2017	Tank #1	Overall Assessment Report (w/ Petrographic Analysis)

Included in the Appendix of this memo are **Appendix A: Field Notes**, **Appendix B: Structural Photographs**, **Appendix C: 2021 SBR Tank #1 Structural Assessment Memo,** and **Appendix D: 2017 SBR Tank #1 Structural Assessment Report.**

OBSERVATIONS

This memo is intended to identify deficient conditions that have developed since the last assessment of SBR Tank #1. The following observations and conclusions are referenced to the same numbering system that was used in the referenced previous Pennoni memo and report, to assist with coordinating the different assessments. Refer to **Appendix A** and **Appendix B** for field notes and photographs corresponding to the observations.

1. At a few locations, blisters were observed in the CIM coating at the floor and wall surfaces, and when applied with pressure, were filled with air and/or fluid. The observed blisters in the coating are consistent with those described in the previous memo.

2. Alligator cracking at vertical joints consistent to what was reported in both previous assessments was again observed.

3. Deterioration in the cementitious skim coating similar to what was reported in 2021 was observed throughout the coating.

4. No spalls were observed as previously documented. It appeared that repairs have been made.

5. The frequency and size of the previously observed horizontal hairline cracks in the exterior ribs of SBR Tank #1 appears to have remained the same.

6. The spall observed in the previous report at the exterior of SBR #4 was not observed due to overgrown vegetation.

7. No efflorescence was observed.

8. Joint sealant deterioration was observed in the exterior of the tanks in a similar state.

Observations A-D were documented in the 2021 memo as additional observations to the preliminary 2017 report items. Items D-E are new additional observations from the latest 2025 assessment.

A. Steel corrosion was once again observed at the iron pipe and mixing arm connections near the bottom of the tank.

B. Deteriorated patches in the walking surface of the top of the tanks were still present as previously documented.

C. No locations of orangish-brown colored deposits were observed.

D. As previously observed, deterioration of the concrete was observed above the CIM coating. Exposed aggregate could be seen at these same locations.

E. The supports for the guide rails for the pump at the northeast corner of Tank #1 were observed deflected upward. Of the lower two guard rails, one was observed lodged against the bottom of the middle support, displaced from the support, while the other was observed missing altogether. At the top support, the horizontal components holding the upper rails in place were observed bent to a diagonal orientation.

F. At one location, the washer of an anchor bolt was observed with steel corrosion, leaving rust stains on surrounding material.

ANALYSIS, CONCLUSIONS, & RECOMMENDATIONS

The analysis, conclusions and recommendations of the existing structure reference the same numbered order as that used in the previous section of the report in order to facilitate coordination between the report sections.

As stated in the previous memo and report, while conditions may appear similar to that documented in the initial 2017 assessment of SBR #1, a direct correlation to the previous material testing results is not possible in the absence of similar additional material testing. Therefore, recommendations #1, #2, #5, and #6 provided in the November 2017 report are still valid, and summaries are provided below.

1. As noted in the 2021 Memo Report, the original CIM coating was removed and replaced in the same locations following the 2017 Report. As previously discussed, the cause of the blistering of the CIM 1000 coating is unclear, but factors contributing to the observed deficiencies include; moisture in the concrete, temperature conditions during application, improper installation/ surface preparation, and cracking of tank walls due to inadequate design of crack control reinforcement.

   While Pennoni continues to recommend full removal of the existing coating and reinstallation with full coverage along all the floor and wall surfaces below the water line in order to maximize the life of the structure, localized repairs continue to appear to be an effective short term remediation. In lieu of full reapplication, Pennoni recommends the removal of the existing coating at locations where blisters are present, and application of a localized coating repairs. Pennoni also recommends that each tank is assessed more frequently for blisters in the CIM coating, as Tank #4 has never been assessed by Pennoni, and Tank #3 has only been assessed once.

2. The discoloration and "alligator" cracking observed at the CIM coating appears to be the result of the coating's age and exposure to ultraviolet radiation, however, as noted in Pennoni's 2017 Report, there is no adverse effect to the function and performance of the membrane. If coatings are removed for reinstalment with full coverage, as recommended in item #1, Pennoni recommended replacement of joints prior to reapplication of the new coating.

3. The deteriorated skim coat observed at the vertical wall surfaces within the tank is more than likely the result of chemical attack and poor skim coat application, see 2017 Report for more information. Based on the extent of deterioration of the existing skim coating it is recommended that the coating be removed for application of a new CIM coating as recommended in item #1.

4. No action required.

5. The monitoring of the hairline cracks should continue as previously recommended.

6. If concrete spall is still present, spall repairs should be performed.

7. No action required.

8. There is no evidence that the sealants have ever been replaced or repaired. Therefore, the sealant material has more than likely been in service for approximately 16 years. Most sealants are capable of providing a 10 to 15-year lifespan before replacement is required, therefore the sealant material has exceeded its useful lifespan and should be replaced.

A. The corrosion on the iron components at the base of SBR #1 is likely caused by the harsh wastewater environment, which accelerates rust formation due to high levels of dissolved oxygen and solids. Steel will readily react with oxygen to form iron oxide (i.e., rust). Normally this reaction is a slow process, particularly when the exposure conditions are controlled, such as the interior of a conditioned building that provides stable temperatures and low humidity. However, the wastewater environment increases the rate of corrosion, resulting in significant loss of cross-sectional area as the steel is converted into rust.

Therefore, it is recommended that the pipes and fittings be cleaned of all latent rust and evaluated for section loss by comparing the thickness of the remaining material against original condition. After the evaluation is completed, it can be determined if additional repairs or replacement (possibly with stainless steel or FRP components if available) is required, or if the pipes and fittings can be re-coated to maximize the lifespan and serviceability of the SBR tank.

B. The exact cause of the deterioration at the concrete patches is unclear. It is recommended that these repairs are repaired using a more durable material to prevent further damage due to freeze/ thaw conditions.

C. No action required.

D. The deterioration observed in the concrete is more than likely due to an acid attack. When hydrogen sulfide is present, sulfuric acid can be formed when the hydrogen sulfide reacts with oxygen. This occurs near, and slightly above the water level in wastewater tanks. The deterioration of the concrete by acids, as previously mentioned is primarily the result of the reaction with calcium compounds that are leached away by the water in the tanks, which results in exposed surface aggregates that can be observed when the tank is drained. Pennoni recommends that when a new coating is applied, as recommended in item #1, the coating is placed above the water line around all walls of the structure.

E. It is unclear if the observed damage is the result of normal use of the guide rails, or if the damage is due to a localized event. The guide rail supports should be removed and replaced with more robust supporting elements, and the guide rails reinstalled.

F. It does not appear that the washer is stainless-steel as are the other steel elements at the connection, and therefore the observed corrosion is due to exposure to moisture and lack of adequate surface protection. The rusted washer should be removed and replaced with a stainless-steel washer.

LIMITATIONS

Recommendations provided in this letter are narrative in nature, commensurate with the level of effort associated with a limited visual condition assessment and not intended to be used for the solicitation of bids or execution of repair work. Therefore, Pennoni cannot be held responsible for the implementation of repairs based on this letter alone. If requested, Pennoni can provide a proposal for services beyond the preparation of a structural evaluation letter, such as the design and documentation of repairs, bid phase services or construction phase services (i.e. RFI review, submittal review, oversight).

The evaluation of existing structures requires that certain assumptions be made regarding the existing conditions. Some of these assumptions may not be confirmed without performing additional invasive investigation and/or altering/destroying otherwise adequate or serviceable portions of the structure. Therefore, Pennoni cannot be held responsible for any latent deficiencies which may exist in the structure, but which have not been discovered as a part of the scope of this evaluation.

The opinions and recommendations in this report are based solely on the information provided by the field observations and our engineering experience. The report does not address any other portion of the structure other than those areas mentioned, nor does it provide any warranty, either expressed or implied, for any portion of the existing structure.

Please contact us if you have any further questions or comments.

Sincerely,

PENNONI ASSOCIATES INC.

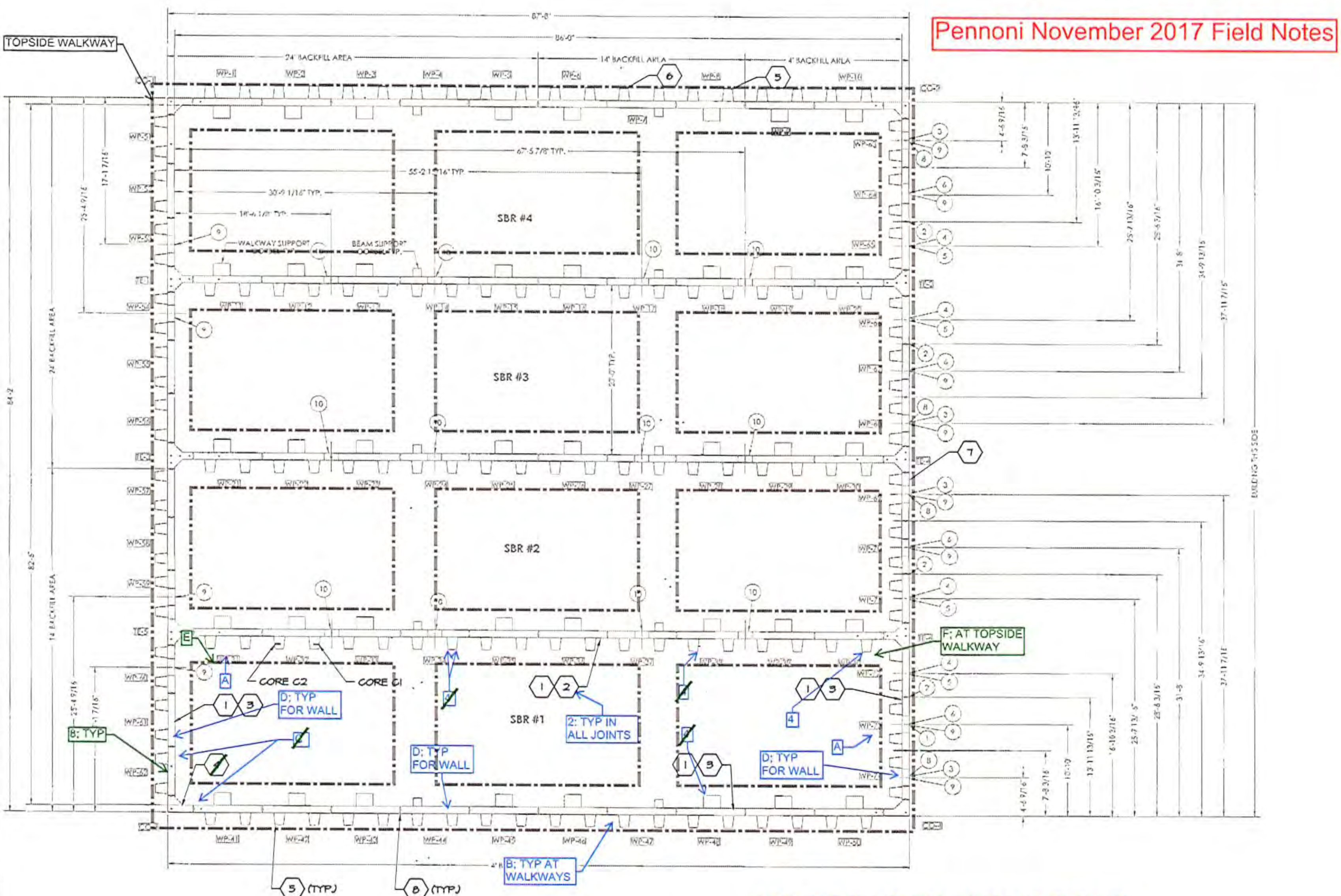
Ross E. Stuart, P.E., S.E.
Associate Vice President, Structural Division Manager

Chris J. Carbone, P.E.
Staff Structural Engineer

\\pennoni.com\data\Accounts\EGMAU\EGMAU25001 - 2025 General Services\DOCUMENTS\SBR Tank #1 Structural Assessment\EGMAU25001 SBR Tank #1 Structural Assessment.docx

Appendix A:

Field Notes



* BLUE CALL OUTS = 2021 ADDITIONS

* GREEN CALL OUTS= 2025 ADDITIONS

FLOOR PLAN

SCALE: 1/8" = 1'-0"

NOTES:
(#) DENOTES THE OBSERVATION NUMBER REFERENCED IN THE STRUCTURAL ASSESSMENT REPORT.

Pennoni
PENNONI ASSOCIATES INC.
1900 Market Street, Suite 300
Philadelphia, PA 19103
T 215.222.3000 F 215.222.3588

SBR TANK STRUCTURAL ASSESSMENT
RIDLEY CREEK WASTEWATER TREATMENT PLANT
1751 TOWNE DRIVE
WEST CHESTER, PA 19380

SBR TANK OBSERVATIONS

EAST GOSHEN MUNICIPAL AUTHORITY
1580 PAOLI PIKE
WEST CHESTER, PA 19380

DATE	NO.	REVISIONS	BY

PROJECT		EGMA1705
DRAWN BY JBB	DATE 9/22/2017	APPROVED MBW
BUILDING	FLOOR	AREA
FLOOR PLAN		
SK-1		
SCALE AS NOTED	SHEET 1 OF 1	REV

Pennoni

Appendix B:

Photography

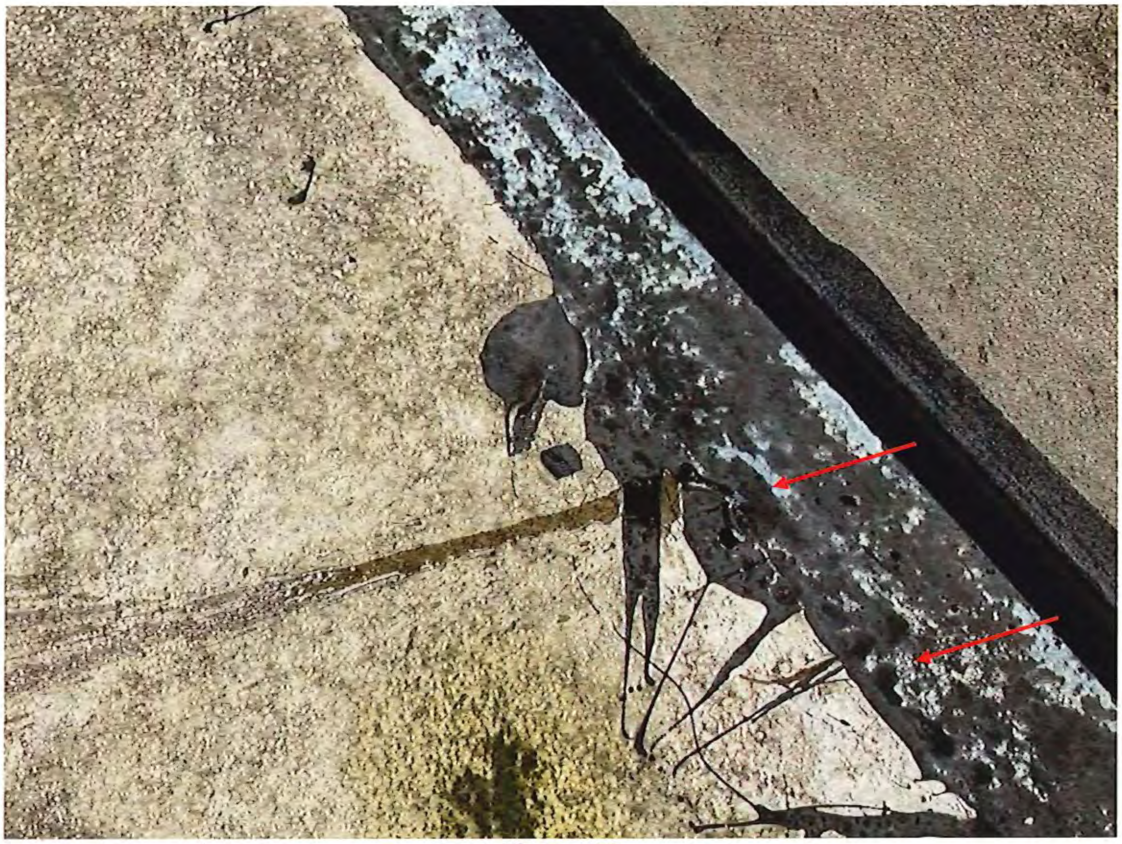


Photo #1A

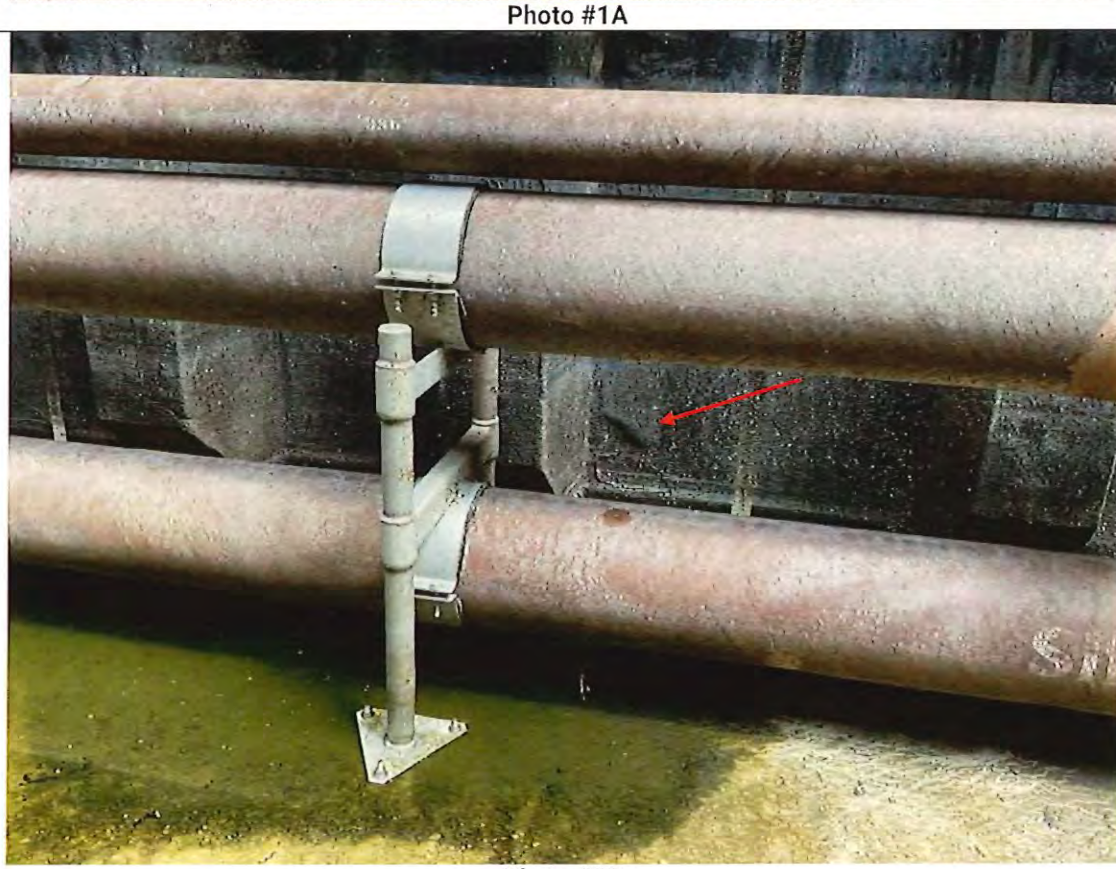


Photo #1B

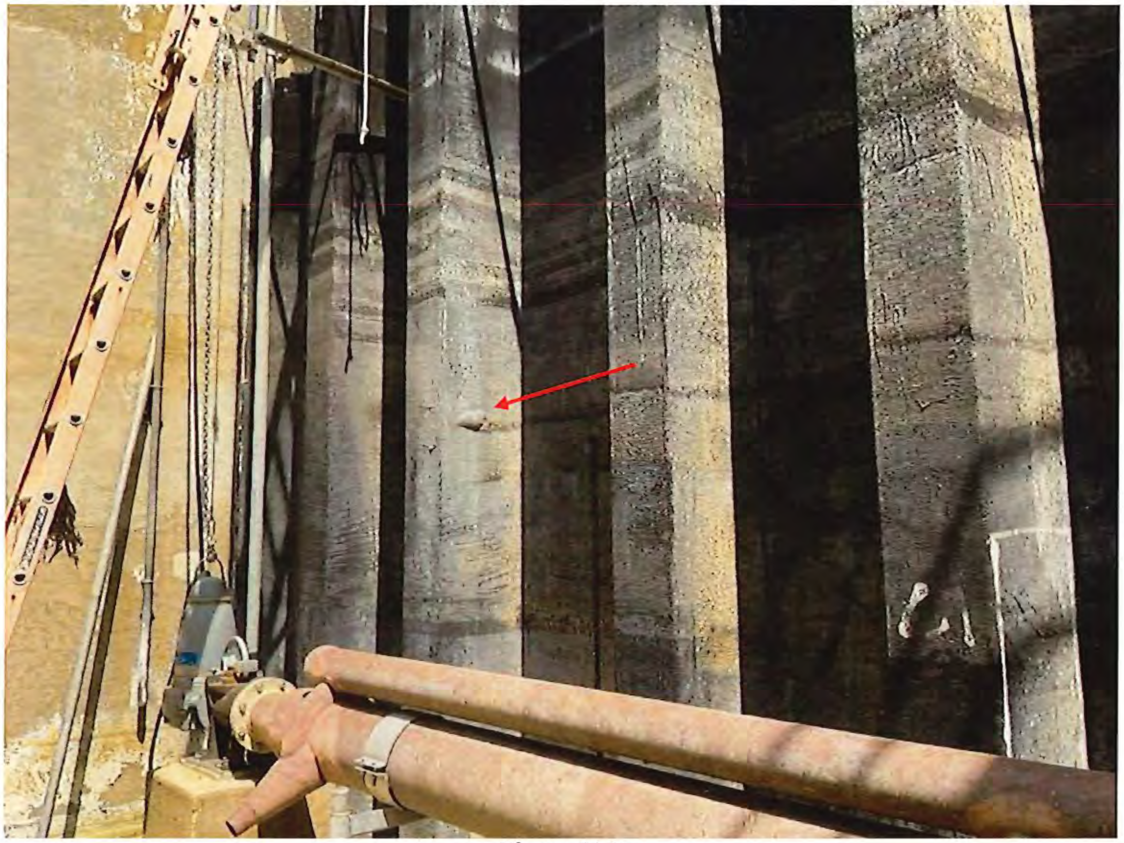


Photo #1C

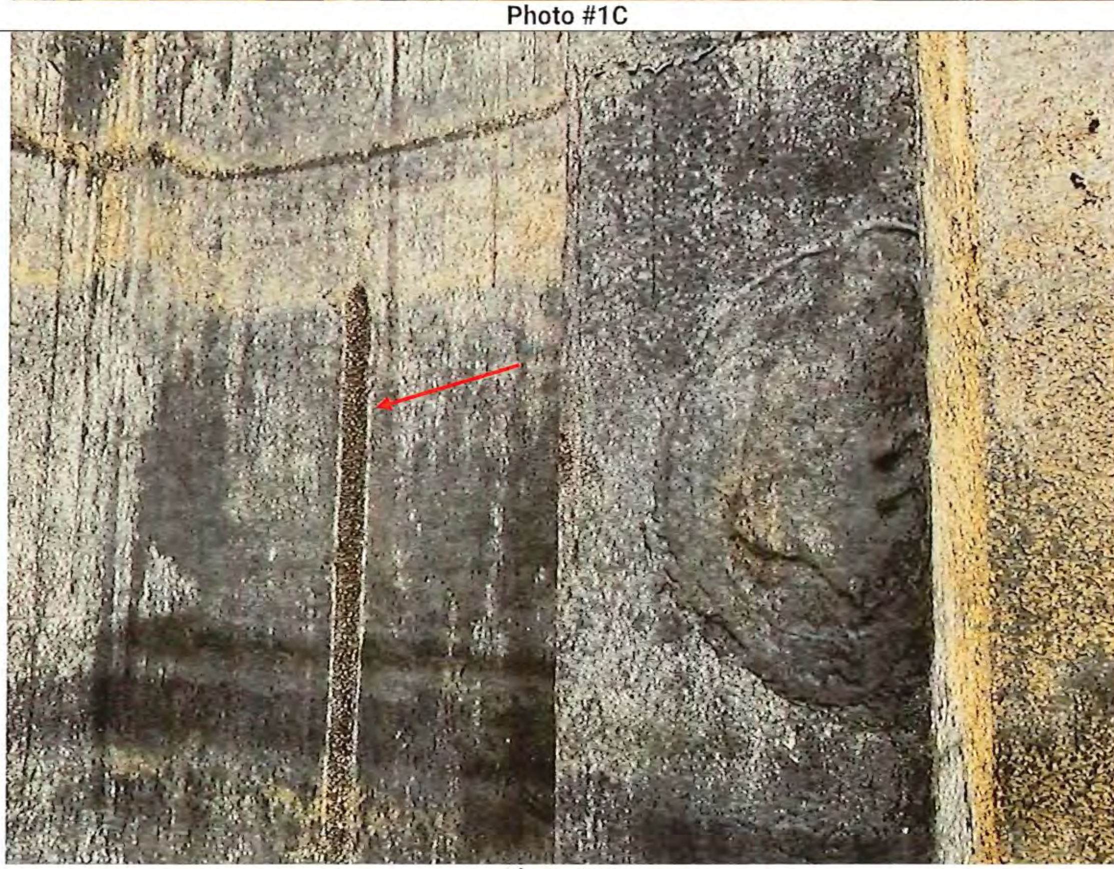


Photo #2A

Photo #2B

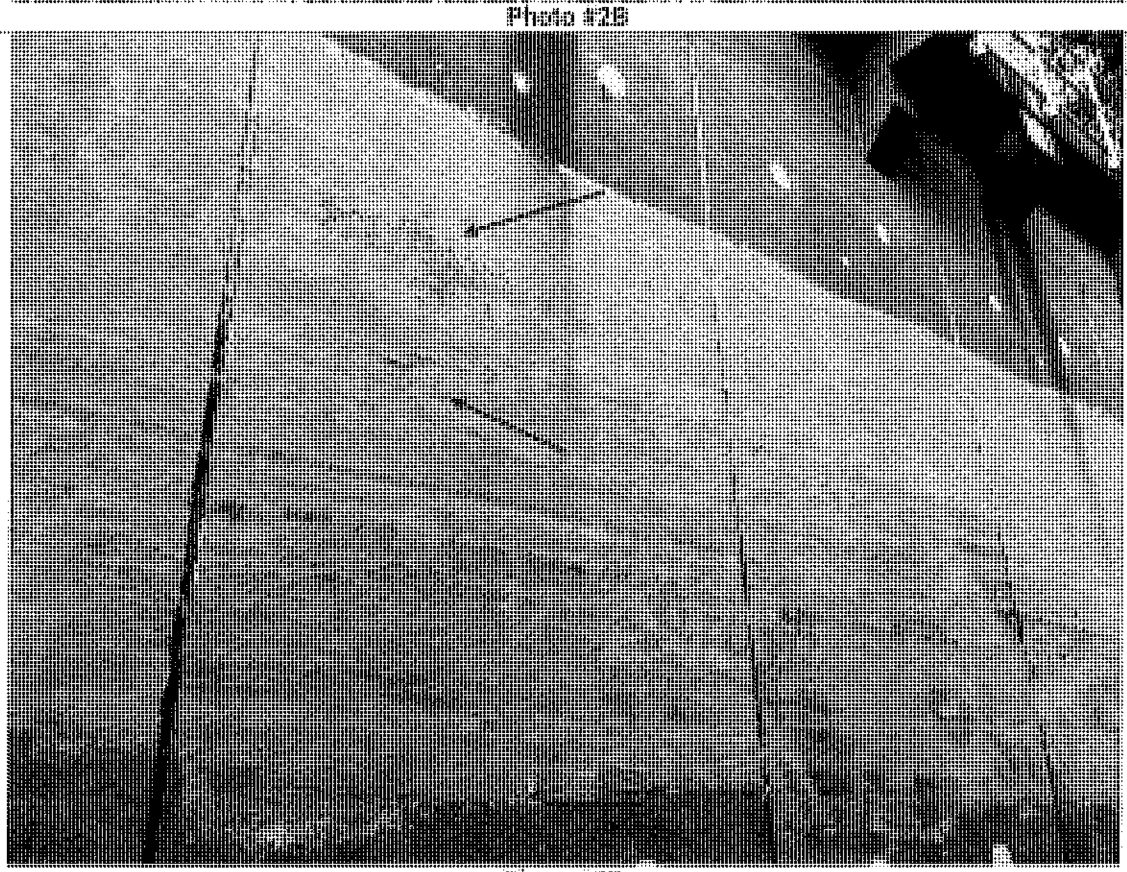


Photo #3B

Photo #3B

Photo #3C

N/A

Photo #4

Photo #5A

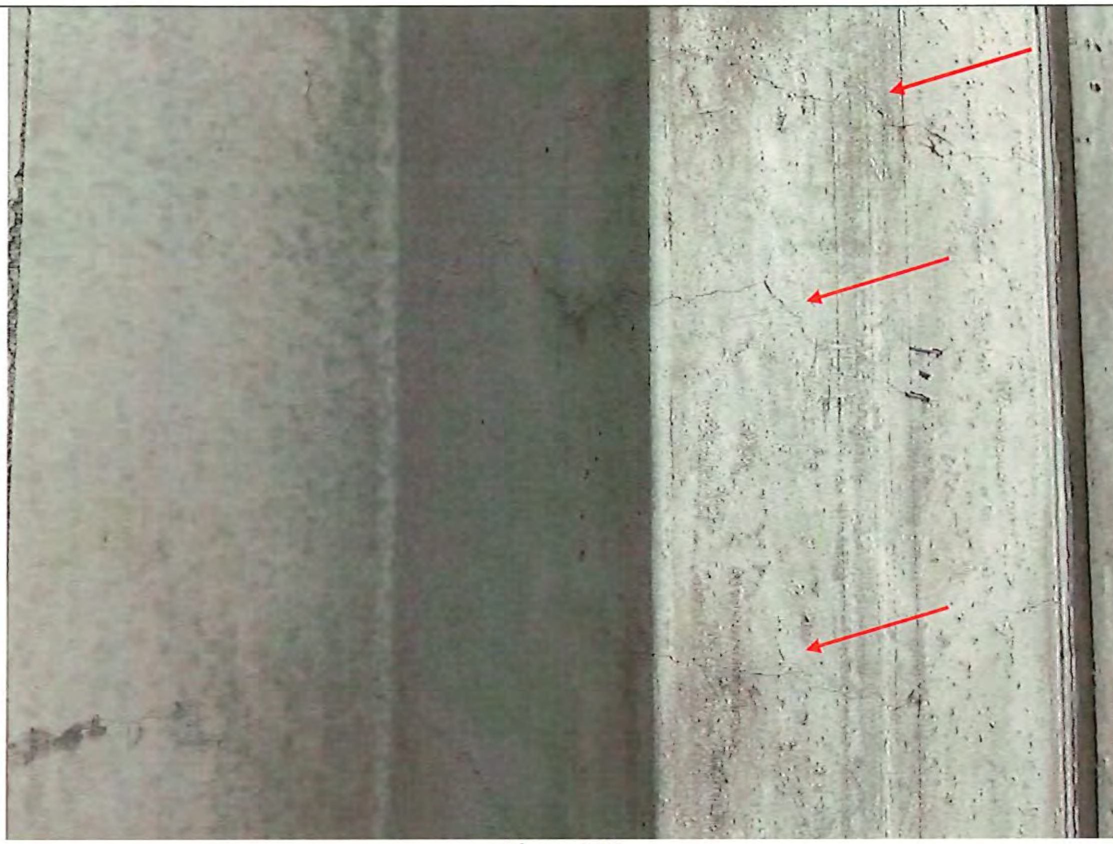


Photo #5B

N/A

Photo #6

N/A

Photo #7

Photo #8A

Photo #8B

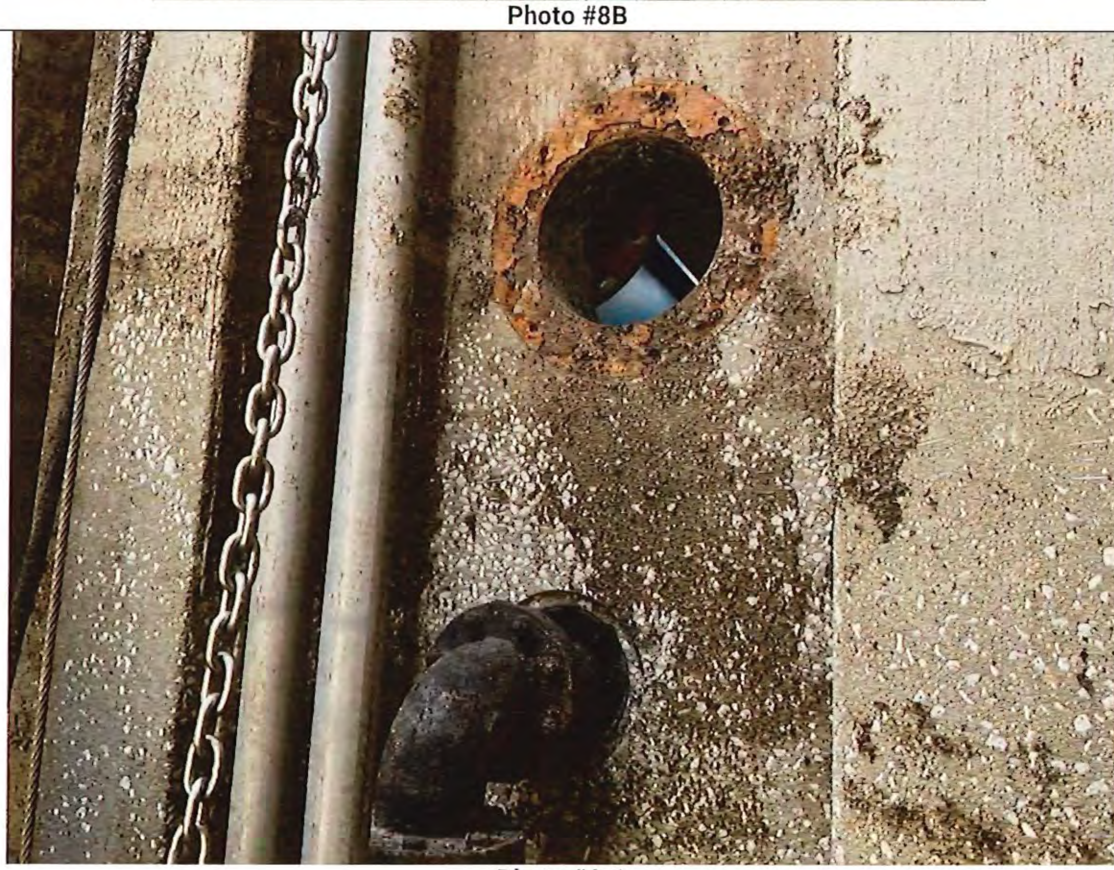


Photo #A.1

Photo #A.2

Photo #B

N/A

Photo #C

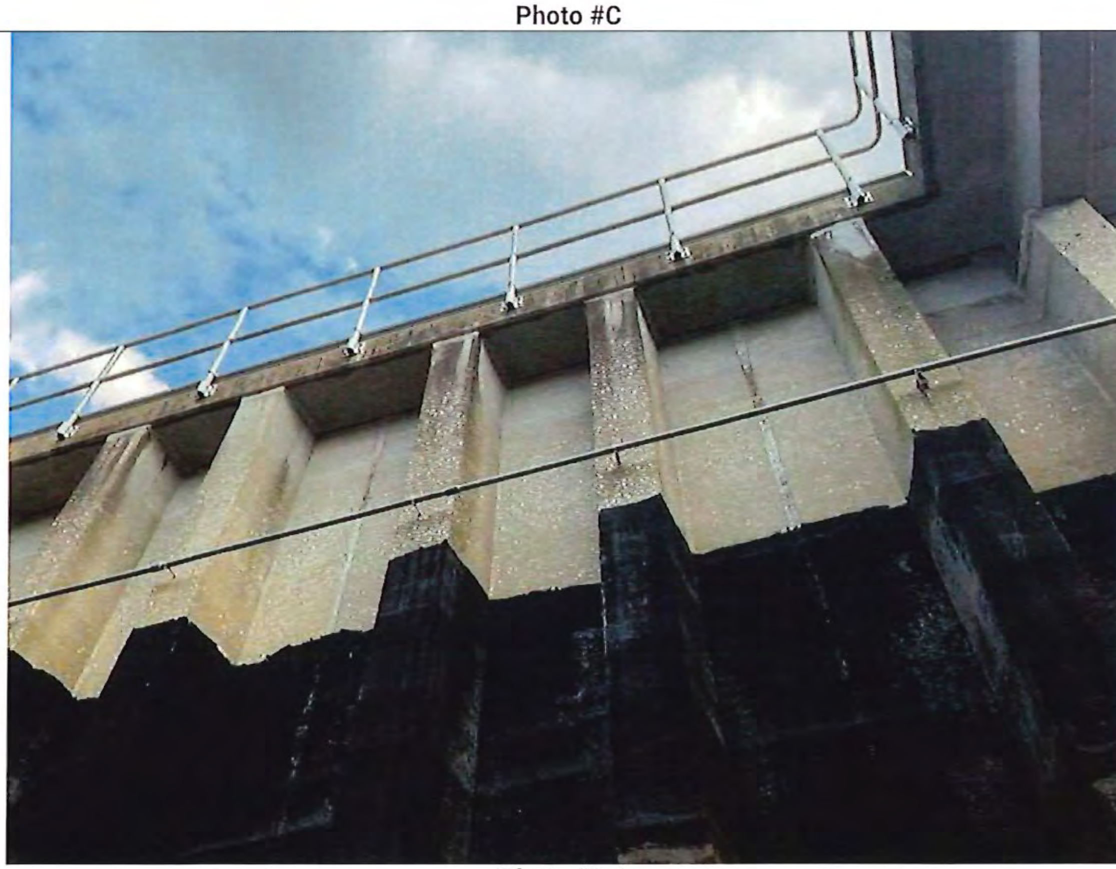


Photo #D.1

Photo #D.2

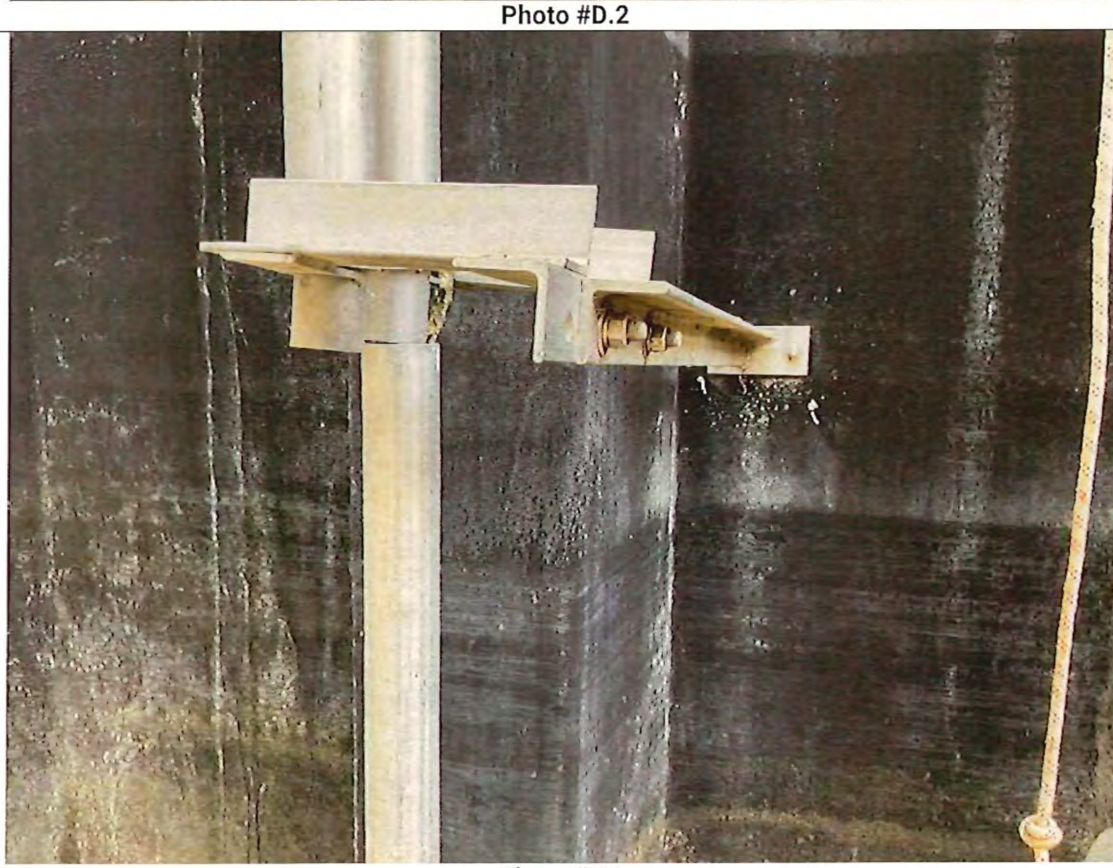


Photo #E.1

Photo #E.2

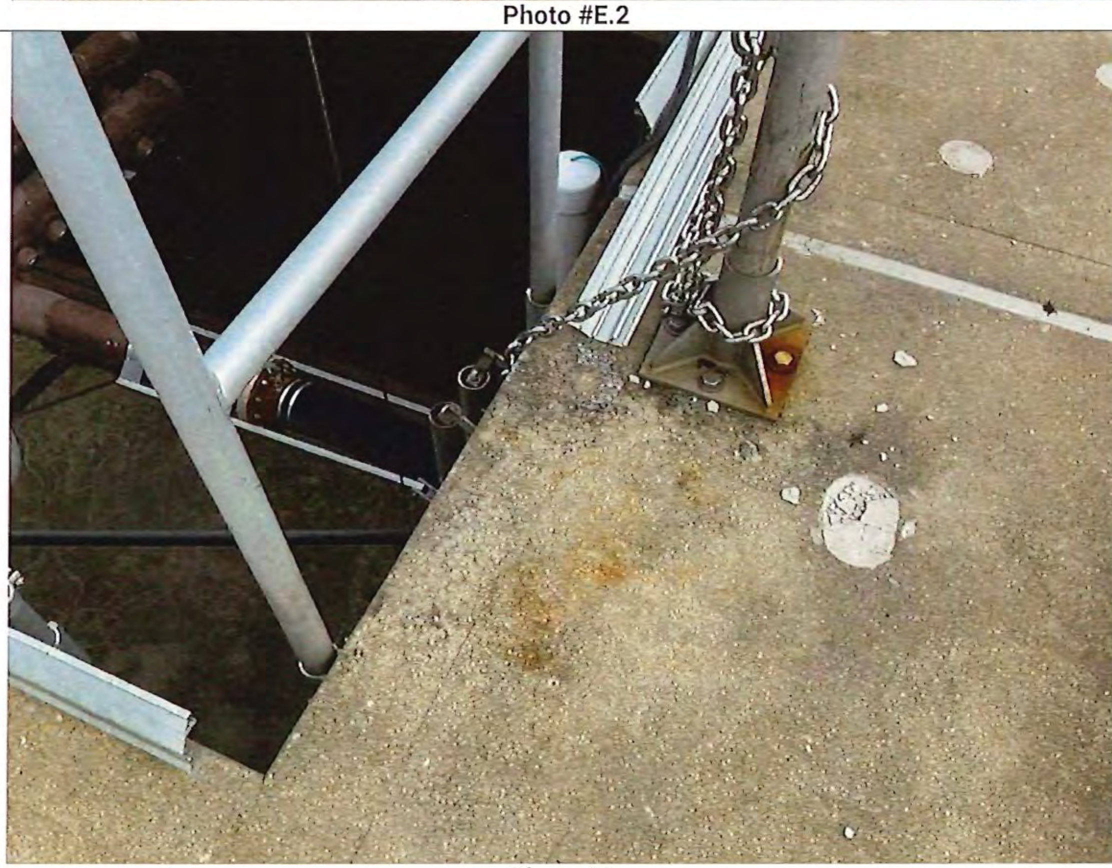


Photo #F

Pennoni

Appendix C:

2021 SBR Tank #1

Structural Assessment Memo

1900 Market Street, Suite 300
Philadelphia, PA 19103
T: 215-222-3000
F: 215-222-3588

www.pennoni.com

MEMORANDUM

TO: Michael Ellis

FROM: Chris J. Carbone, EIT
D. Matthew Stuart, P.E., S.E., P.Eng, F.ASCE, F.SEI, A.NAFE, SECB

DATE: May 26, 2021

RE: East Goshen Municipal Authority
Sequencing Batch Reactor (SBR) Tank #1

SUBJECT: Structural Assessment Memo

Pennoni performed a site visit on May 5th, 2021 to conduct a visual condition assessment of the exterior and inside of SBR Tank #1. A previous site visit was performed on August 23, 2017, and a subsequent report of the investigation was issued on November 10th, 2017 (see attached).

This memo is intended to identify deficient conditions that have developed since the last assessment. The following observations and conclusions are referenced to the same numbering system that was used in the referenced previous Pennoni report, to assist with coordinating the two different assessments. Referenced **Photos** and **Field Notes** associated with this more recent assessment are attached to this memo.

1. Pennoni was informed that following the previous 2017 assessment, the existing CIM coating was removed and repaired, and a new coating was applied to the same areas as described in the previous report. At the areas where cores had been taken for material testing, it was also observed that the concrete had been repaired and covered with a thickened CIM patch. Unfortunately, a reoccurrence of the same deficient conditions, including fluid and air filed bubbles, were observed throughout the coating as described in the previous report (see **Photo 1**).

2. Alligator cracking similar to what was reported in 2017 was observed (see **Photo 2**).

3. Deterioration in the cementitious skim coating similar to what was reported in 2017 was observed throughout the coating (see **Photo 3A & 3B**).

4. The spalling discussed in the previous report was still present with several new spalls observed (see **Photo 4** and **Field Notes** for locations).

5. The frequency and size of the previously observed horizontal hairline cracks appears to have remained the same.

6. The spall observed in the previous report at the exterior of SBR #4 was still present.

7. No efflorescence was observed, and it is unclear if the residue observed previously was intentionally cleaned off or dissipated on its own.

8. Joint sealant deterioration was observed in the exterior of the tanks (see **Photo 5)**.

Additional observations documented that were unrelated to the 2017 report include the following items.

A. Corrosion was observed at the iron pipe and mixing arm connections near the bottom of the tank (see **Photo A**).

B. Deteriorated patches in the walking surface of the top of the tanks were observed (see **Photo B**).

C. Orangish-brown colored deposits were observed in an apparent intentional spacing. One of these locations were scratched off revealing no apparent steel corrosion beneath (see **Photo C1, C2, C3**).

D. Deterioration of the concrete was observed above the CIM coating. Exposed aggregate could be seen at these same locations (**Photo D**)

RECOMMENDATIONS

As stated in the previous report, while conditions may appear similar to that documented in the previous assessment of SBR #1, a direct correlation to the previous material testing results is not possible in the absence of similar additional material testing. Therefore, recommendations #1, #2, #5, and #6 provided in the November 2017 report are still valid, and additional recommendations from the most recent visit are provided below:

3. Based on the extent of deterioration of the existing coating it is recommended that the coating be removed, the surface properly prepared, and the new CIM 1000 coating be applied throughout all walls.

4. The localized spalling observed at the top of the ribs is most likely due to freeze thaw damage to the concrete. The spalls should be repaired to ensure the continued serve life of the tank.

8. The sealant material appears to have reached the end of its service life and is in need of replacement.

A. The corrosion exhibited by the iron pipe and mixing arm at the base of SBR #1 is more than likely due to the exposure to the aggressive environment of the wastewater, which includes high dissolved oxygen and solids. Steel will readily react with oxygen to form iron oxide (i.e., rust). Normally this reaction is a slow process, particularly when the exposure conditions are controlled, such as the interior of a conditioned building that provides stable temperatures and low humidity.

   However, the wastewater environment increases the rate of corrosion, resulting in significant loss of cross-sectional area as the steel is converted into rust. Therefore, it is recommended that the pipes and fittings be cleaned of all latent rust and evaluated for section loss by comparing the thickness of the remaining material against original condition. After the evaluation is completed, it can be determined if additional repairs or replacement (possibly with stainless steel or FRP components if available) is required, or if the pipes and fittings can be re-coated to maximize the lifespan and serviceability of the SBR tank.

B. The exact cause of the deterioration at the concrete patches is unclear. It is recommended that future repairs use a more durable material and that the area to be repaired be properly prepared to receive the specified repair product.

C. It is unclear what these deposits are or what is generating the growth. In addition, the removal of the growth at the one location did not reveal any underlying corrosion or concrete deterioration. As a result, it is recommended to remove all of the deposits and then monitor the conditions in the future.

D. The deterioration observed in the concrete is more than likely due to an acid attack. When hydrogen sulfide is present, sulfuric acid can be formed when the hydrogen sulfide reacts with oxygen. This occurs near, and slightly above the water level in wastewater tanks. The deterioration of the concrete by acids, as previously mentioned is primarily the result of the reaction with calcium compounds that are leached away by the water in the tanks, which results in exposed surface aggregates that can be observed when the tank is drained.

LIMITATIONS

The evaluation of existing structures requires that certain assumptions be made regarding the existing conditions. Some of these assumptions may not be confirmed without expending additional sums of money and/or destroying otherwise adequate or serviceable portions of the structure. Therefore, Pennoni Associates cannot be held responsible for any latent deficiencies which may exist in the structure, but which have not been discovered as a part of the scope of this evaluation.

Pennoni

If you have any questions or comments, please feel free to contact us.

Sincerely,

PENNONI ASSOCIATES INC.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED
PROFESSIONAL
DENNIS MATTHEW STUART
ENGINEER
PE049568E

D. Matthew Stuart

Christopher Carbone

D. Matthew Stuart, P.E., S.E., P.Eng, F.ASCE, F.SEI, A.NAFE, SECB
Senior Structural Engineer

Chris J. Carbone, EIT
Graduate Engineer

Photos

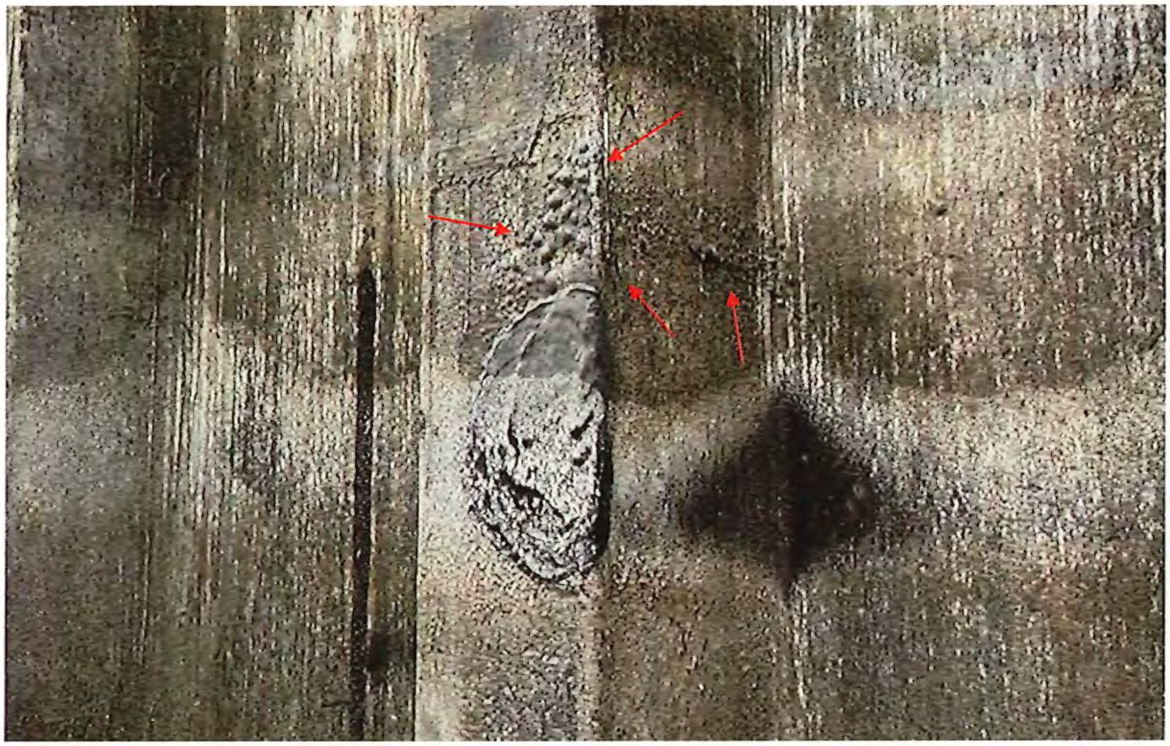


Photo #1:

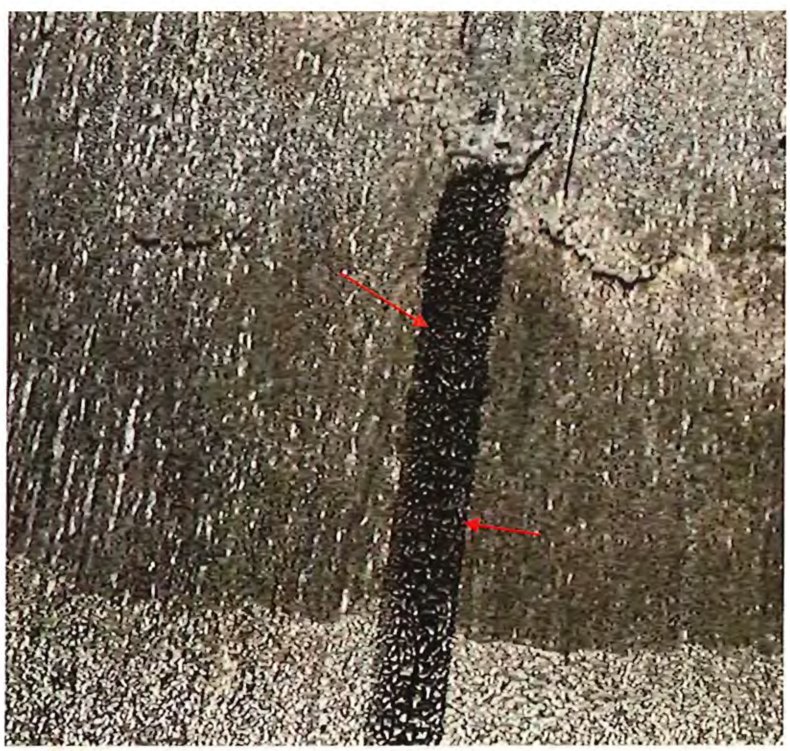


Photo #2:

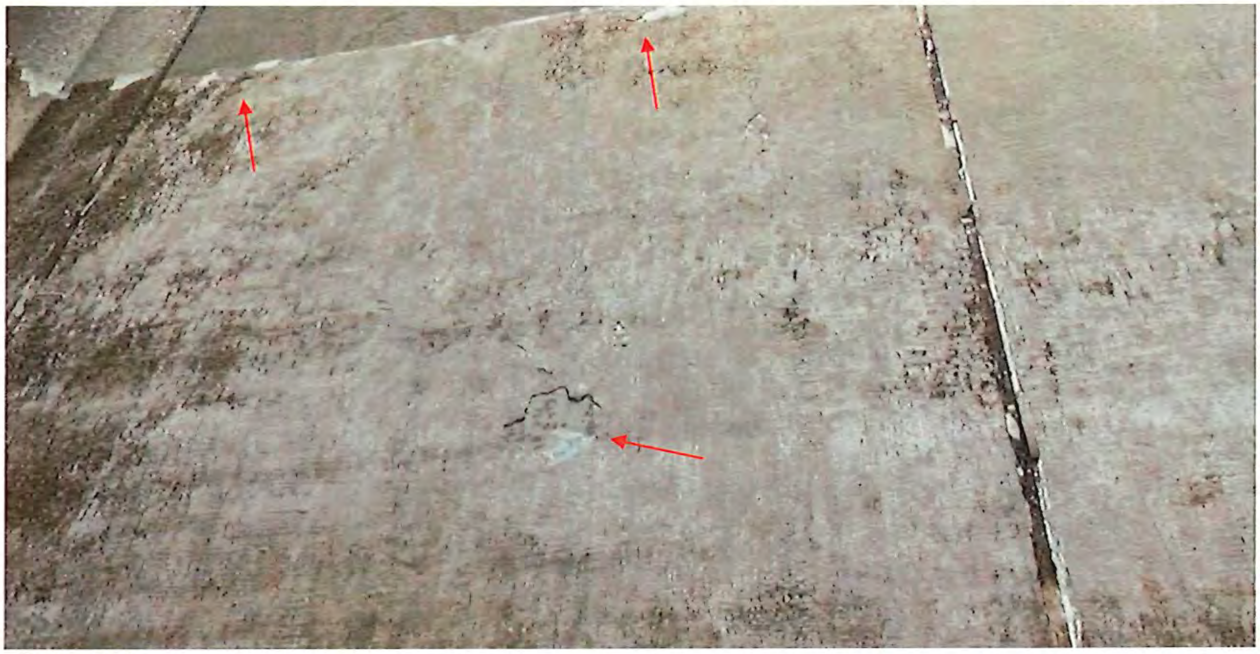


Photo #3A:

Photo #3B:

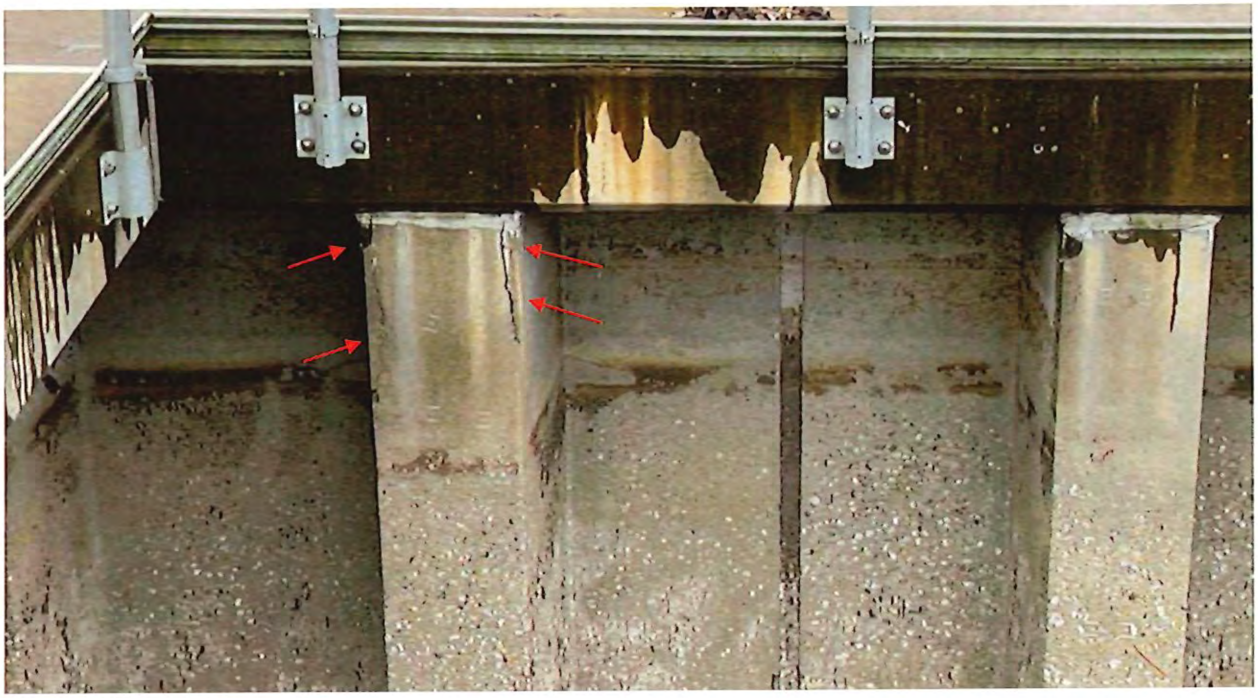


Photo #4:

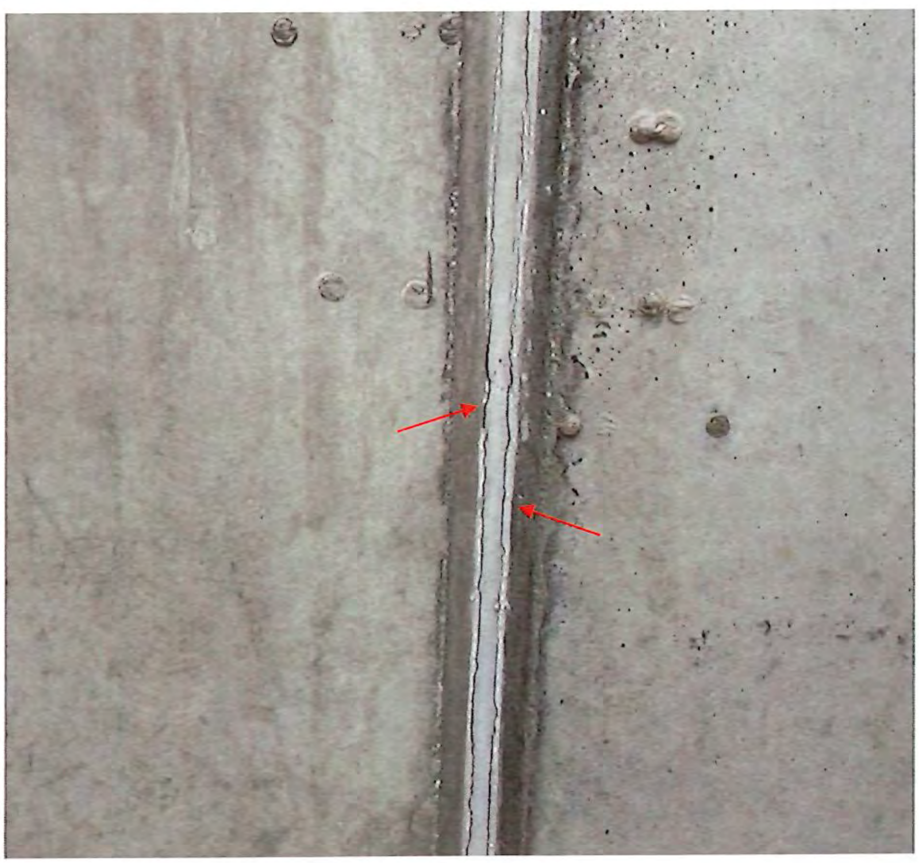


Photo #5:

Photo #A:

Photo #B:

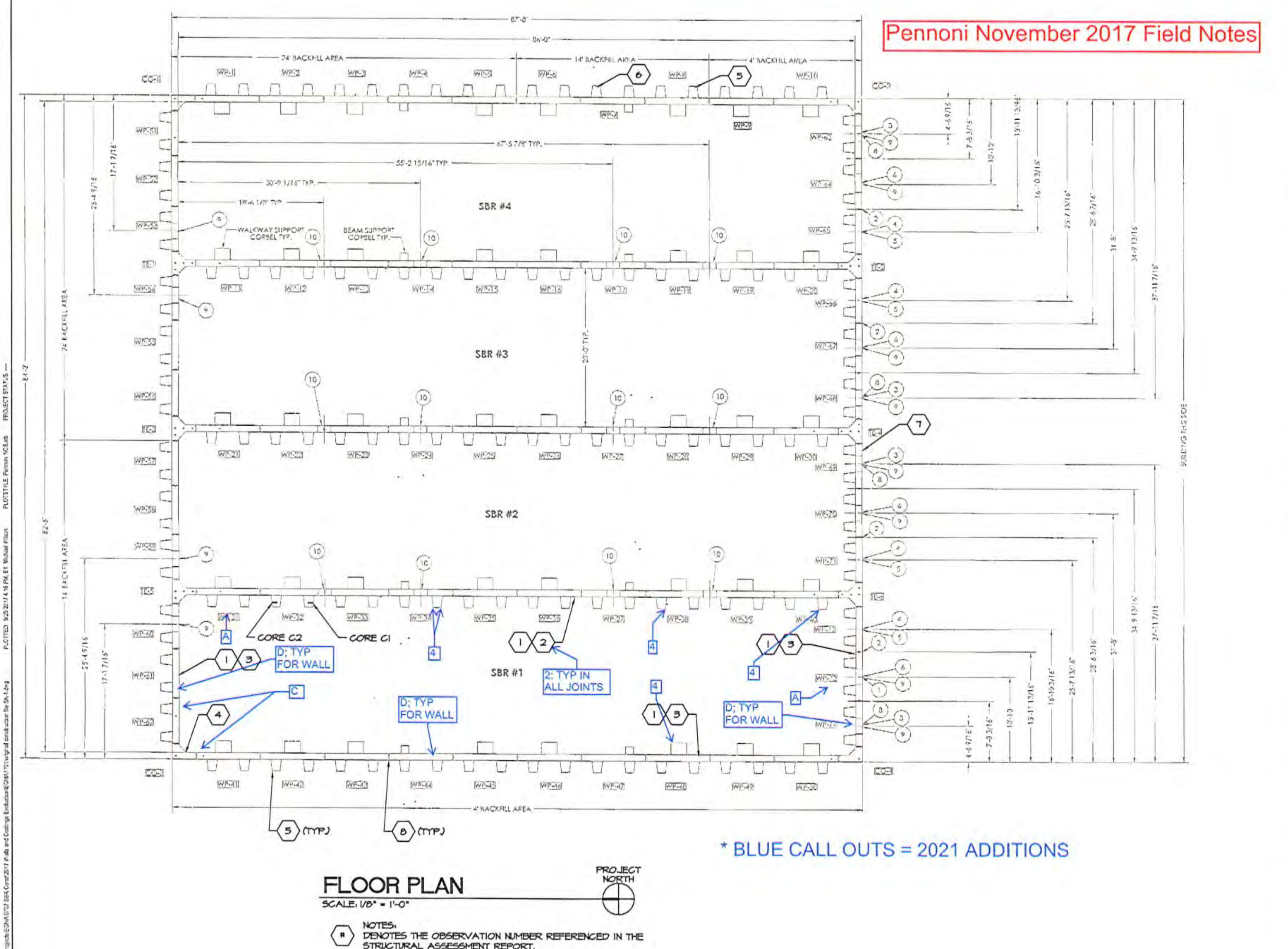
Photo #C1:

Photo #C2:

Photo #C3:

Photo #D:

Field Notes



FLOOR PLAN

SCALE: 1/8" = 1'-0"

NOTES:
(#) DENOTES THE OBSERVATION NUMBER REFERENCED IN THE STRUCTURAL ASSESSMENT REPORT.

PENNONI ASSOCIATES INC.
1900 Market Street, Suite 300
Philadelphia, PA 19103
T 215.222.3000 F 215.222.3588

SBR TANK STRUCTURAL ASSESSMENT
RIDLEY CREEK WASTEWATER TREATMENT PLANT
1751 TOWNE DRIVE
WEST CHESTER, PA 19380

SBR TANK OBSERVATIONS

EAST GOSHEN MUNICIPAL AUTHORITY
1580 PAOLI PIKE
WEST CHESTER, PA 19380

DATE	NO.	REVISIONS	BY

PROJECT		EGMA1705
DRAWN BY JBB	DATE 9/22/2017	APPROVED MBW
BUILDING	FLOOR	AREA
FLOOR PLAN		
SK-1		
SCALE AS NOTED	SHEET 1 OF 1	REV

Appendix D:

2017 SBR Tank #1

Structural Assessment Report

1900 Market Street, Suite 300
Philadelphia, PA 19103
T: 215-222-3000
F: 215-222-3588

www.pennoni.com

EAST GOSHEN MUNICIPAL AUTHORITY
SEQUENCING BATCH REACTOR TANKS
STRUCTURAL ASSESSMENT

STRUCTURAL ASSESSMENT REPORT

NOVEMBER 10, 2017

Submitted To:

East Goshen Municipal Authority
1580 Paoli Pike
West Chester, PA 19380

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
DENNIS MATTHEW STUART
ENGINEER
NO. PE-049568-E

D. Matthew Stuart, P.E., S.E., P.Eng, F.ASCE, F. SEI, SECB
PA License No. PE-049568-E
Structural Division Manager, Pennoni Associates

PAI Project No. EGMA1705

1900 Market Street, Suite 300
Philadelphia, PA 19103
T: 215-222-3000
F: 215-222-3588

www.pennoni.com

November 10, 2017

EGMA1705

East Goshen Municipal Authority
Attn: Rick Smith, Township Manager
1580 Paoli Pike
West Chester, PA 19380

RE: Structural Assessment
Sequencing Batch Reactor Tanks
Ridley Creek Wastewater Treatment Plant
1751 Towne Drive
West Chester, PA 19380

Dear Mr. Smith:

The following report summarizes the structural assessment of an existing sequencing batch reactor (SBR) tank located at the Ridley Creek Sewage Treatment Plant (RCSTP) in East Goshen Township, Pennsylvania.

SCOPE OF WORK

The project involved the structural condition assessment of an existing sequencing batch reactor (SBR) tank located at the Ridley Creek Sewage Treatment Plant (RCSTP) in East Goshen Township, Pennsylvania. The purpose of the investigation was to determine the current condition of the concrete and CIM 1000 coating located at the tank divider walls and to provide recommendations for addressing the current conditions in order to maximize the remaining service life of the structure.

The assessment was based on visual observations of the exposed and readily accessible structural components in order to identify readily observable structural deficiencies or conditions that may require repair work. The field assessment was conducted on August 23, 2017 by Pennoni. Photos taken during the field assessment are contained in **Appendix B: Photos**.

In addition, two (2) partial depth concrete cores were extracted from the inside face of the empty tank walls for the purpose of conducting a petrographic analysis of the same. Refer to **Appendix A: Field Notes** for the location of these concrete samples. The purpose of the material testing was to aid in the identification of the underlying causes of the observed deterioration via petrographic analysis of the concrete.

Existing drawings and previous reports were made available to Pennoni and were used as a reference for this report, and are listed below. A review of these same drawings and reports was included as a part of our investigation of the structure.

- November 2008 Dutchland Project Submittal Documents for Ridley Creek WWTP Upgrade
- March 2009 Dutchland Ridley Creek WWTP Precast QA/QC Information
- 2009 Dutchland "Ridley Creek Wastewater Treatment Plant Upgrade" Final Design Drawings
- May 11, 2009 SBR Tank Construction Meeting Minutes
- May 12, 2009 Dutchland Letter to Jeff Beach of Worth & Company, Inc.
- May 14, 2009 Dutchland Letter to Jeff Beach
- May 27, 2009 Dutchland Letter to Jeff Beach
- June 9, 2009 Sika Corporation Letter to Mary Ann Stolzfus of Dutchland
- June 10, 2009 Dutchland Letter to Jeff Beach
- June 16, 2009 RCSTP SBR Tanks CIM Coatings Update prepared by Pennoni
- June 30, 2009 Jorgensen & Close Associates, Inc. letter to Nazar Sabti of Dutchland
- August 2009 Ridley Creek WWTP Timeline of Crack Repair Correspondence
- November 2006 CIM Industries, Inc. CIM 1000 Product Information
- July, 2010 CIM Industries Inc. Instruction Guide for the Application of CIM to Concrete
- March 29, 2017 Chase Corporation letter to Joshua Allen of Dutchland

INTRODUCTION

The purpose of this report is to systematically describe the affected portions of the structure, document observations, analyze those findings, draw conclusions from the analysis, and make recommendations for the repair and rehabilitation of the affected portions of the existing structure, if feasible. Each part of this report that follows (Description, Project History, Observations, Material Testing, Analysis and Conclusions and Recommendations) provides a thorough picture of the current state of the existing structure and includes recommendations that can contribute to extending the service life of the existing affected structure.

DESCRIPTION OF STRUCTURE

The SBR tanks are located within the RCSTP, a facility that primarily treats residential wastewater in East Goshen Township, Pennsylvania. The SBR tanks are constructed with precast concrete, and were installed in 2009 as part of an overall facility upgrade. The structural design and detailing of the precast concrete tanks were delegated to the precast concrete manufacturer, Dutchland, Incorporated.

Based on the 2009 Dutchland "Ridley Creek Wastewater Treatment Plant Upgrade" drawings, the overall footprint of the four (4) tank system is approximately 87-feet long by 84-feet wide, with each individual tank measuring approximately 87-feet long by 21-feet wide. The tank height is approximately 24-feet. On the south side of the tank, there is a structurally independent treatment building immediately adjacent to the tank, which was constructed at the same time as the SBR tank during the 2009 RCSTP facility upgrade. At the southwest corner, a galvanized metal stair provides access from grade to the walkways above the tanks. Submittal records indicate that the tank wall panels were constructed with 5000 psi concrete. The cast in place concrete tank foundation slab is indicated to be 15-inches thick.

The precast concrete wall panels are double-tee cross-sections with the double tee stems, or ribs, oriented in the vertical direction of the wall. The wall panels consist of 10-inch thick flanges with two ribs per panel section, each projecting roughly 18-inches from the face of wall, for a total section depth of 28 inches, and measure approximately 10-inches wide. The overall width of the wall panels varies, but the typical panel is approximately 6-feet wide. A review of existing project submittal calculations prepared by Dutchland, dated November 2008, indicate that the wall panels were designed as simple span beams, with "pinned" supports at the top and bottom of each panel. The same project submittal calculations also indicate the double tee wall panels are reinforced with standard Grade 60 ASTM A-615 steel deformed bar reinforcing. A cementitious skim coat is present on the interior face of the tank wall panels, although the full extent is unclear due to the presence of the CIM 1000 coating and wastewater debris.

Precast concrete walkways are located along the perimeter of the top of the tanks, between each of the four tanks, and at approximately third points perpendicular to the long dimension of the tanks. The 2009 Dutchland drawings indicate that the walkways are reinforced with conventional reinforcement and DYWIDAG unbonded monostrand post-tensioning cables. Based on the Dutchland calculation submittals, the precast concrete walkways were designed to provide lateral support at the top of the tank wall panels and were designed to span as beams between perpendicular walkways. A review of the reinforced concrete walkway structure was not included as a part of the scope of services for this investigation.

Two horizontal pipes are installed near the base of tank #1, adjacent to the wall between tank #1 and tank #2. A review of these pipes was not included as a part of the scope of services for this investigation.

Steep variations in the exterior grade were observed on-site and as a result the exterior tank walls retain varying levels of backfill depending on their location relative to the surrounding grade. The south and west elevation are fully exposed as it appears that finished grade on these sides of the tank are approximately level with the tank slab elevation. From the northwest corner, finished grade quickly rises until it is approximately equal to the top of the tank walkways at the northeast corner. From the northeast corner, finished grade slopes down somewhat such that most of the east elevation of the tank is below grade. A cast in place concrete retaining wall, which was not included in the assessment, intersects the southeast corner of the tank, which allows the finish grade to drop to approximately equal with the base of the tank slab. The exterior of the tank wall panels on the south elevation are visible from within the treatment building.

PROJECT HISTORY

Pennoni understands that shortly after the SBR tanks were installed in 2009, the precast wall panels exhibited cracking and water seepage at the longitudinal walls separating tanks #1 and #2 and tanks #2 and #3. The cracks were first coated with a cementitious product, which failed, and then routed and sealed with Sika 1a sealant, a polyurethane-based elastomeric sealant, which also failed. Subsequently the tank divider walls were coated with the CIM 1000 product, currently manufactured by Chase Corporation, from the bottom of the walls to an elevation above the level of the aforementioned cracking. Because the RCSTP system is currently operating with one tank empty, blisters and peeling of the CIM 1000 coating have been observed within the empty tanks on a recurring basis. As a result, Dutchland has been performing repairs of this same coating deterioration on an ongoing basis by cutting out the isolated deficiencies and re-coating with the CIM 1000 product.

Refer to **Appendix E: Timeline of Crack Repair Correspondence** for more information regarding the initial cracks and subsequent discussions.

OBSERVATIONS

The accessible and readily observable portions of the exterior of the SBR tank were assessed during the site visit. Additionally, the interior of tank #1 was observed as this tank was empty at the time of visit. Tanks #2, #3, and #4 were each filled with wastewater and thus the interior of these same tanks was not examined. The following observations were noted during the conditional assessment:

1. Within tank #1, the CIM 1000 coating was applied to all horizontal mat foundation slab joints, along the slab-wall joint on all four (4) sides of the tank, and from the slab level to a height of approximately 16-feet above the top of slab at the divider wall separating tank #1 and tank #2 only (see Photos #1A and #1B). No coating was present on the interior face of the other three tank #1 walls. Evidence of a thin second coat of membrane was observed in select areas of the tank, typically along the slab-wall joint. Intermittent blistering of the CIM 1000 coating was present on all observed surfaces except at the horizontal slab construction joints (see Photo #1C). The fluid-filled blisters on the coating were most prevalent at low elevations along the perimeter of the tank and at the ribs of the interior tank separation wall (see Photo #1D). A cementitious skim coat was observed on the three (3) interior walls of tank #1 that were not coated with the CIM 1000 membrane. Patched lifting points were observed on the vertical face of these same interior walls.

2. The CIM 1000 coating on the interior walls of tank #1 was discolored and exhibited "alligator" cracking at some locations (see Photos #2A and #2B).

3. The existing skim coat applied to the vertical wall surfaces within tank #1 exhibited degradation and appeared to be eroded (see Photo #3).

4. Minor spalling of the concrete surface within tank #1 was observed at a few locations on the wall panels, at an elevation at or near the typical water line, which exposed the embedded coarse aggregate within the concrete matrix (see Photo #4).

5. Horizontal hairline cracks were observed on the ribs of the exterior tank walls, on the west wall of tank #1 (see photo #5A) and the east wall of tank #4 (see Photo #5B).

6. One spall was noted on the exterior ribs of the tank structure, on the east wall of tank #4 (see Photos #6).

7. Efflorescence was observed on the south tank wall, within the treatment building (see Photo #7).

8. A small portion of the joint sealant used between precast wall panels on the exterior face of the SBR tank exhibited adhesive and cohesive failure, separating from the concrete substrate and showing signs of cracking in the caulking material itself (see Photo #8A and #8B).

MATERIAL TESTING

In addition to the visual observations that were conducted as a part of the on-site condition assessment, material samples from selected areas of tank #1 were obtained for the purposes of further laboratory analysis. Two (2) locations for testing were chosen and are identified on the Field Notes Drawings in **Appendix A**. Core sample C1 was selected from an area where the existing CIM 1000 coating appeared to be in good condition, while core sample C2 was selected from an area where the existing CIM 1000 coating was blistering and therefore was judged to be in poor condition.

PETROGRAPHIC ANALYSIS

A total of two (2) partial depth concrete core samples were taken as described in Table #1 below. Both of the open core holes were filled with high strength grout after the core sample had been removed. The results of the petrographic analysis of the concrete cores conducted by Wiss, Janney, Elstner Associates, Inc. (WJE) are provided in a report included in **Appendix D: Petrographic Examination of Concrete Cores**.

TABLE #1

Pennoni Material Testing Results Summary			
Sample #	**Sample Location**	**Sample Description**	**Carbonation Depth**
C1	Tank #1, south interior wall	Web of TT wall panel rib	1/16-inch
C2	Tank #1, south interior wall	Web of TT wall panel rib	1/32-inch

The petrographic analysis of the two cores indicated that the concrete was highly air entrained (approximately 12 – 14%); however, this does not appear to have adversely affected the bond between the cementitious paste and the aggregate. The aggregates consisted of crushed limestone coarse aggregate and manufactured siliceous sand fine aggregate. The aggregate was noted as being uniformly distributed throughout both cores. The concrete paste was noted to contain Portland cement and fly ash with a minor amount of cement-sized limestone fragments. A concrete skim coat was noted to be present in core C2 but not core C1. The skim coat was described as a light gray, sanded mortar with a thickness ranging from approximately 6 mils to 60 mils. Carbonation was detected in both cores, to a depth of 1/16-inch in core C1 and to a depth of 1/32-inch in core C2, as noted in Table #1 above. A few microcracks were observed in the concrete near the surface of cores C1 and C2.

The CIM 1000 coating was observed to be applied in two applications, and possibly three in some areas, on the surface of cores C1 and C2. Spherical air voids were detected within the body of the CIM 1000 layers. A blister was present on the surface of core C2

ANALYSIS and CONCLUSIONS

OBSERVATIONS

The analysis and conclusions of the existing tank observations reference the same numbered order as that used in the previous section of the report to facilitate coordination between the report sections.

1. The exact cause of the observed blistering of the CIM 1000 coating is unclear; however, there appear to be numerous factors that contributed to the condition as revealed by the assessment of the SBR tanks, which are explained in further detail below.

   First, the manufacturer's recommendations for the proper application of the CIM 1000 coating indicate that the surface must be completely clean and dry to ensure proper adhesion and function. When the coating is applied over a porous substrate such as concrete, the non-breathable CIM 1000 coating seals in the air and moisture that is naturally trapped within the concrete material. When environmental conditions cause the air to warm and the moisture to vaporize, the increased pressure on the backside of the coating causes blisters to form.

   The CIM 1000 product information recommends moisture testing be performed by two or more of the following tests to ensure the condition of the concrete is adequate to receive the coating: the plastic sheet method (ASTM D4263), relative humidity test (ASTM F2170-09), calcium chloride test, or the radio frequency test. No evidence has been found to indicate that a moisture test was performed at the time the CIM 1000 coating was applied. Therefore, the in-situ condition of the concrete substrate (i.e., continuously exposed to moisture due to the constant presences of wastewater) was more than likely not adequate, per the manufacturer's requirements, to receive the coating and may have therefore contributed to the observed deterioration.

Second, the CIM 1000 manufacturer's recommendations for the proper application also indicate that the substrate shall not be in a temperature-rising mode or exposed to direct sunlight while the material is applied in order to ensure proper adhesion and function. Blisters can form in the membrane when the coating is applied in direct sunlight as the heat from the sun causes the surface of the applied coating to dry more rapidly than the lower layers of the coating film. The rigid, dried outer layer of the applied coating limits the ability of the lower levels of membrane to dry. Thus, when the lower layers do heat up and expand, the resulting vapor pressure causes blisters to form. This process is sometimes referred to as "outgassing." Submittal records were not found that indicated the time of day the coating was applied. Therefore, given the presence of blisters discovered in the petrographic analysis, it is more than likely that the concrete was in a temperature rising mode at the time of the CIM 1000 application, which may have contributed to the observed deterioration of the coating.

Third, Pennoni understands from review of project correspondence that a Chase Corporation (current manufacturer of CIM 1000 coating) representative visited the facility on February 8, 2017 to examine the coating system. This individual indicated that the installers did not use an epoxy primer, such as CIM 61BG Epoxy Primer, before installing the CIM 1000 coating, as recommended in the product literature. Per the CIM 1000 Product data, the primer is recommended to minimize outgassing, see **Appendix F – CIM 1000 Product Data** for additional information. However, the Chase representative stated that while a primer is recommended, it is not required to obtain a warranty on the coating. Results from the petrographic analysis confirm that a primer was not used during the installation of the coating. Therefore, the lack of primer application, per the manufacturer, more than likely contributed to the observed deterioration of the coating.

Finally, the petrographic analysis indicated that the concrete surface below the CIM 1000 membrane was not properly prepared in accordance with the manufacturer's recommendations; bug holes were not filled and the surface was not properly scarified prior to application of the membrane. Therefore, the lack of proper surface preparation, per the manufacturer, more than likely contributed to the observed deterioration of the coating.

It also does not appear that the cracks in the reinforced concrete tank divider walls are directly related to the blistering of the CIM 1000 coating. In Dutchland's May 14, 2009 letter to Worth & Company, Dutchland concluded that the cracks were observed within a range of approximately 8-feet to 15-feet above the top of the base slab and were caused by deflection of the flange side of the walls due to flexural stress. Based on field observations of tank #1, most of the membrane blisters were observed below a height of 8-feet, therefore suggesting that the previously observed wall panel cracks are not directly correlated with the defects in the CIM 1000 coating.

However, these same cracks, which were observed by Pennoni on the exterior face of tank #1 and #4, and the microcracks discovered during the petrographic analysis, appear to be related to a reinforcing concrete design that did not provide proper crack control in a severe environment. A review of the Dutchland calculations for the wall panels indicates that the calculated reinforcement stress exceeded the allowable tensile stress as defined in ACI 350-06: *Code Requirements for Environmental Engineering Concrete Structures and Commentary*. Specifically, the tensile stress in the reinforcement due to flexure bending (fs) was calculated by Dutchland to vary between 14.8 to 37.8 ksi, which should have been limited to 17 ksi per ACI 350-06, section 9.2.6.3.

2. The discoloration and "alligator" cracking observed at the CIM 1000 coating appears to be the result of the coating's age and exposure to ultraviolet radiation. The petrographic analysis indicates that no pinholes were detected on the exterior surface of the coating. In addition, no degradation of the coating was detected. Therefore, the discoloration and "alligator" cracking of the CIM 1000 coating does not appear to adversely affect the function and performance of the membrane.

3. The deteriorated skim coat observed at the vertical wall surfaces within tank #1 is more than likely the result of chemical attack, exacerbated by poor construction of the same, as the petrographic report suggests that the skim coat was a poorly mixed product. Pennoni understands that the RCSTP utilizes aluminum sulfate, a substance that slowly corrodes concrete per ACI 350-06 and ACI 515-13 *Guide to Selecting Protective Treatments for Concrete*. Additionally, this facility utilizes soda ash (sodium carbonate), which is not by itself harmful to concrete, but water containing soda ash may be absorbed into the concrete substrate where it may react with other chemicals in the future as noted in ACI 350-16 and ACI 515-13.

   Pennoni also understands that sodium bisulfite and sodium hypochlorite (commonly known as bleach when dissolved in water), two chemicals known to cause corrosion in concrete according to ACI 350-06 and ACI 515-13, were previously employed to treat wastewater in the SBR tank, but are no longer used.

4. The moderate spalling of the concrete within tank #1 that was observed at or near the typical water line may be the result of chemical attack and poor construction of the skim coat, similar to Item #3. Hydrogen sulfide may be present in the wastewater as a byproduct from other chemical reactions occurring in the tanks, although it is typically not prevalent in open air tanks such as these. Hydrogen sulfide produces sulfuric acid when combined with oxygen. The creation of sulfuric acid typically occurs on the walls at an elevation equal to or slightly above the normal water surface elevation in the tanks. The deterioration of concrete by acids is primarily the result of reaction between these chemicals and the calcium hydroxide of the hydrated Portland cement, which results in the formation of water-soluble calcium compounds that are leached away by the water in the tanks.

5. The horizontal hairline cracks observed on the ribs of the exterior tank walls, on the west side of tank #1 and the east side of tank #4 are more than likely the result of flexural stresses, see Item #1 for additional discussion. Due to the lack of backfill on the outside of these tank walls, there is no balancing force to counteract the hydrostatic water pressure

from inside the tanks, thus increasing the likelihood of crack formation on the tensile face of the wall panels. By inference, it is reasonable to assume that similar flexural cracks formed on the interior wall panels that separate tanks #1 through #4 when one tank is filled and an adjacent tank is emptied, which also provides an explanation for the same cracks that occurred shortly after the SBR tank was constructed.

6. The localized spalling observed on the exterior ribs of the tank structure, on the west wall of tank #4 is more than likely impact damage that occurred during the construction or erection of the precast concrete element.

7. The efflorescence noted on the south elevation of the SBR tank from inside the treatment building indicates that moisture is migrating through the concrete, which then evaporates on the surface leaving soluble salts and other mineral deposits on the surface of the concrete.

8. No evidence exists indicating that the sealant in the vertical wall panel joints has recently been replaced or repaired. Therefore, the sealant material has more than likely been in service for approximately 8 years. Most sealants are capable of providing a 10 to 15-year lifespan before replacement is required. Therefore, it is more than likely that the joint sealant is failing due to a combination of exposure to weather/environmental factors, flexural stresses caused from the filling and emptying of tanks and the material approaching the end of its intended service life.

MATERIAL TESTING

With the exception of some atypical features described in the Material Testing portion of this report, in general, the results of the petrographic analysis of the two core samples indicate that the concrete appeared to be of good quality, with the exception of the cementitious skim coat noted in core C2. However, evidence that proper surface preparation of the concrete was not performed or proper installation procedures were not followed prior to application of the CIM 1000 membrane, as discussed in greater detail in Item #1 of the Observations, was confirmed by the petrographic analysis.

The depth of carbonation is less than what would be expected for a concrete structure of this age. Typically, carbonation occurs at a rate of 1-inch every 50 years, therefore the expected depth of carbonation should be 0.20-inches (±10-year-old structure/50), which is greater than the maximum depth noted in the petrographic report of 1/16-inch (0.063-inches). Therefore, carbonation of the concrete is not expected to adversely affect the service life of the structure in the near term.

RECOMMENDATIONS

The recommendations for repair of the observed damage reference the same numbered order as that used in previous sections of the report to facilitate coordination between the report sections.

1. One of the intended goals of this investigation was to provide the Client with recommendations for maximizing the remaining service life of the SBR tanks, which includes determining if a coating is required at the SBR tanks within the context of the fair-to-poor condition of the existing CIM 1000 coating (mostly fair with isolated poor areas) and cost to replace the same. The petrographic study of the concrete cores and visual assessment of the tanks revealed limited deterioration of the actual concrete structure, and no evidence that the internally embedded rebar is corroding. However, the analysis of the likely causes of minor surface spalling observed inside tank #1 (see Observations #4 and #5) and subsequent research into the chemicals that are reported to have been used in the SBR tanks indicated that the concrete is subject to chemical attack and degradation, which if left unaddressed could drastically reduce the service life of the structure.

   Therefore, in order to maximize the service life of the structure, a protective coating should be utilized on all concrete surfaces exposed to wastewater. While preventing degradation of the concrete due to chemical attack is reason enough to recommend the installation of a coating, secondary benefits include preventing the migration of water through cracks caused by an inadequate flexural design per ACI 350-06 and preventing/slowing the depth of carbonation, both of which also have an adverse effect on the service life of the structure.

   <u>As such, our primary recommendation is to remove the existing CIM 1000 coating membrane and install a new coating system in order to maximize the remaining service life of the concrete.</u> Pennoni recommends the new coating be applied to all interior tank concrete surfaces. In accordance with industry standards for protective coatings on reinforced concrete, we recommend the new coating be installed for the full height of all interior walls and the entire slab area within each of the four tanks, Per Chapter 3 of ACI 515-13, it is recommended that a polyurethane or urethane coating be applied to concrete elements exposed to aluminum sulfate, a chemical that Pennoni understands is currently used by the RCSTP. Pennoni recommends the Sherwin Williams Sherflex elastomeric polyurethane protective coating be used and that the installer follow all of the manufacturer's recommendations for the installation of the product.

   Since the existing coating is not yet experiencing complete system failure and is projected to have at least several years of remaining functional life, it is not considered critical that the coatings be replaced immediately. However, they should be replaced and installed on the remainder of the tank interior surfaces sooner-than-later to protect the concrete and maximize the life of the tanks. It is anticipated that the one offline tank can have the existing coating removed and a new coating installed while the other three tanks are in service. The re-coating work should therefore be performed before plant flows increase to the extent that all four tanks need to be operational at the same time. For these reasons, we recommend the coatings be planned for replacement within the next five years.

   Visual inspections of coating and concrete conditions can continue to be conducted by Pennoni as each tank is drained for routine maintenance over the next several years. It is our understanding that a new tank is drained approximately every six months. A determination of the specific time to initiate replacement of the coatings can be made depending upon the prevalence of any progressing deterioration of the coatings and/or concrete during the inspections.

Given the costs associated with coating all of the tanks, the East Goshen Municipal Authority could elect instead to perform a service life analysis of the existing affected structure to determine the likely remaining life of the tanks with and without any new coatings; however, a detailed assessment of the remaining service life of the tanks is beyond the scope of the current investigation. A service life analysis, such as that provided by the SIMCO Technologies' (SIMCO) STADIUM software, will provide the data needed to determine the most economical approach for the SBR tanks. Pennoni has successfully collaborated with SIMCO on several other deteriorated concrete projects that required a detailed analysis of the remaining service life of the structure in order to identify the most practical and economic approach to repairing the affected structure. The cost of a service life analysis would be approximately $25,000.

2. See Item #1.

3. No action is recommended.

4. No action is recommended.

5. The hairline cracks should be monitored on a regular basis for signs of further deterioration. Pennoni does not recommend routing and sealing the cracks on the exterior of the tanks at this time, as this may "trap" moisture in the concrete.

6. No action is recommended.

7. Moisture infiltration resulting in the observed efflorescence will be addressed if the recommendations in Item #1 are completed.

8. The existing deteriorated sealants should be removed and replace in the near future.

LIMITATIONS

The evaluation of existing structures requires that certain assumptions be made regarding the existing conditions. Some of these assumptions may not be confirmed without expending additional sums of money and/or destroying otherwise adequate or serviceable portions of the structure. Therefore, Pennoni Associates cannot be held responsible for any latent deficiencies which may exist in the structure, but which have not been discovered as a part of the scope of this evaluation.

If you have any questions or comments, please feel free to contact us.

Sincerely,

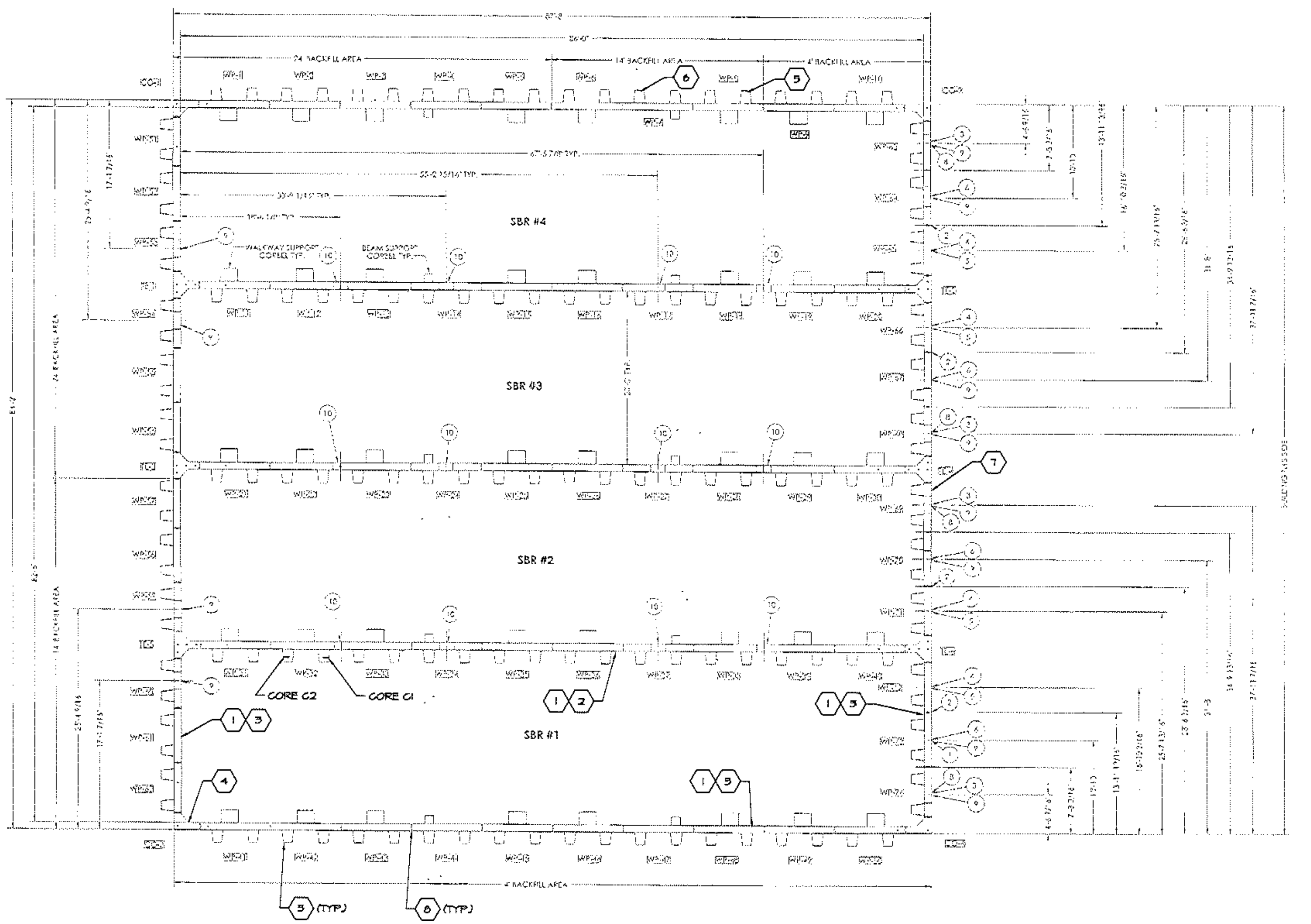
PENNONI ASSOCIATES INC.

Ross Stuart, P.E., S.E.
Structural Division Manager

D. Matthew Stuart, P.E., S.E., P.Eng, F.ASCE, F.SEI, SECB
Senior Structural Engineer

Michael Wilson
Michael Wilson, E.I.T.
Project Engineer

Appendix A:
Field Notes



FLOOR PLAN

SCALE: 1/8" = 1'-0"

PROJECT NORTH

NOTES:
(#) DENOTES THE OBSERVATION NUMBER REFERENCED IN THE STRUCTURAL ASSESSMENT REPORT.

Pennoni

PENNONI ASSOCIATES INC.
1900 Market Street, Suite 300
Philadelphia, PA 19103
T 215.222.3000 F 215.222.3588

SBR TANK STRUCTURAL ASSESSMENT

ROLEY CREEK WASTEWATER TREATMENT PLANT
1751 TOWNE DRIVE
WEST CHESTER, PA 19380

SBR TANK OBSERVATIONS

EAST GOSHEN MUNICIPAL AUTHORITY
1580 PAOLI PIKE
WEST CHESTER, PA 19380

DATE	NO.	REVISIONS	BY

PROJECT		EGMA1705
DRAWN BY JBB	DATE 9/22/2017	APPROVED MBW
BUILDING	FLOOR	AREA
FLOOR PLAN		
SK-1		
SCALE AS NOTED	SHEET 1 OF 1	REV

Appendix B:

Photos


Photo #1A


Photo #1B

Photo #1C

Photo #1D

Photo #2A

Photo #2B

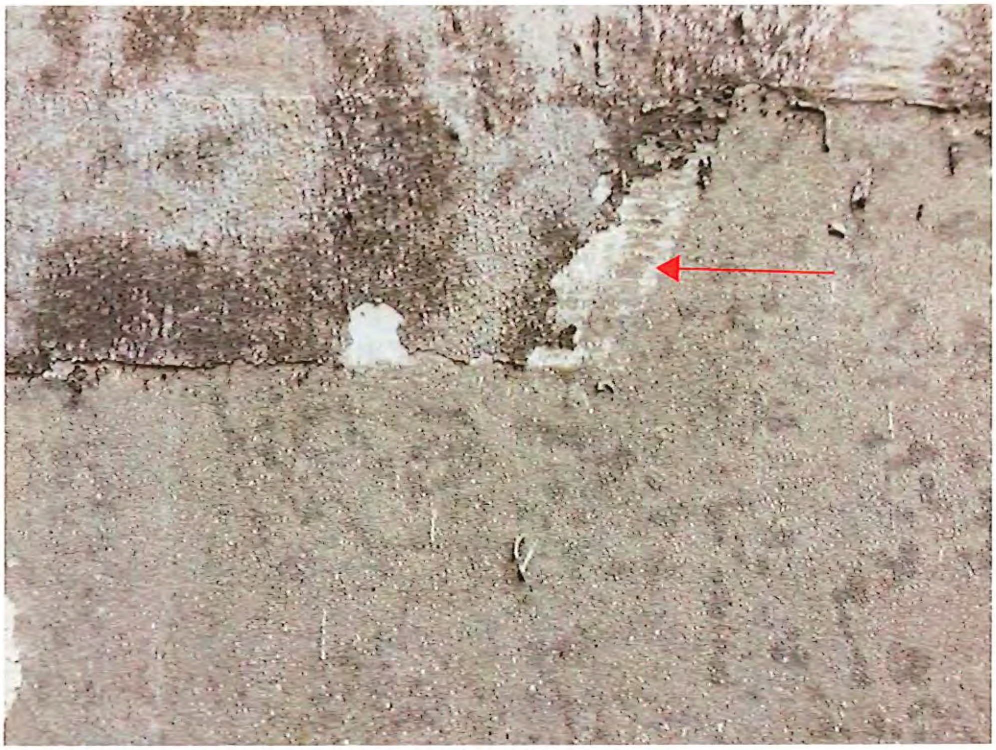


Photo #3

Photo #4

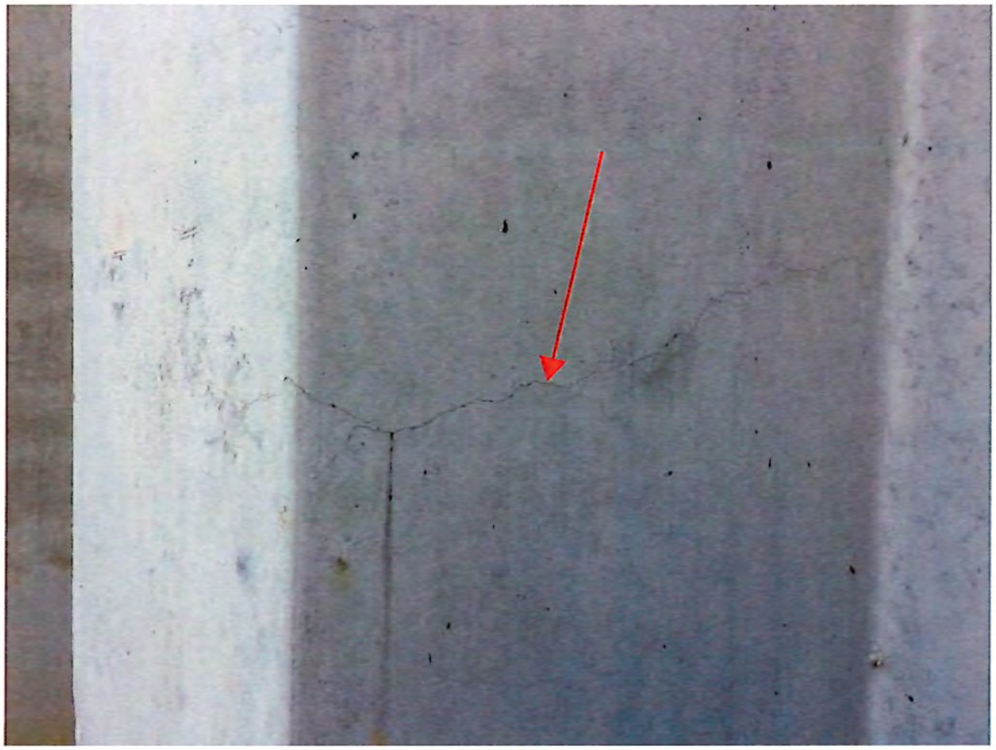


Photo #5A

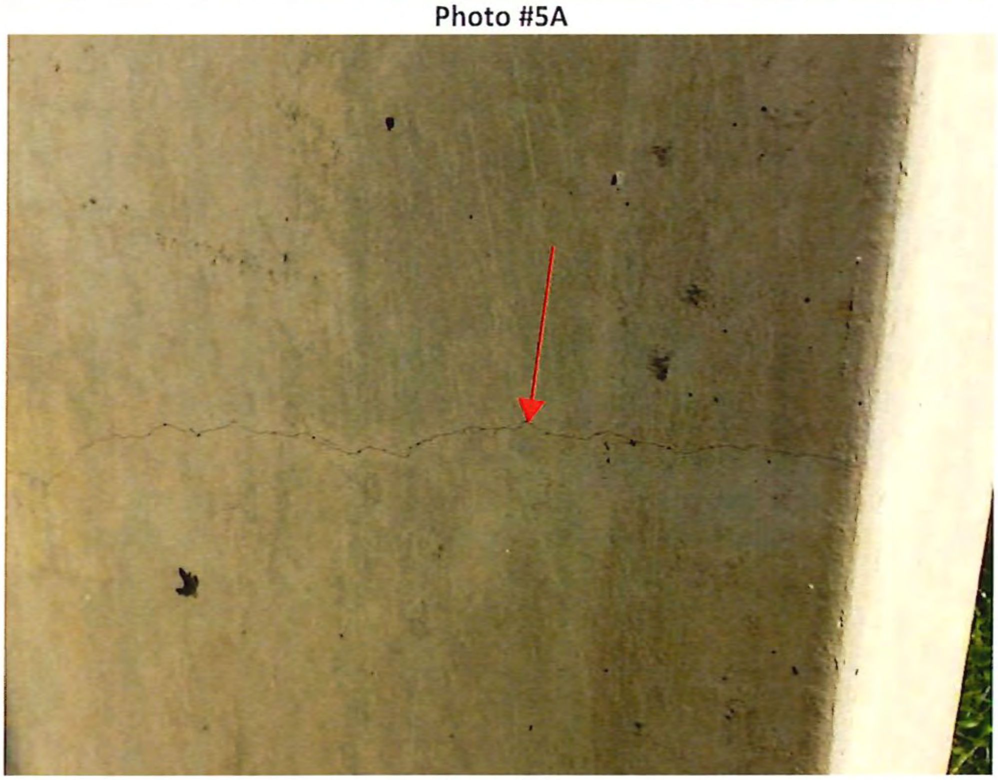


Photo #5B

Photo #6

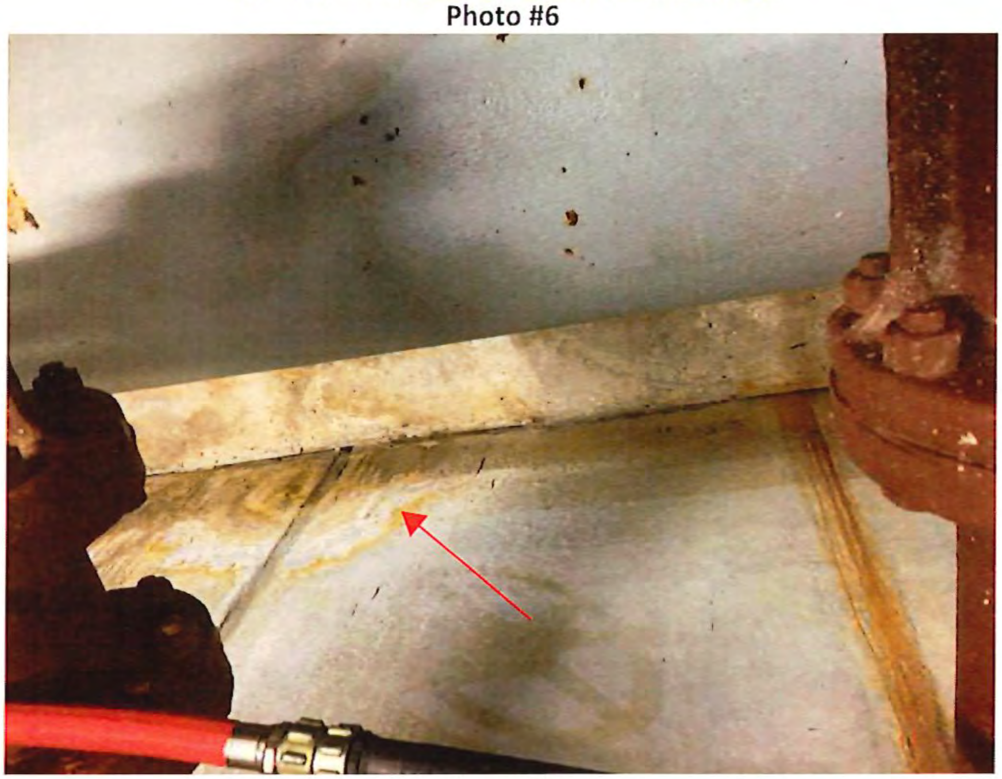


Photo #7

Photo #8A

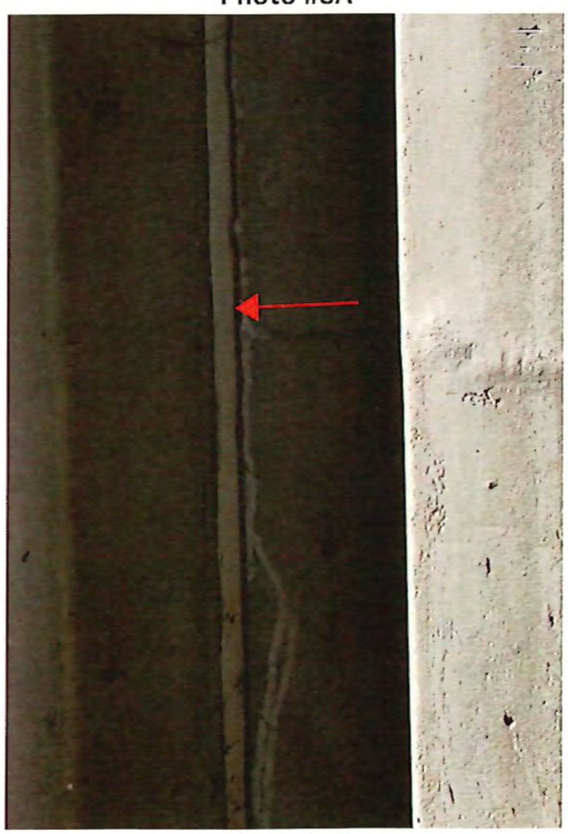


Photo #8B

Appendix C:

Ridley Creek Wastewater Treatment Plan Upgrade Drawings by Dutchland

OFFICE
COPY

RIDLEY CREEK

WASTEWATER TREATMENT PLANT UPGRADE

CHESTER COUNTY, PA

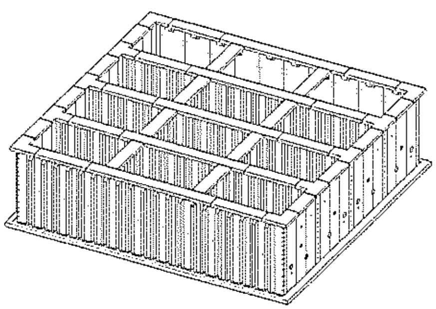
THIS SUBMITTAL WAS REVIEWED FOR GENERAL CONFORMANCE TO THE CONTRACT DOCUMENTS, NOZZLE LOCATIONS, EQUIPMENT LOCATION AND ATTACHMENT, AND POTENTIAL INTERFERENCES ONLY. STRUCTURAL REBAR AND CONCRETE DESIGN WAS NOT REVIEWED NOR IS IT PART OF THIS APPROVAL.

☐ APPROVED
☒ APPROVED AS CORRECTED

☐ REVISE AND RESUBMIT
☐ REJECTED

By [illegible] Date 1/27/05

PENNONI ASSOCIATES INC.
CONSULTING ENGINEERS



ENGINEER:
PENNONI ASSOCIATES, INC.
ONE DREXEL PLAZA
3001 MARKET STREET
PHILADELPHIA, PA 19104

OWNER:
EAST GOSHEN MUNICIPAL AUTHORITY
1580 PAOLI PIKE
WEST CHESTER, PA 19380

GENERAL CONTRACTOR:
WORTH & COMPANY
6263 KELLERS CHURCH ROAD
PIPERSVILLE, PA 18947

PRELIMINARY	☐
PERMITTING	☐
BID DOCUMENT	☐
FINAL DESIGN	X
MANUFACTURING	☐
AS BUILT	☐

MANUFACTURER:

Dutchland
INCORPORATED
Precast Concrete Environmental Solutions

160 Rt. 41 • PO Box 549 • Gap, PA 17527-0549
Ph. 717-442-8282 Fax 717-442-9330
www.dutchlandinc.com

SUBMITTAL DRAWING

DATE ISSUED
JAN 23 [illegible]

INDEX OF DRAWINGS:

1-27-05

DESIGN CRITERIA				
Live Load: per IBC 2003				
	Walkway Live Load		60	psf
	Walkway Live Load Reduction Factor		NA	
Wind Load: per IBC 2003				
	Basic Wind Speed (V)		90	mph
	Wind Importance Factor (Iw)		1.15	(Category III)
	Wind Exposure		C	
Seismic: per ACI 350.3-06				
	Site Type		D	
	Importance Factor (Ie)		1.25	
	Response Modification Coefficient for Impulsive Component (Rwi)		2.5	
	Response Modification Coefficient for Corrective Component (Rwc)		1	
	Ss		0.270	
	S1		0.061	
	Fa		1.577	
	Fv		2.4	
	Sds		0.20	
	Sd1		0.1	
	Design Base Shear (V)		142.6	kips
	Overturning Moment		5048.2	kip-ft
	Overturning Factor of Safety		9.1	
	Analysis Procedure:		Dynamic Modeling	
Soil:				
	Allowable Bearing Pressure (qall)		3,000	psf
	Moist Soil Unit Weight		135	pcf
	Combined Soil & Water Pressure		135	pcf
	Coefficient of At-Rest Pressure (Ko)		0.5	
	Coefficient of Sub-Grade Friction (u)		0.5	
	Subgrade Modulus		120	k/cu ft
ACI Criteria: per ACI 318-02 & ACI 350-06				
	Durability Factor (Sd)	Walls	1.08	
	Durability Factor (Sd)	Walkway	1.56	
ACI 350-06 Load Case: 9-1 Controls				
	Dead Load Factor		1.4	
	Fluid Load Factor		1.4	
	Live Load Factor		1.6	
	Load Handling Factor		1.5	
	Flexural Strength Reduction Factor		0.9	
	Shear Strength Reduction Factor		0.75	
Allowable Deflection:				
	Walls		L/180	
	Walkways		L/180	

A. STRUCTURES

1. THE PRECAST CONCRETE STRUCTURES ARE DESIGNED FOR NORMAL SOIL CONDITIONS AND NORMAL pH LEVELS (6-9 S.U.).

2. ALL PRECAST CONCRETE STRUCTURE COMPONENTS TO BE CONSTRUCTED FROM TYPE I/II CEMENT WITH TYPE "F" FLY ASH. THE CONCRETE COMPRESSION STRENGTH SHALL BE 6000 PSI @ 28 DAYS.

3. ALL REBAR TO BE GRADE 60 A.S.T.M. A-615.

4. PRECAST CONCRETE WALL PANELS AND WALKWAYS SHALL BE POST-TENSIONED AFTER ERECTION WITH SHEATHED, GREASE ENCAPSULATED, 7 STRAND, 0.6" DIAMETER CABLE.

5. PRECAST CONCRETE WALL PANELS SHALL HAVE A MINIMUM WALL THICKNESS OF 10" FOR FLAT WALLS AND 8" FOR CURVED WALLS.

6. ALL TANKS SHALL BE DESIGNED TO BE FREE STANDING AND ABLE TO WITHSTAND EXTERNAL SOIL PRESSURES WITH THE TANK EMPTY.

7. ALL INTERNAL WALLS SHALL BE DESIGNED TO HAVE A FULL LIQUID LEVEL ON ONE SIDE AND BE EMPTY ON THE OTHER SIDE.

8. STRUCTURAL DESIGN SHALL CONFORM TO ACI 318 & ACI 350 CODES

9. BASE SLAB CONCRETE SHALL BE 4000 PSI @ 28 DAYS.

10. ALL POST-TENSIONING STRANDS SHALL BE JACKED TO AN INITIAL FORCE OF 46.0 KIPS.

B. STRUCTURAL PENETRATIONS:

1. THE GENERAL CONTRACTORS SHALL BE RESPONSIBLE TO VERIFY LOCATIONS OF PIPE PENETRATIONS AND OTHER OPENINGS REQUIRED FOR MECHANICAL EQUIPMENT WITH THE TANK MANUFACTURER. PENETRATIONS AND EMBEDDED ITEMS NOT SHOWN ON THE APPROVED SHOP DRAWINGS SHALL BE THE RESPONSIBILITY OF THE GENERAL CONTRACTOR. IN NO EVENT SHALL PENETRATIONS AND EMBEDDED ITEMS BE ADDED TO STRUCTURES OR MODIFICATIONS BE MADE TO STRUCTURES WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE TANK MANUFACTURER.

COORDINATE WITH CONTRACTOR

⚠ 2. DRILLING EMBEDMENT OF 3-3/4" ON INTERIOR OF CIRCULAR TANKS AND FOR RECTANGULAR TANKS WALL AS FOLLOWS: 3-1/2" FOR 10" THICK WALL, 4-1/2" FOR 12" THICK WALL, 5-1/2" FOR 14" THICK WALL, FOR EQUIPMENT ATTACHMENT IS PERMISSABLE AT ALL LOCATIONS EXCEPT TENSIONING ANCHOR POINTS. DEEPER DRILLING DEPTHS SHALL BE COORDINATED WITH THE TANK MANUFACTURER.

⚠ 3. DRILLING EMBEDMENT OF 2-1/2" FROM TOP, 4-1/2" FROM SIDES, AND 3-1/2" FROM BOTTOM OF WALKWAY IS PERMISSABLE AT ALL LOCATIONS EXCEPT TENSIONING ANCHOR POINTS. DEEPER DRILLING DEPTHS SHALL BE COORDINATED WITH THE TANK MANUFACTURER.

NO.	REVISION	DATE	BY
1	[illegible]	[illegible]	[illegible]

SEAL

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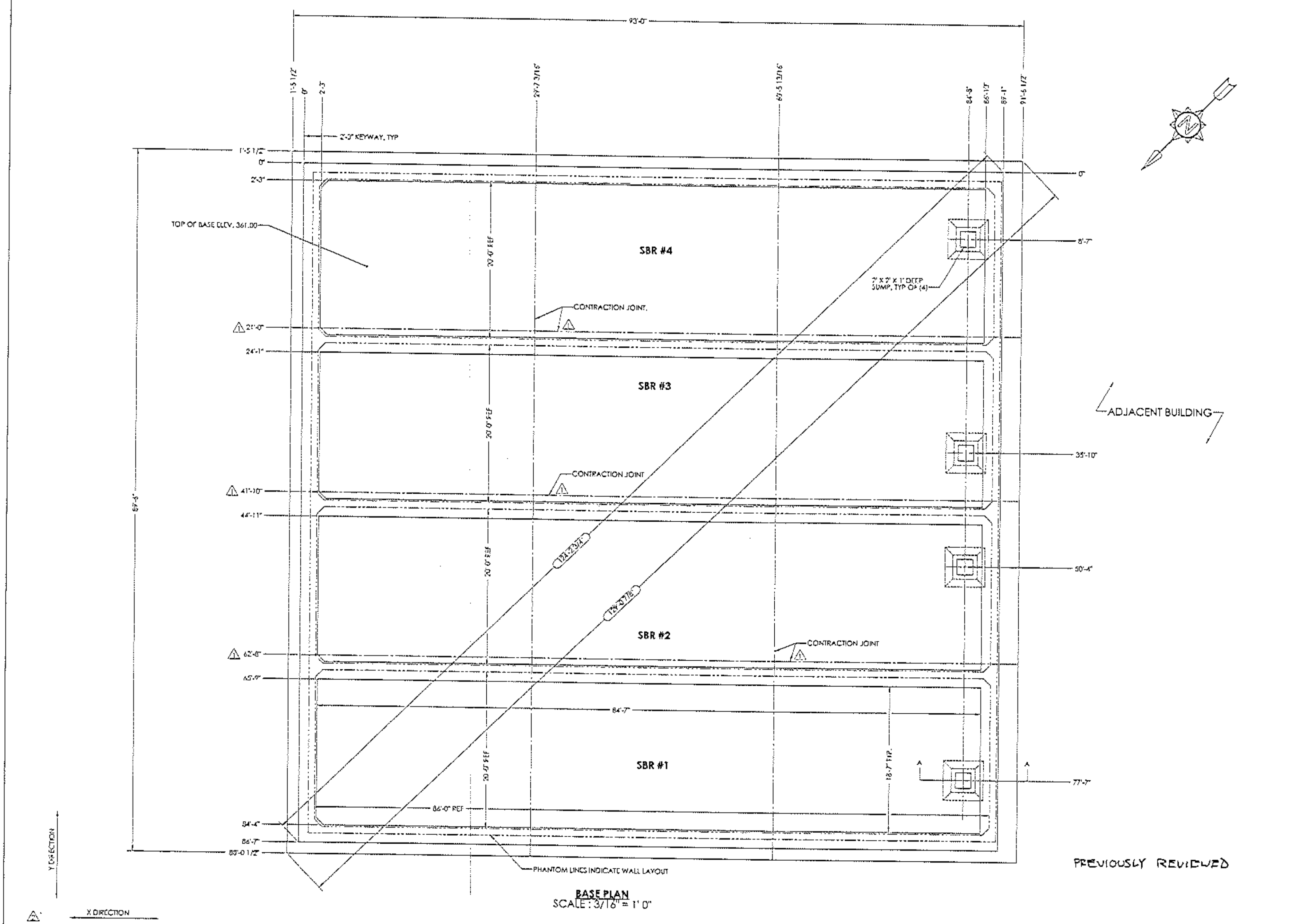
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT
UPGRADE
CHESTER COUNTY, PA

GENERAL NOTES

Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-08
Scale: NTS
Sheet No. 01



BASE PLAN
SCALE : 3/16" = 1' 0"

PREVIOUSLY REVIEWED

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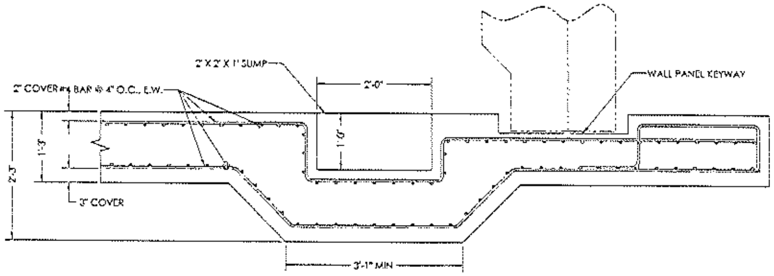
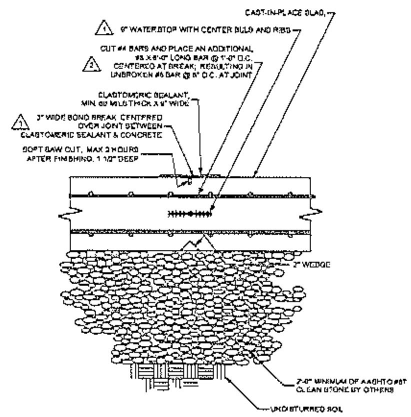
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT
UPGRADE
CHESTER COUNTY, PA

BASE PLAN

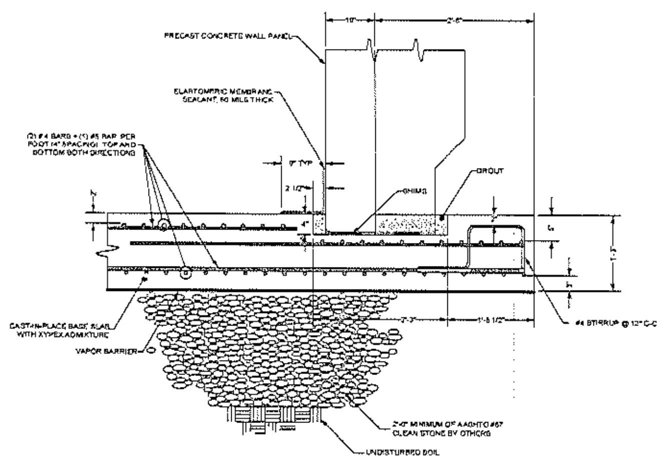
Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DME
Checked By: TAW
Issue Date: 11-10-08
Scale: 3/16" = 1'-0"
Sheet No. 02



SECTION A-A
SUMP REINFORCEMENT DETAIL
SCALE: 1" = 1'-0"



CONTRACTION JOINT IN BASE SLAB
SCALE: NTS



BASE SLAB/WALL PANEL CONNECTION
RIBBED WALL PANELS
SCALE: NTS

PREVIOUSLY REVIEWED

REINFORCING BAR LAP SPLICE & DEVELOPEMENT LENGTHS FOR 4000psi CONCRETE:
#4 BAR 29" LONG
#5 BAR 36" LONG
#6 BAR 43" LONG
#8 BAR 63" LONG

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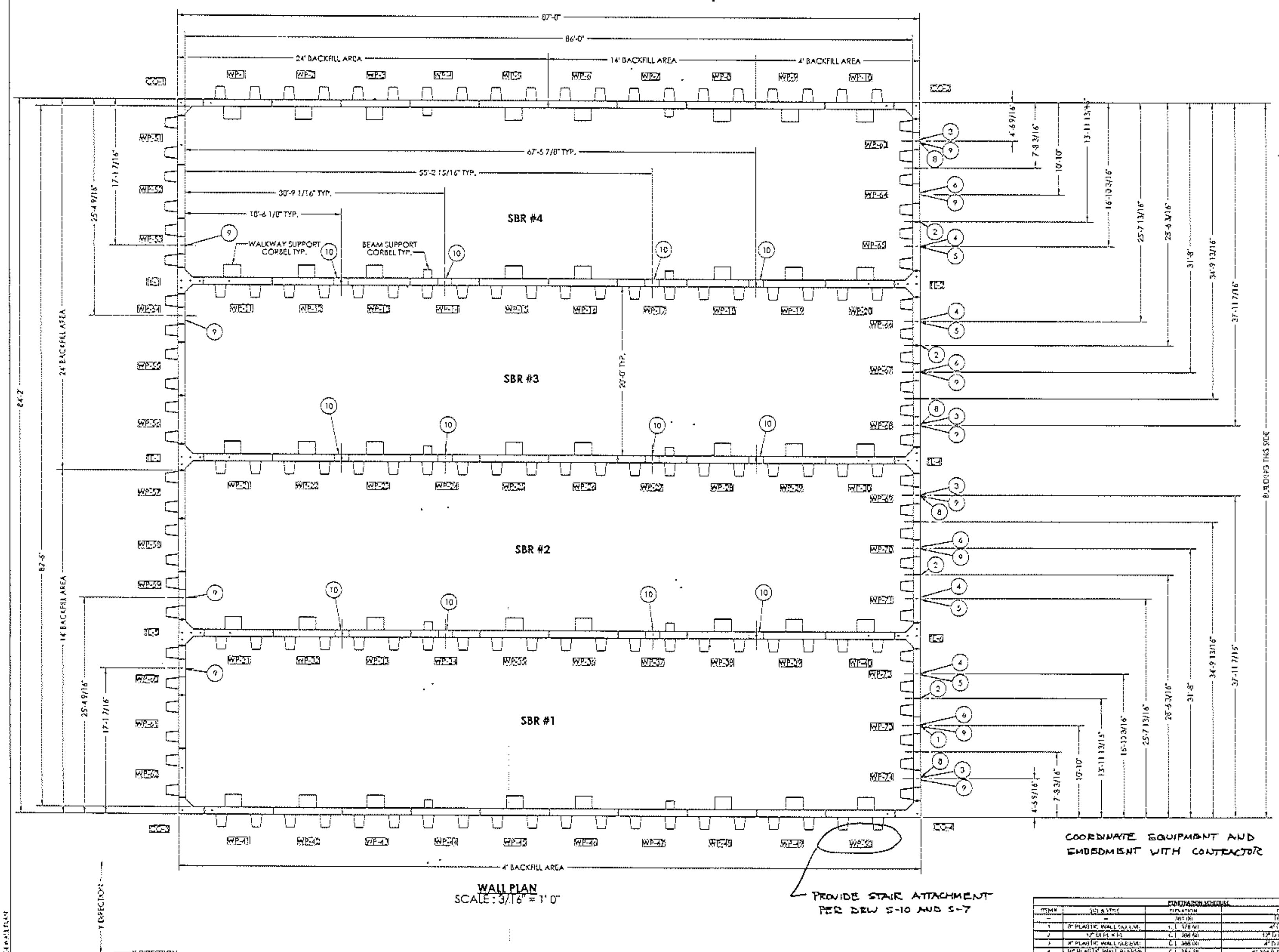
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT UPGRADE
CHESTER COUNTY, PA

BASE DETAILS

Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-06
Scale: AS NOTED
Sheet No. 03



WALL PLAN
SCALE: 3/16" = 1' 0"

PENETRATION SCHEDULE			
ITEM #	SIZE & STYLE	ELEVATION	DESCRIPTION
—	—	[illegible]	TOP OF BASE
1	8" PLASTIC WALL SLEEVE	C.L. 378.[illegible]	4" DI VENT PIPE
2	12" DI FL X FL	C.L. 388.[illegible]	12" DI INFLUENT PIPE
3	8" PLASTIC WALL SLEEVE	C.L. 388.00	4" DI TO BUS DUMP
4	10" PLASTIC WALL SLEEVE	C.L. 384.25	6" 304 S.S. AIR LINE TO SBRS
5	3" PLASTIC WALL SLEEVE	C.L. 379.17	1" PVC SCH80 ALUM
6	12" DI FL X FL	C.L. 375.00	12" DI DECANT LINE
7	VOID		VOID
8	12" DI FL X FL	C.L. [illegible]	12" WALL PIPE WITH PUDDLE FLANGE
9	4" X 24" OPENING	INV 384.42	4" X 24" ELECTRICAL CONDUIT CUTOUT
10	4" X 30" OPENING	INV 384.42	4" X 30" SPILLWAY OPENING

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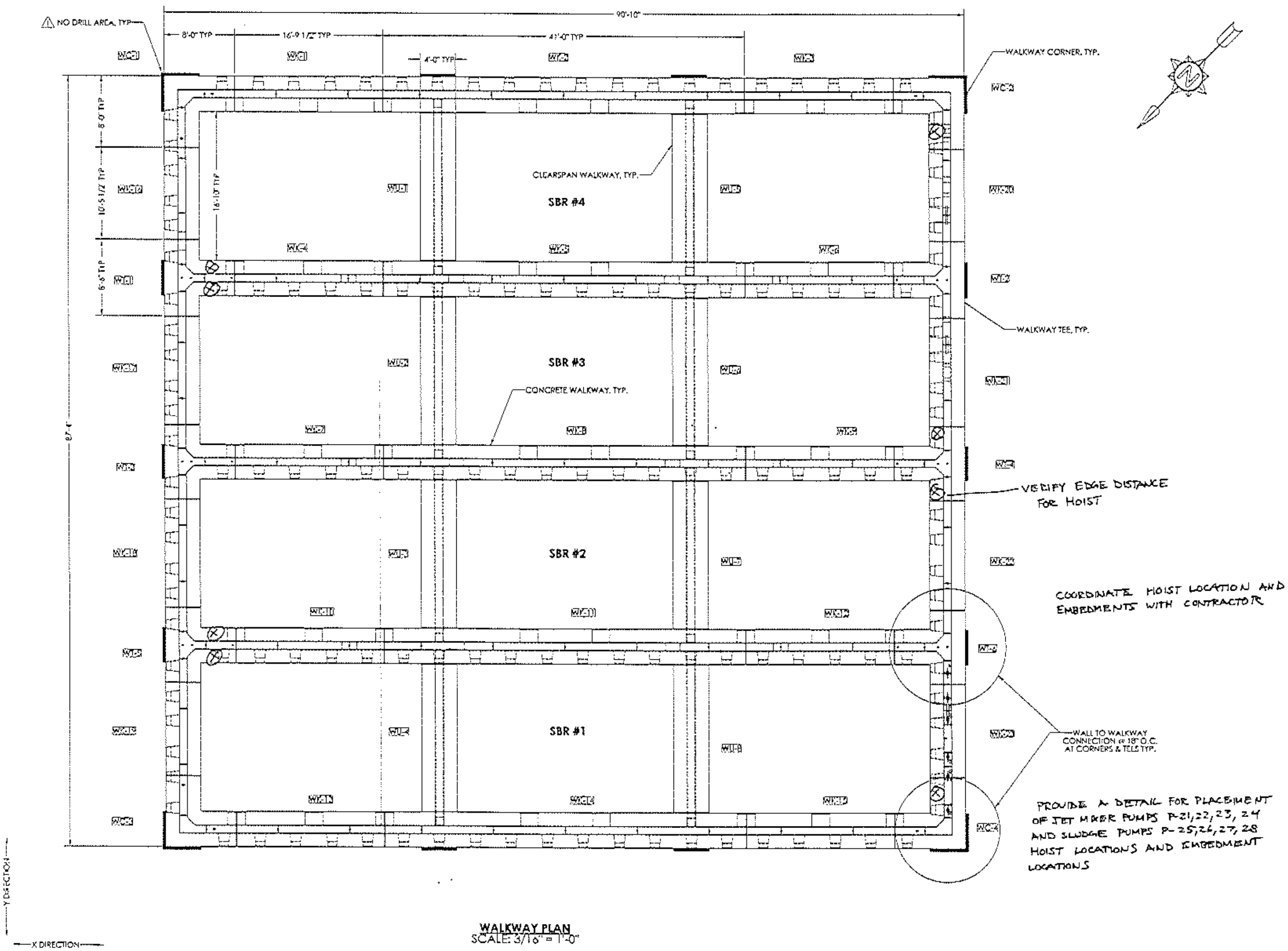
PROJECT:
RIDLEY CREEK WASTEWATER TREATMENT PLANT UPGRADE
CHESTER COUNTY, PA

WALL PLAN

Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-06
Scale: 3/16" = 1'-0"
Sheet No. 04



WALKWAY PLAN
SCALE: 3/16" = 1'-0"

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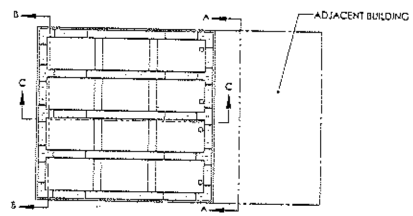
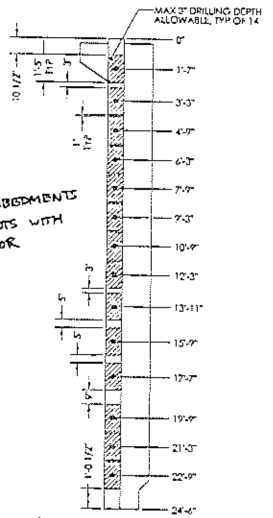
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT
UPGRADE
CHESTER COUNTY, PA

WALKWAY PLAN

Job Number: 06176
Project Manager: MF
Drawn By: MCP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-08
Scale: 3/16" = 1'-0"
Sheet No. 05

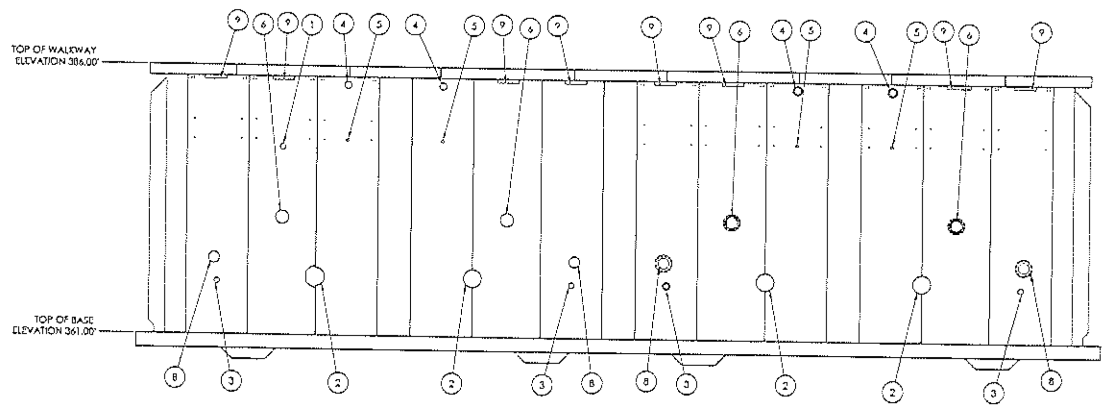


PLAN VIEW
SCALE: 1" = 30' 0"

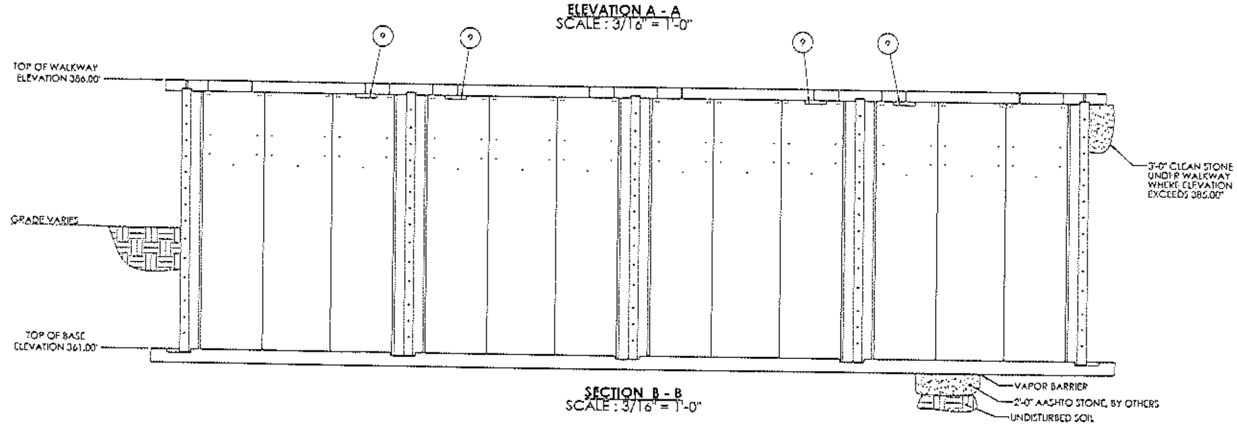


X & Y DIRECTION ALLOWABLE DRILLING LOCATION DETAIL
SCALE: 3/8" = 1'-0"

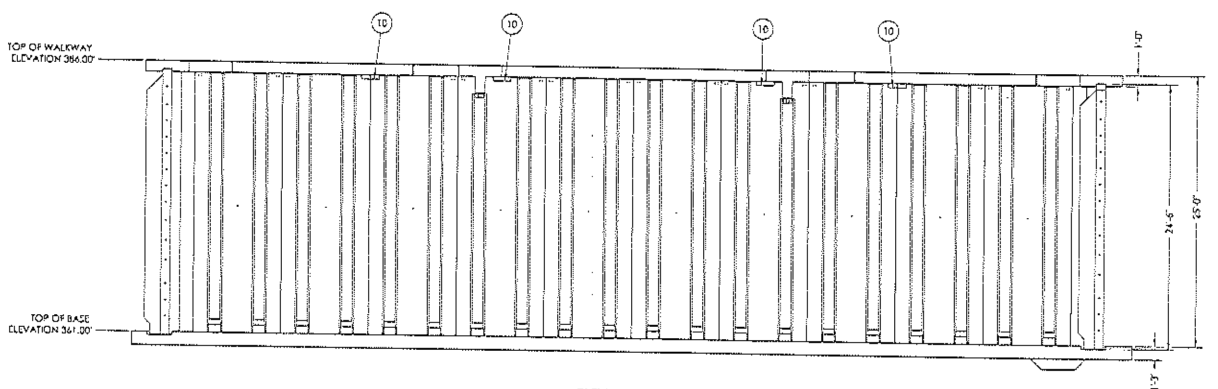
COORDINATE EMBEDMENTS AND ATTACHMENTS WITH CONTRACTOR



ELEVATION A - A
SCALE: 3/16" = 1'-0"



SECTION B - B
SCALE: 3/16" = 1'-0"



ELEVATION C - C
SCALE: 3/16" = 1'-0"

PENETRATION SCHEDULE

ITEM #	SIZE & TYPE	ELEVATION	DESCRIPTION
—	—	361.00	TOP OF BASE
1	4" PLASTIC WALL SLEEVE	C.L. 378.50	4" D.I. VENT PIPE
2	12" DIFL x FL	C.L. 366.50	12" D.I. INFLUENT PIPE
3	4" PLASTIC WALL SLEEVE	C.L. 366.00	4" D.I. TO SUB PUMP
4	10" PLASTIC WALL SLEEVE	C.L. 364.25	6" 304 S.S. AIR LINE TO BLWR [illegible]
5	1" PLASTIC WALL SLEEVE	C.L. 374.17	1" PVC [illegible] ALUM
6	12" DIFL x FL	C.L. 371.00	12" D.I. DECANT LINE
7	VOID		VOID
8	12" DIFL x FL	C.L. 368.50	12" WALL PIPE WITH BLIND FLANGE
9	4" x 24" OPENING	INV. 384.42	4" x 24" ELECTRICAL CONDUIT CUTOUT
10	4" x 20" OPENING	INV. 384.42	4" x 20" SPILLWAY OPENING

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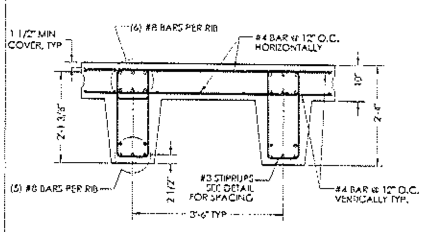
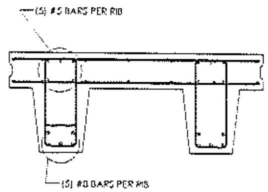
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT UPGRADE
CHESTER COUNTY, PA

ELEVATIONS & SECTIONS

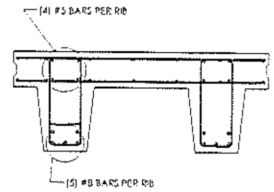
Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-08
Scale: 3/16" = 1'-0"
Sheet No. 06



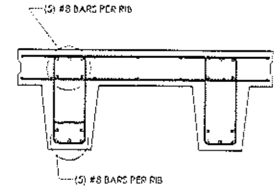
RIBBED WALL REINFORCING SECTION PANELS # 1-5, 51-56
SCALE : 3/4" = 1'0"



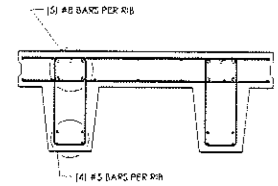
RIBBED WALL REINFORCING SECTION PANELS # 6-8, 57-62
SCALE : 3/4" = 1'0"



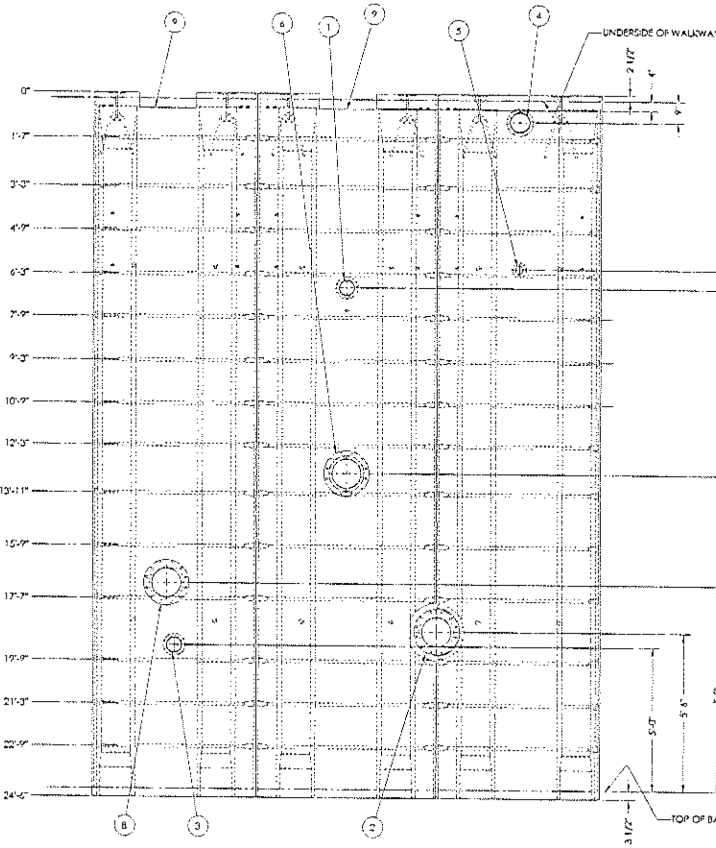
RIBBED WALL REINFORCING SECTION PANELS # 9-10, 41-50
SCALE : 3/4" = 1'0"



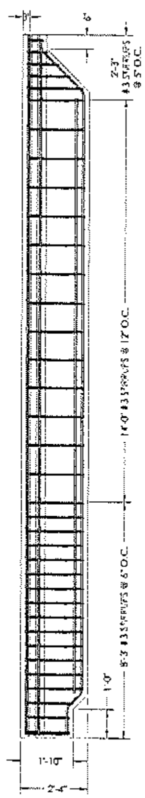
RIBBED WALL REINFORCING SECTION PANELS # 11-40
SCALE : 3/4" = 1'0"



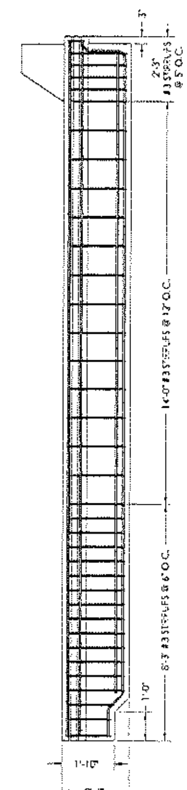
RIBBED WALL REINFORCING SECTION PANELS # 63-74
SCALE : 3/4" = 1'0"



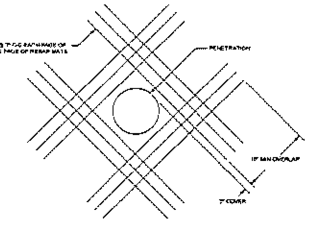
EXTERIOR WALL PANELS CONDUIT & PENETRATION LOCATIONS
SCALE : 1/2" = 1'0"



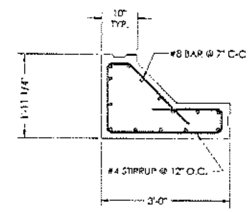
EXTERIOR RIBBED WALL STIRRUP SPACING
SCALE : 1/2" = 1'0"



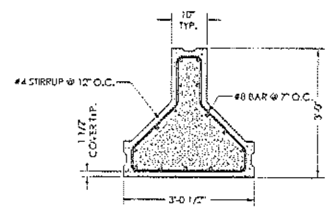
INTERIOR SQUARE RIBBED WALL STIRRUP SPACING
SCALE : 1/2" = 1'0"



REBAR LAYOUT AROUND PENETRATIONS Ø24" & SMALLER
NTS



CORNER REINFORCING
SCALE : 3/4" = 1'0"



TEE REINFORCING
SCALE : 3/4" = 1'0"

PENETRATION SCHEDULE

ITEM #	SIZE & TYPE	ELEVATION	DESCRIPTION
--	--	361.00	TOP OF BASE
1	8" PLASTIC WALL SLEEVE	C.L. [illegible]	4" D.I. VENT PIPE
2	12" DIFL X FL	C.L. 368.[illegible]	12" D.I. INFLUENT PIPE
3	8" PLASTIC WALL SLEEVE	C.L. 366.66	4" D.I. TO SUB DUMP
4	10" PLASTIC WALL SLEEVE	C.L. 384.35	[illegible]
5	3" PLASTIC WALL SLEEVE	C.L. [illegible]	1" PVC SCHED ALUM
6	12" DIFL X FL	C.L. [illegible]	12" D.I. DECANT LINE
7	VOID		VOID
8	12" DIFL X FL	C.L. 368.33	12" WALL PIPE WITH BLIND FLANGE
9	4" X 24" OPENING	INV. 384.43	4" X 2'-0" ELECTRICAL CONDUIT CUTOUT
10	4" X 20" OPENING	INV. 384.43	4" X 20" SPILLWAY OPENING

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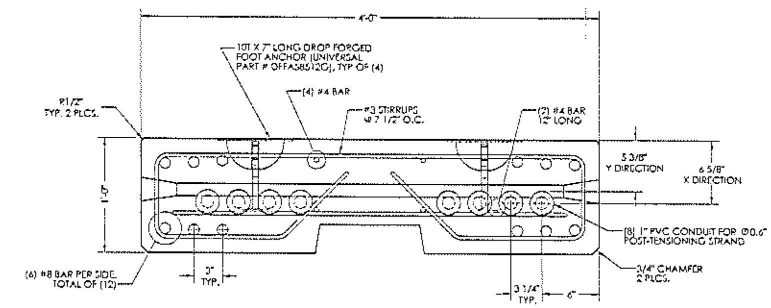
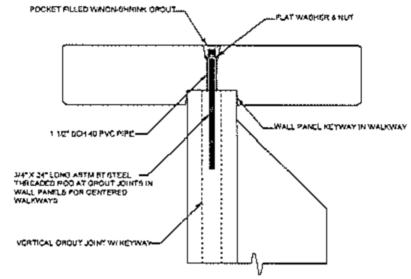
PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT
UPGRADE
CHESTER COUNTY, PA

WALL PANEL DETAILS

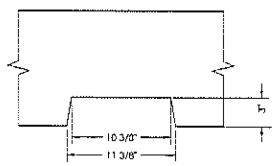
Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
Issue Date: 11-10-08
Scale: AS NOTED
Sheet No.: 07



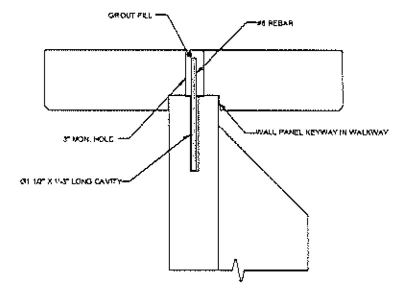
WALKWAY REINFORCEMENT DETAIL
SCALE : 2" = 1'0"



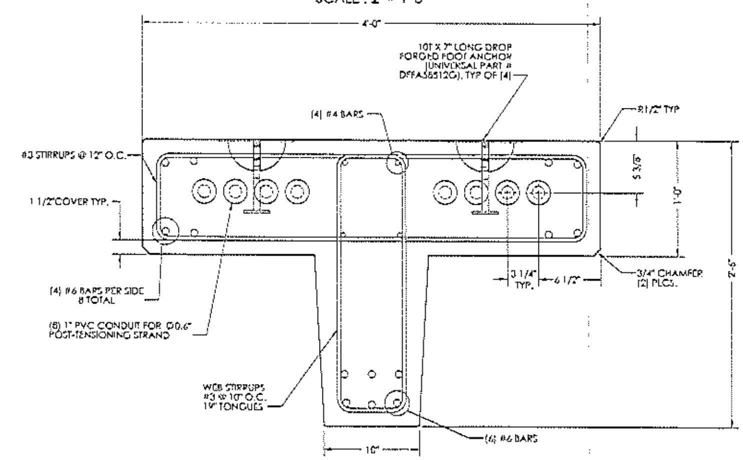
WALL PANEL/WALKWAY CONNECTION AT WALL JOINT DETAIL
SCALE: NTS



WALKWAY KEYWAY DETAIL
SCALE : 2" = 1'0"



WALL PANEL/WALKWAY CONNECTION DETAIL
SCALE: NTS



CLEARSPAN WALKWAY REINFORCEMENT DETAIL
SCALE : 2" = 1'0"

PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT UPGRADE
CHESTER COUNTY, PA

WALKWAY DETAILS

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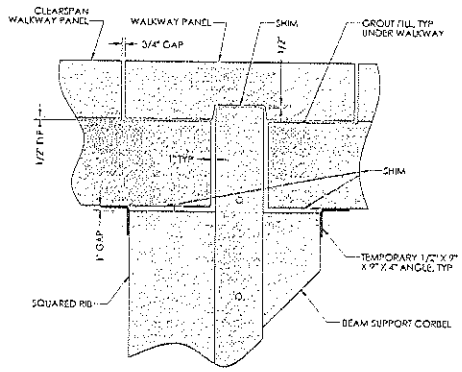
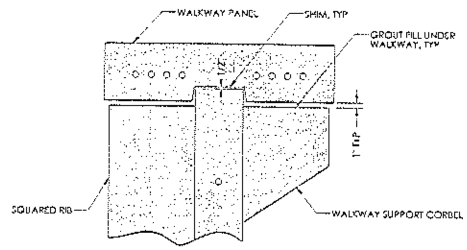
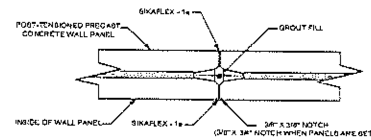
Job Number: 06176	
Project Manager: MF	
Drawn By: MGP	
Engineered By: DMB	
Checked By: JES	
Issue Date: 11-10-08	
Scale: AS NOTED	
Sheet No. 08	



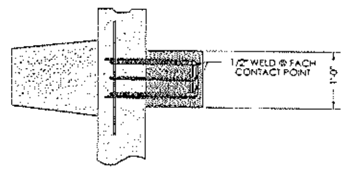
BEAM SUPPORT CORBEL CONNECTION DETAIL
SCALE : 1" = 1'0"

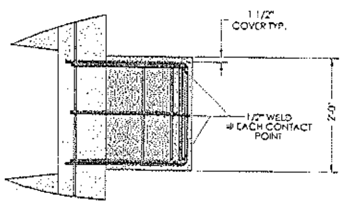


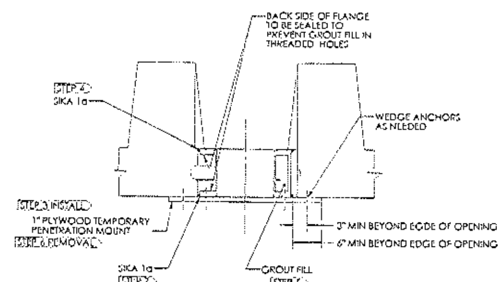
WALKWAY SUPPORT CORBEL CONNECTION DETAIL
SCALE : 1" = 1'0"



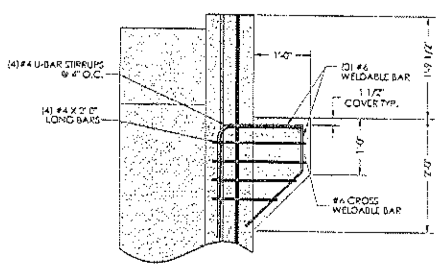
WALL PANEL JOINT
NTS







SECTION B-B
INSTALLATION
SCALE: 1" = 1'-0"



BEAM SUPPORT CORBEL DETAIL
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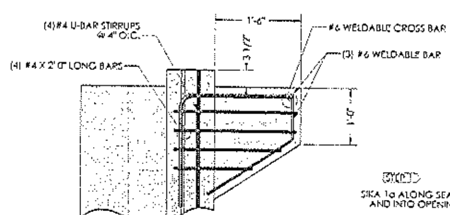
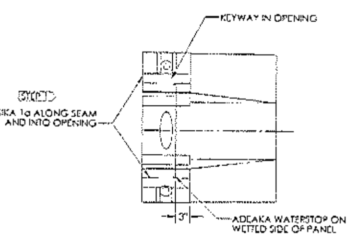
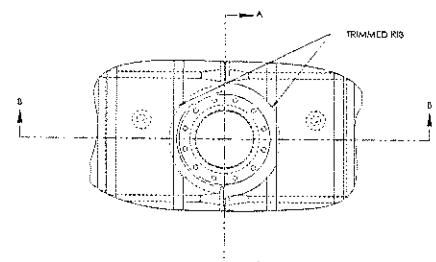


WALKWAY SUPPORT CORBEL DETAIL
SCALE : 1" = 1'0"



SECTION A-A
WALL PREPARATION
SCALE: 1" = 1'-0"



PENETRATION IN WALL SEAM
INSTALLATION SEQUENCE
SCALE: 1" = 1'-0"

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160 Rt. 41 • PO Box 549 • Gap, PA 17527-0549
PA 717-442-8282 Fax 717-442-9330
www.dutchlandinc.com

PROJECT:
RIDLEY CREEK
WASTEWATER TREATMENT PLANT UPGRADE
CHESTER COUNTY, PA

MISCELLANEOUS DETAILS

Job Number: 06176
Project Manager: MF
Drawn By: MGP
Engineered By: DMB
Checked By: TAW
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Appendix D:

Petrographic Analysis of Concrete Cores

RIDLEY CREEK SEWAGE TREATMENT PLANT
Petrographic Examination of Concrete Cores

West Chester, Pennsylvania

September 8, 2017
WJE No. 2017.5268

Prepared for:
Mr. Matthew Stuart
Structural Division Manager
Pennoni Associates Inc.
3001 Market Street
Philadelphia, Pennsylvania 19104

Prepared by:
Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax

RIDLEY CREEK SEWAGE TREATMENT PLANT
Petrographic Examination of Concrete Cores

West Chester, Pennsylvania

Karla Kruse

Karla Kruse, PE (OH)
Associate III and Petrographer

Susanne M. Papas

Susanne M. Papas
Senior Associate and Project Manager

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Ridley Creek Sewage Treatment Plant
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INTRODUCTION

At the request of Mr. Matthew Stuart of Pennoni Associates (Pennoni), Wiss, Janney, Elstner Associates, Inc. (WJE) completed a document review and petrographic examination of two concrete cores that had been extracted from a wall of SBR Tank #1 at the Ridley Creek Sewage Treatment Plant located in West Chester, Pennsylvania. In 2009, renovations that included the installation of four precast concrete, post-tensioned sequencing batch reactor (SBR) tanks were completed. The tanks were a delegated design by Dutchland. Soon after installation and during initial testing, seepage through cracks in the tanks was observed. The cracks were treated with a cementitious product that failed, and they were subsequently routed and sealed with Sika 1a sealant. The sealant also failed, and as a result, CIM 1000, a CIM Industries liquid urethane coating system manufactured by Chase Corporation, was installed on the interior of the tanks. The coating is currently exhibiting bubbling and peeling from the tank interior (Figure 1). The pattern of distress on the tank walls was not provided to WJE. The petrographic studies were requested to determine the current condition of the concrete and the coating material.

DOCUMENT REVIEW

Pennoni provided several documents to WJE for review during the current studies. A summary of pertinent information from each of the documents is provided below.

CIM Industries Instruction Guide: Application of CIM to Concrete, dated July 2010

- *The CIM shall consist of a minimum of 55 dry mils...*
- *CIM shall be applied to clean, dry, structurally sound concrete.*
- *Concrete shall only be coated while the concrete is in a temperature declining mode (usually late afternoon). CIM 61BG Epoxy Primer may be used to minimize outgassing...Therefore, if concrete is coated in direct sunlight (e.g. a temperature rising mode), outgassing will generally occur.* The CIM 61BG Epoxy Primer is a high solids epoxy primer according to manufacturer's literature.
- Section 4.1 *New Concrete,* states that *it is recommended to remove the concrete laitance and expose the tops of the underlying aggregate. This condition is typically represented by an ICRI Concrete Surface Profile of 4 to 6 to expose aggregate. In order to properly prepare the concrete, and remove any release agents or curing compounds, any one of the following can be performed: 1. Abrasive blasting..., 2. Water blasting..., 3. Shot blast...*
- Section 4.3 *Bugholes,* states that *It is important to blast all concrete surfaces where bugholes are present to expose the full view of the hole...Bugholes should be filled with appropriate repair materials...*
- *C.I.M. Industries recommends performing two or more of the following tests to confirm appropriate moisture levels for properly prepared substrates: 1. Plastic Sheet method..., 2. Relative Humidity test..., 3. Calcium Chloride test..., 4. Radio Frequency test...*
- CIM 1000 Trowel Grade may be used to fill cracks, to coat penetrations, and used on sharp edges. According to product literature, CIM 1000 Trowel Grade is a liquid applied urethane elastomer coating.
- *When working with CIM, vertical or sloped surfaces require a minimum of two (2) applications of approximately 30 mils each to obtain the required thickness.*

Letter from Maribeth Taylor (Chase Corporation) to Mr. Joshua Allen (Dutchman), dated March 29, 2017

- *Blistering evident at the transitions and along the cold joint of the divider wall.*
- *Evidence of thin second coat of membrane; peeling from the first coat in select areas. Field sample measured less than 30 mils.*

Dutchland Project Submittal, dated November 2008

- Included was the precast concrete mix design prepared by Dutchland with a revised date of January 31, 2006. The mix design specifies the use of 529 pounds of cement and 176 pounds of fly ash. The air content is designed to be 6 percent. The designed water-to-cementitious materials ratio (w/cm) is 0.38. The 28-day compressive strength is designed to be 5,000 psi.
- CIM Industries CIM 1000 Product Data Sheets contain similar data as presented above for the installation guide. *CIM 1000 is a liquid applied urethane coating that cures in hours to form a tough elastomeric liner that adheres to most substrates, forming a chemical and abrasion resistant barrier for waterproofing, corrosion protection, and containment of water and most aqueous chemicals.* The PDS also indicates a solids content (by volume) of 88 percent.
- A PDS for ProSpec BlendCrete manufactured by Sakrete was provided in the submittal. This is intended for use *as a patching material for strand pockets, lifting pockets in the walkways, and any other type hole that requires patching. ProSpec BlendCrete is a one component, polymer modified, cement based concrete and masonry patching compound requiring only the addition of water. To fill areas deeper than 2", add 15 lbs. of clean saturated surface dry 3/8" pea gravel...*

ProSpec BlendCrete Safety Data Sheet (SDS) from Website, dated December 21, 2012

- Ingredients listed on the SDS include: quartz sand, alumina cement, portland cement, calcium carbonate, kaolin, and lithium carbonate.

No information regarding the method of coating installation was provided by Pennoni for review.

LABORATORY TESTING

Samples

Two concrete cores 3-1/4 inches in diameter were received from Pennoni on August 25, 2017, for our studies. The cores had been extracted horizontally through adjacent vertical interior walls of SBR Tank #1 at WP-32. They were not full depth, and had fractured at a depth of 4-1/2 and 5-1/2 inches, respectively, within the concrete wall. The exterior surface of both cores contains a black coating membrane reported to be the CIM 1000 coating. For this report, the exterior surface of the cores represents the interior formed tank walls on which the coating was applied. The interior surface of the cores represents the fracture surface within the tank wall. No reinforcement was intersected by either core. The as-received appearance of the samples is presented in Figures 2 and 3.

Studies

Full-depth longitudinal slabs were cut from the middle of each core and oriented perpendicular to the exterior core surface. The sawed surfaces of the slabs were then lapped using progressively finer water-cooled diamond abrasive discs to achieve a fine matte surface suitable for examination under a reflected light microscope. Lapped surfaces are pictured in Figure 4. Thin sections were prepared for the outer 2 inches of each core. The thin sections and powder mounts were examined using a petrographic microscope. The lapped surfaces, thin sections, and remainders of the cores were examined using methods outlined in ASTM C856, *Practice for Petrographic Examination of Hardened Concrete*.

Findings

Coating and Concrete Near-Surface Zone

The exterior surfaces of Cores C1 and C2 were covered with a black coating material presumed to be CIM 1000. The material was elastic when probed with a steel needle. Two applications (Figure 5), and possibly three in some areas (Figure 6), of the coating were detected on the exterior surface of both cores. The average dry film thickness (DFT) for the coating layers on both cores is provided in Table 1. The exterior surface of the coating on the cores was discolored and cracked in an "alligator crack" pattern (Figure 7). No pinholes were detected within the exterior surface of the coating. Beyond the distress visible on the exterior surface of the coating, no degradation of the coating was detected within the cross-sectional surfaces of the cores. Spherical air voids were detected within the body of the CIM 1000 layers.

Core C1 - The CIM 1000 was applied directly to the surface of Core C1 (Figure 8). Minor undulations on the exterior formed surface profile of the concrete were detected. The surface does not appear to have been mechanically scarified or roughened prior to installation of the coating (Figure 13). The exterior surface of the concrete is discolored black to dark tan. Voids or bugholes that became infilled with CIM 1000 during the first coating application were detected on the exterior concrete surface, indicating that they had not been previously filled as recommended by the installation guide (Figure 9). The cementitious paste immediately (within 1/64 inch) below the finished concrete surface was tan in color and may be a result of an interaction with the CIM 1000 and/or due to carbonation of the paste. The presence of primer, as recommended by the manufacturer, would be detected as a beige-colored, discrete film-forming layer. Application Guide CIM IG-2 states a primer should be applied with a minimum of 5 mils wet and additional applications as needed to eliminate pinholes. A thin (approximately 4-5 mils) primer layer was not detected in either of the examined cores. The CIM 1000 had complete contact with the concrete substrate. Within the coating, the layers appeared to be well bonded to each other, and the coating also appeared to be well bonded to the finished surface of the concrete; however, cracks within the concrete immediately below the finished surface were present (Figure 10). These cracks were oriented parallel to the exterior surface at a typical depth of approximately 1/64 inch (Figure 11).

Despite these cracks, the coating appeared to be well adhered, as it was peeled (with difficulty) from the surface of the concrete in the laboratory and did not separate along the cracks within the concrete. When the exterior surface of the concrete was exposed by removal of the coating, the concrete was smooth and contained several bugholes that had been infilled with coating (Figure 12).

Core C2 - When viewed in cross-section, the concrete tank wall had been coated with a sanded skim coat, which was then overlain with the CIM 1000 coating (Figure 14). This skim coat layer was not present in Core C1.

The skim coat is a light gray, sanded mortar. The minimum thickness of the skim coat was measured to be approximately 6 mils and the maximum approximately 60 mils. The sand is angular quartz and quartzite. When viewed in thin section, the skim coat contains an abundant amount of high relief, low birefringent particles that are not uniformly distributed throughout the layer (Figure 15). Occasionally, red and yellow-colored particles (as viewed in reflected lighting on the thin section) are observed along the edge of sand particles (Figure 16). The color of these particles is consistent with aluminate cement, although additional studies would be needed to confirm this interpretation. Residual portland cement particles and a trace amount of fragmental limestone was detected. A few air voids were present within the skim coat and were partially filled with secondary deposits. The skim coat was applied to a smooth concrete surface that did not appear to have been mechanically scarified. (Figures 14-15 and 18-20). The cementitious paste along the interface with the skim coat was carbonated, indicating that the concrete had been exposed to the atmosphere for some period of time prior to application of the skim coat. The skim coat was in contact with the concrete, and no voids or separations were detected. However, microcracks oriented parallel to the exterior surface were detected in the thin section from the concrete (Figure 17). The exterior surface of the skim coat had a roughened profile and may have been scarified or finished to give some surface relief prior to installation of the CIM 1000 (Figure 18). Slight darkening of the near-surface paste where the skim coat had been in contact with the CIM 1000 was present.

The CIM 1000 coating on Core C2 was similar to that described on Core C1. The coating appears to have been applied in two applications, possibly three in some areas. Within the thickness of each application exist bubbles of entrapped air. No separations were present between the individual applications of the CIM 1000.

The coating had separated from the exterior surface of the skim coat (Figures 14, 18, 19, and 20). The skim coat had a roughened exterior surface profile that was reflected in the debonded surface of the innermost layer of the CIM 1000 (Figure 20), indicating both materials had been in intimate contact at some point before they became separated.

A blister was present on the surface of Core C2. The blister was probed in the core's as-received condition, and no fluids were present within the void space. The blister was a result of adhesive separation along the coating-to-skim coat interface. The thickness of the coating at the blister location was similar to other measured locations, and the overall thickness was in excess of the manufacturer's required minimum of 55 mils DFT. The roughened surface profile of the skim coat was reflected on the innermost surface of the coating (Figure 21), indicating that the materials had been in contact prior to the blister formation.

When the CIM 1000 coating was peeled from the core in the laboratory, white deposits were detected lining the surfaces of the coating and skim coat at the blistered locations (Figure 22). These deposits had optical properties consistent with carbonated secondary deposits, indicating that this region had been exposed to moisture migration after initial installation. Despite the separation detected on the lapped surfaces between the coating and the skim coat, the adhered portion of the coating was difficult to remove from the skim coat surface in the laboratory. The coating primarily peeled (adhesively) from the exterior surface of the skim coat, although some areas of the coating remained bonded to the skim coat, and the skim coat separated (adhesively) from the exterior concrete surface (Figure 23). The exterior surface of the skim coat that was in contact with the coating was discolored red-brown to dark brown in color (Figure 24). No discoloration was detected on the skim coat at the blistered location.

Concrete

The concrete represented by both examined cores is compositionally similar. The concrete contains crushed limestone coarse aggregate and manufactured siliceous sand fine aggregate (Figure 25). The coarse aggregate has a maximum size of 3/4 inch and is uniformly distributed throughout the cores. The fine aggregate consists primarily of quartz and feldspar and a trace amount of chert.

The paste contains portland cement and fly ash (Figure 26). The amount of fly ash was consistent with that specified in the mix design (25 percent). When viewed in thin section, residual portland cement particles were seen to be closely-spaced in both cores. A minor amount of cement-sized limestone fragments were also detected within the paste. The cementitious paste was dark gray in color as a result of a low w/c. On a microscopic level, mottling from light to dark gray was detected, indicating variability in w/c due to incomplete initial mixing. The paste could not be scratched using a copper probe. Fresh fracture surfaces had a vitreous luster and did not readily absorb water applied to them. Calcium hydroxide was abundant in thin section but exists as small, discrete blades. Based on these observations, the w/cm was estimated to be low, consistent with the mix design. The paste was highly air-entrained (Figure 27), and the volume of air was estimated to be 12-14 percent, double or more than double the specified air content of 6 percent. The voids in the concrete were generally spherical, entrained air voids. Needles of ettringite were detected lining some voids in Cores C1 and C2 in thin section indicating some secondary movement of water through the concrete (Figure 28).

Fresh fracture surfaces prepared in the laboratory were treated with phenolphthalein indicator solution to measure the depth of paste carbonation. The carbonation in the concrete was detected to a depth of 1/16 inch in Core C1 and 0 to 1/32 inch in Core C2 and was associated with a tan discoloration along the exterior of the concrete. Carbonation was detected to a depth of 1/32 inch on the exterior surface of the skim coat of Core C2 (Figure 29). The laboratory-induced fracture surfaces of both cores pass through coarse aggregate particles, indicating firm paste-to-aggregate bond.

DISCUSSION

Two concrete cores, reportedly taken from precast concrete tank walls, were examined to determine the cause of blistering of the urethane coating on the interior surface. The concrete represented by both cores is consistent with the precast mix design, including the proportions of portland cement and fly ash and the low w/cm, with the exception of the entrained air content. The volume of air in both Cores C1 and C2 was substantially in excess of that specified in the mix design; however, the highly air-entrained nature of the concrete does not appear to have adversely affected the bond between the cementitious paste and aggregate.

The interior surface of the precast concrete tanks had been coated with a black material. This black coating, reportedly CIM Industries, Inc. CIM 1000, is an asphalt-extended urethane. The discoloration of the cementitious paste of the concrete (in Core C1) and the skim coat (in Core C2) in contact with the CIM 1000 coating is consistent with a bitumen-containing coating product where a portion of the bitumen, aided by the presence of solvent in the coating formulation, has been absorbed into the porous, cementitious substrate. This discoloration was not readily observed at the blistered locations and may indicate the coating had limited initial contact at blister locations, possibly due to localized moisture or outgassing of concrete.

The CIM 1000 coating had been applied to a smooth, formed concrete tank surface in Core C1. The undulations on the exterior surface of the concrete tank are due to bugholes on the formed surface. Surface preparation had not been performed prior to application of the coating, which is contrary to recommendations by the coating manufacturer, CIM, in their installation guide and product data. The bugholes were not properly prepared and infilled with a repair material, in contrast to the manufacturer's recommendations to prepare and fill them. While cracks oriented parallel to the exterior concrete surface are present in Core C1 (and microcracks were detected in the thin section of Core C2), the coating appears to be well bonded to the substrate. The cracks do, however, act as planes of weakness within the system and may represent a future failure plane. Although it could not be determined when the cracks formed during the studies, the general lack of surface preparation on the concrete surfaces may indicate they formed after installation of the coating rather than as a result of surface preparation. No distress such as alkali silica reaction (ASR) was detected in the concrete except the cracks near the surface of Cores C1 and C2.

The CIM 1000 coating had been applied to a roughened exterior surface profile of a skim coat in Core C2. The skim coat had been applied to a formed concrete surface that had received no surface preparation, although the bond between the materials is firm. The skim coat appears to represent a poorly mixed product. The skim coat contains quartz sand, portland cement, possibly high alumina cement, and a small amount of fragmental limestone. These ingredients are consistent with the reported ingredients on the ProSpec BlendCrete SDS, although it cannot be confirmed during the current studies if the skim coat represents this product. It is unknown to WJE if this material is an approved substrate material for the CIM coating. The exterior surface of the skim coat has a rough profile and appears to have been scarified or given a rough surface texture during troweling prior to application of the coating. Regardless, the coating has primarily separated from the skim coat (adhesive failure). The mirrored surface relief of the skim coat in the coating along the failure plane, at both unblistered and blistered locations, indicates that the coating and the skim coat had been in initial contact, although the materials may have separated shortly thereafter at blistered locations.

The blistering is likely a result of moisture in and outgassing from the concrete substrate. Product literature recommends performing moisture testing on the substrate prior to coating application. It is unknown to WJE if any moisture testing was performed and the age of the precast tanks prior to installation of the coating. The presence of secondary deposits within the blister indicates that moisture may have been present at the separated interfaces indicating osmotic blistering may be contributing factor. At the time the cores arrived in the laboratory, no fluid was observed within the blister. The coating had been in intimate contact with the skim coat at the blister location, indicating the blister formed after initial installation. However, the general lack of discolored skim coat at the blistered location may indicate the materials had not been in intimate contact for a prolonged period of time prior to their separation. The use of an epoxy primer, as recommended, would be expected to lessen the effects of substrate moisture on the coating bond.

The CIM 1000 coating is reported in product literature to be 88 percent solids by volume. The remaining volume is composed of solvents. The flashing of solvents can affect the bond of the coating to porous substrate if the coating is applied in a rising temperature environment and/or in sunlight. While the timing of coating installation was not reported by Pennoni to WJE, volatilization of solvents from the coating could have contributed to blister formation.

The CIM 1000 coating on both cores consists of two, and at some locations three, applications. The inter-layer bond strength is firm, and separation between the layers, as was mentioned by Ms. Maribeth Taylor of Chase Corporation in her March 29, 2017, letter to Mr. Joshua Allen of Dutchland, Inc., was not observed in the examined cores. While the average thicknesses of the individual layers are greater than the required DFT (Table 1), locations were observed in both cores where the thickness is less than the recommended 30 wet mils in one of the layers. In general both cores exhibit, a total thickness of the coating (at blistered and non-blistered locations) greater than CIM's minimum recommended thickness.

SUMMARY

To summarize the pertinent findings from the studies:

Concrete

- The concrete is highly air entrained but still firm and intact, with the exception of a few near-surface microcracks.

- The cause(s) of the microcracks was not determined by the studies, but the cracks likely formed after installation of the coating.
- The cracks may represent a future plane of weakness in both cores.

CIM Industries, Inc. CIM 1000 Coating

- The coating was applied to a concrete surface that does not appear to have been scarified (in the case of Core C1) and was applied over a skim coat mortar (in the case of Core C2).
- An epoxy primer as recommended by the coating manufacturer was not detected in either core.
- Although the formed concrete surface does not appear to have been properly scarified in Core C1, the coating was well bonded to the concrete surface.
- Based on the petrographic studies, the skim coat in Core C2 may represent a proprietary product, but further studies would be needed to fully characterize it.
- Separation between the CIM 1000 and the skim coat is present in Core C2, at both blistered and non-blistered locations. Despite the separation, the coating was difficult to remove from the surface of Core C2 and may indicate good bond at non-blistered locations. It is unknown to WJE if the skim coat material was approved for use by the coating manufacturer.
- In Core C2, the reflection of the irregular surface profile of the skim coat in the CIM 1000 at the blistered location indicates the two materials had achieved initial contact during installation. However, the general lack of staining of the skim coat beneath the coating at the blister may indicate that the initial bond between the two materials was poor and adhesive separation may have occurred shortly after installation.
- No differences were readily visible during the examination at the blistered locations compared to the non-blistered locations, such as total coating thickness, surface preparation, or coating layers, that could explain the formation and location of the blisters.
- The volatilization of solvents from the CIM 1000 coating and the presence of moisture in the concrete substrate are likely contributors to the blister formation and lack of bond.
- Although the average layer thickness and the average combined total coating thickness meets the product requirements for both cores, the thickness at several discrete locations of both layers in both cores were below the recommended minimum of 30 mils WFT (equivalent to 26 mils DFT).

Table 1. Average CIM 1000 Coating Thickness

Average Coating Dry Film Thickness (mils)	Core C1	Core C2	CIM Recommended Minimum DFT[1]
First Applied Layer	37	32	26
Second Applied Layer	27	33	26
Third Applied Layer (select locations only)	29	32	--
Total Thickness	69	76	55

[1] The CIM 1000 product literature states an individual layer minimum thickness of approximately 30 mils. It is assumed that this recommendation is a wet thickness measurement. Due to the volume of solids (88%) reported for the product, the corresponding dry thickness is approximately 26 mils (DFT). The product literatures states a minimum DFT for the total coating to be a minimum of 55 mils.

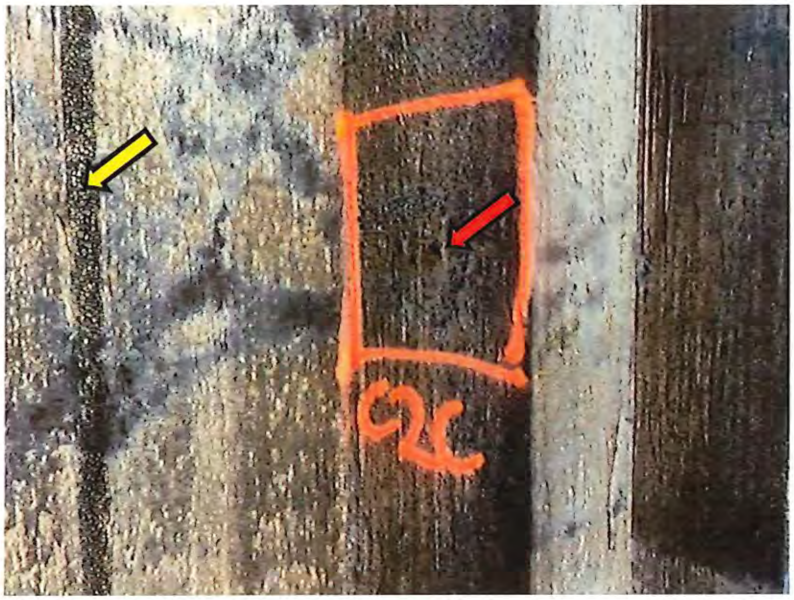

Figure 1. Microcracking within the outer surface of the CIM 1000 coating (yellow arrow) and blistering (red arrow) of the coating is visible on the interior tank wall. This was the location where Core C2 was extracted. Image provided by Pennoni.

Figure 2. The as-received appearance of the exterior coated surface (top left), the interior fracture surface (top right), and the side of Core C1 is pictured.

Figure 3. The as-received appearance of the exterior coated surface (top left), the interior fracture surface (top right), and the side of Core C2 is pictured. A blister on the exterior surface of Core C2 is identified with an arrow.

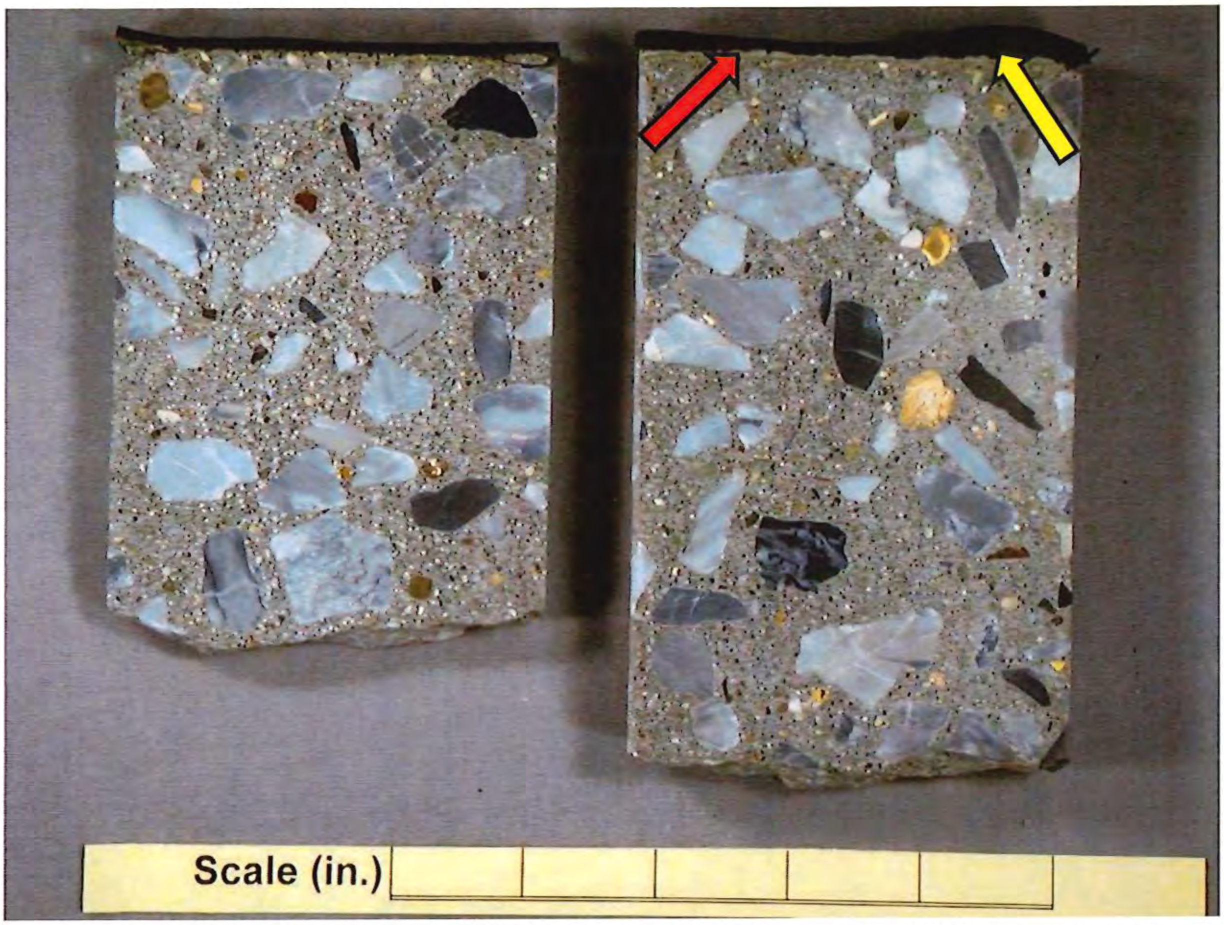

Figure 4. The lapped surfaces of Core C1 (left) and Core C2 (right) are pictured. The cores represent compositionally similar concrete. A blister on the surface of Core C2 is identified with a yellow arrow. A skim coat (red arrow) is located between the CIM 1000 coating and the concrete in Core C2 and is not present in Core C1.

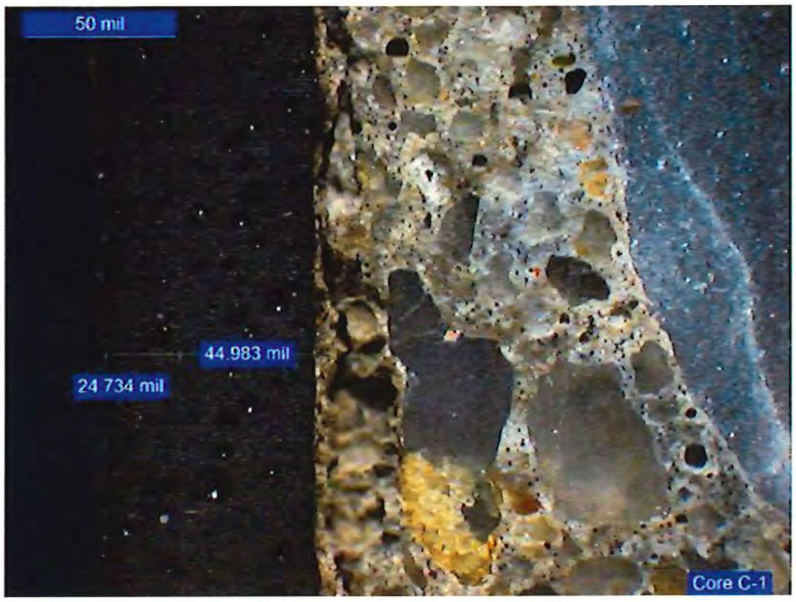

Figure 5. Two applications of the coating were detected on the exterior surface of both cores, pictured for Core C1. At this location, the first application of the coating is measured to be 44.983 mils DFT, and the second application is 24.734 mils DFT.

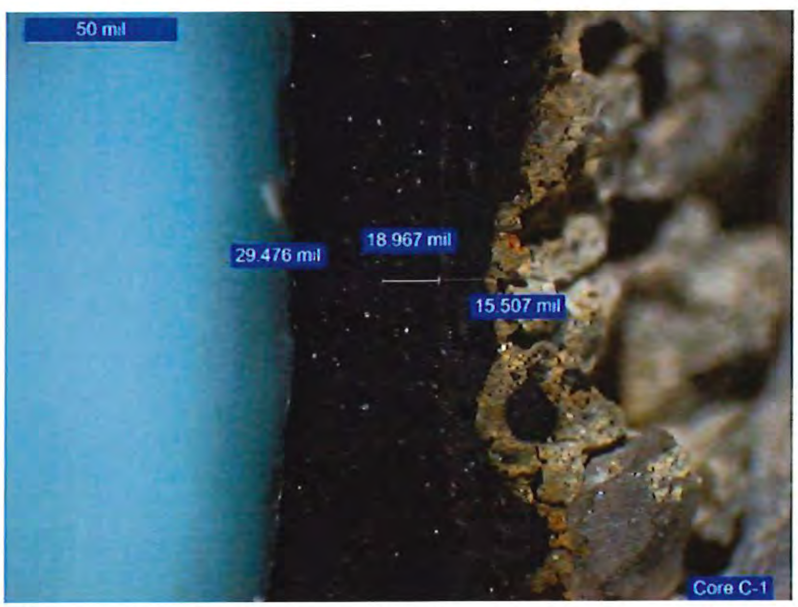

Figure 6. At the location pictured for Core C1 (also observed in an area in Core C2), there appear to be three applications of the CIM 1000 coating. The first application was measured to be 15.507 mils DFT, second application to be 18.967 mils DFT, and the third application to be 29.476 mils DFT.

Figure 7. The exterior surface of the coating exhibits an "alligator cracking" pattern, pictured for Core C2.

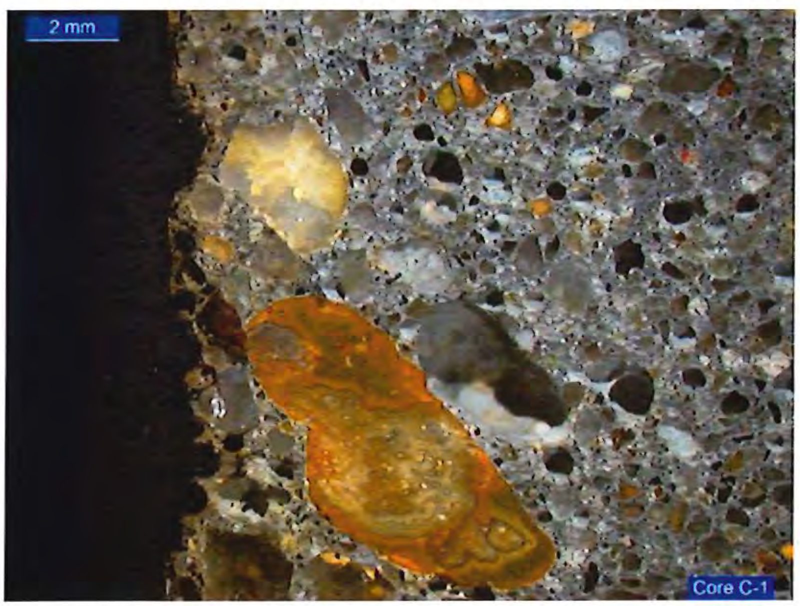

Figure 8. In Core C1, the CIM 1000 coating was applied directly to the concrete tank wall, and no primer was detected. The concrete immediately in contact with the coating is tan in color compared to gray color in the body of the core.

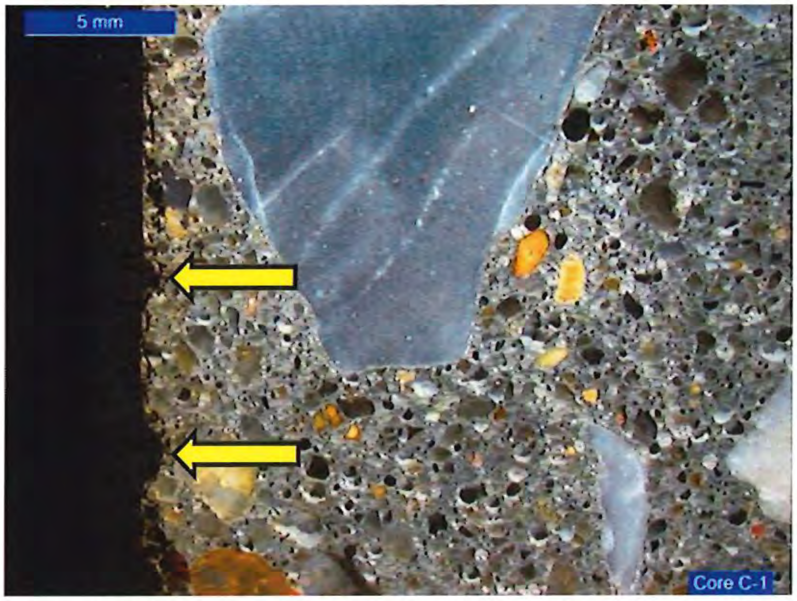

Figure 9. Voids, or bugholes (arrows), present on the exterior surface of the concrete substrate became infilled with CIM 1000 during the first coating application. The exterior surface of the concrete appears to be a smooth, formed surface.

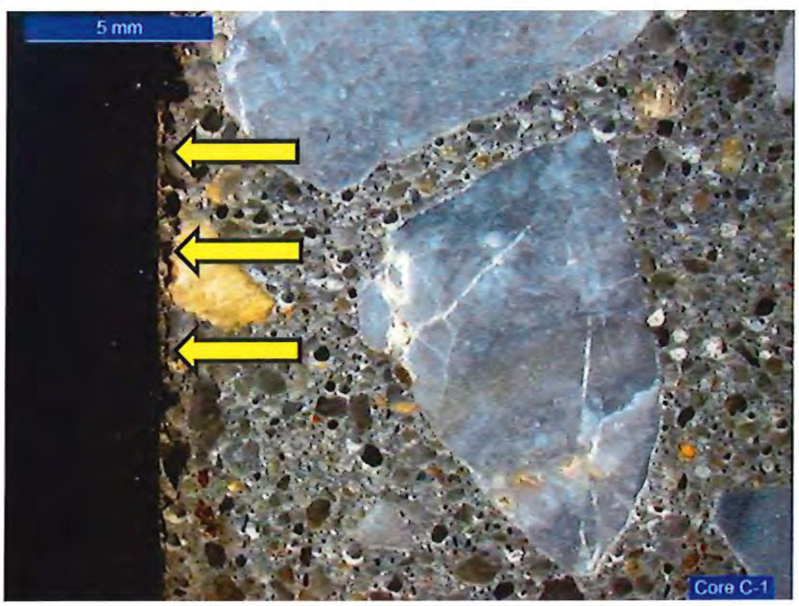

Figure 10. The CIM 1000 coating is well bonded to each other and to the exterior surface of the concrete. A crack (arrows) is located immediately inboard of the coating-to-concrete surface in Core C1.

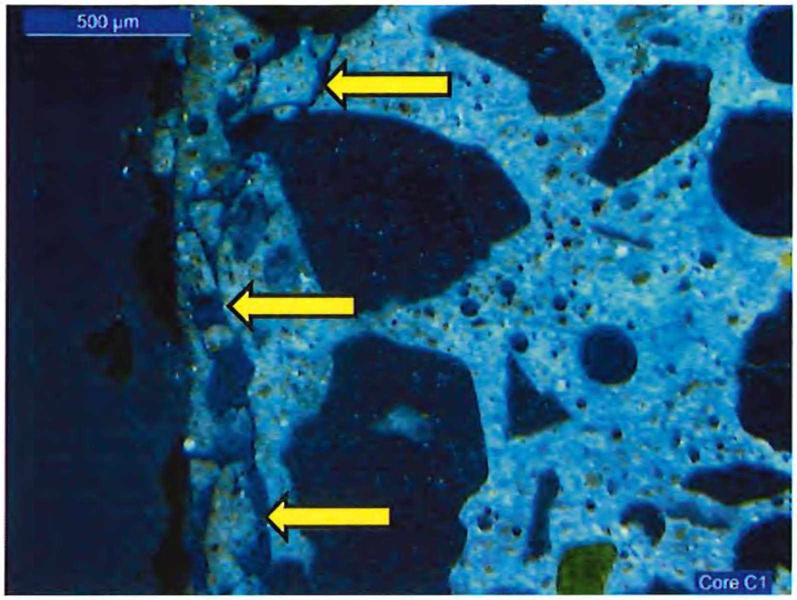

Figure 11. Parallel cracks (arrows) are located at a depth of approximately 1/64 inch from the exterior surface of the concrete in Core C1. Image taken of the thin section using reflected light.

Figure 12. The CIM 1000 coating was peeled from the concrete surface in the laboratory. The exterior surface of the concrete after coating removal is pictured. Several depressions are pictured on the exterior surface that became partially to fully infilled with coating.

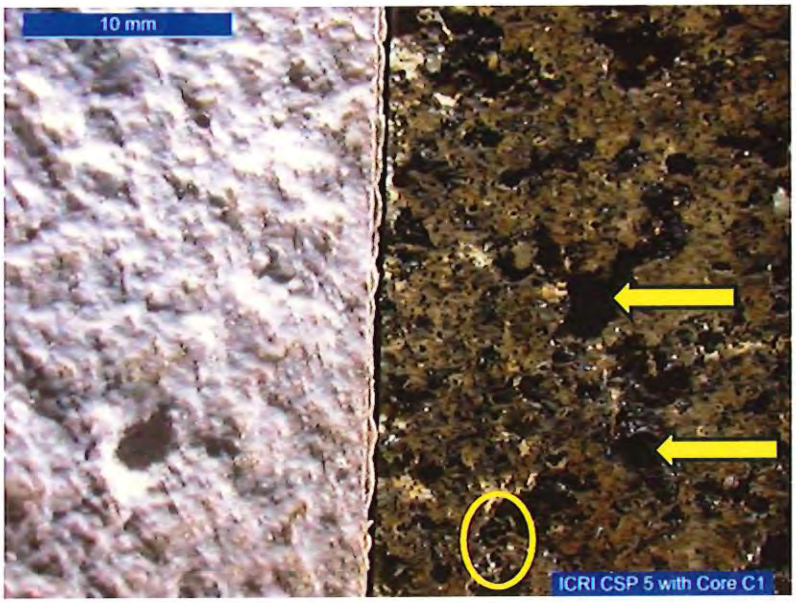

Figure 13. Per the product installation instructions, the concrete should be scarified to an ICRI CSP of 4-6. The ICRI CSP 5 profile chip is pictured adjacent to the exterior concrete surface of Core C1. The exterior surface of the concrete in Core C1 does not appear to have been mechanically scarified or roughened prior to installation of the coating. The voids (arrows) on the surface are bugholes typical on a formed surface. A cluster of truncated air voids are present in the circled region.

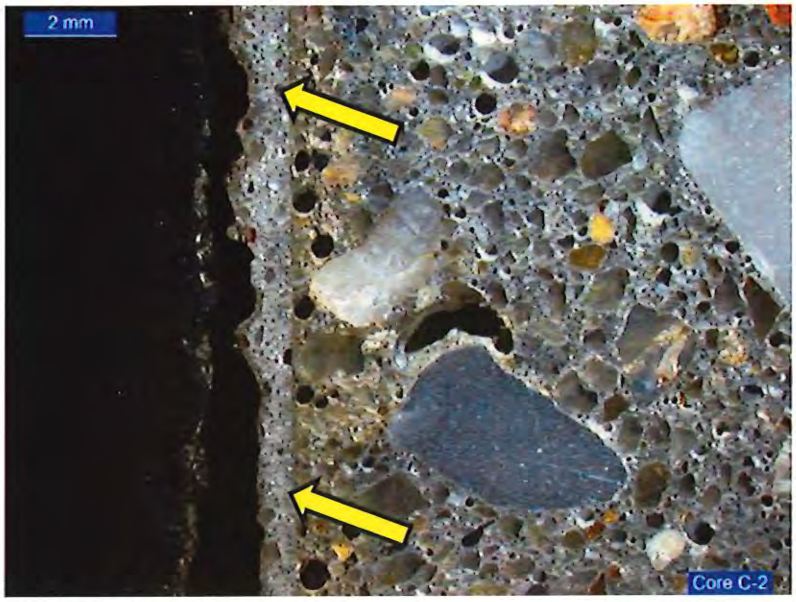

Figure 14. The CIM 1000 coating in Core C2 had been applied to a skim coat layer (arrows) that had been applied to the exterior concrete surface. The coating has adhesively separated from the skim coat. Compare to Core C1 in Figure 8 where the skim coat is not present.

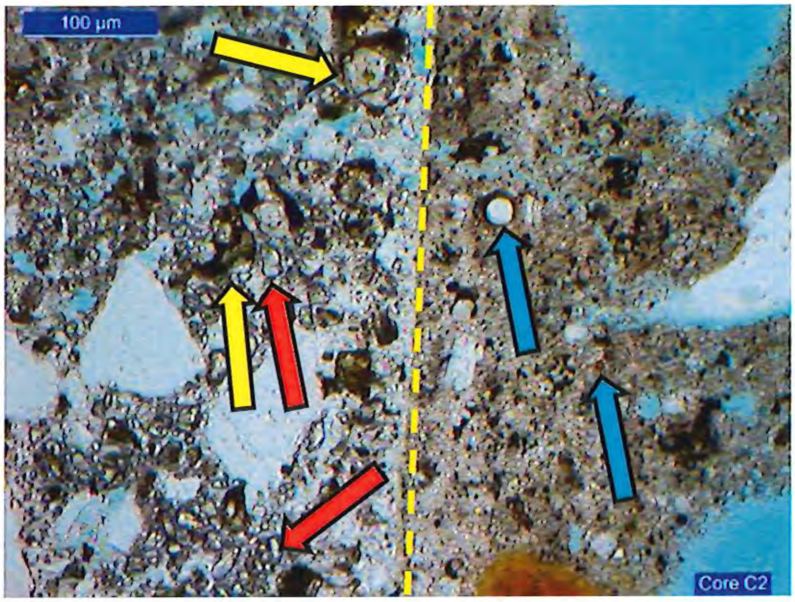

Figure 15. The skim coat is pictured to the left of the concrete substrate (interface marked with a dashed line) in the thin section of Core C2 pictured in plane-polarized light. The skim coat contains portland cement (yellow arrows) and possibly aluminate cement (red arrows). Fly ash spheres in the substrate concrete are identified with blue arrows.

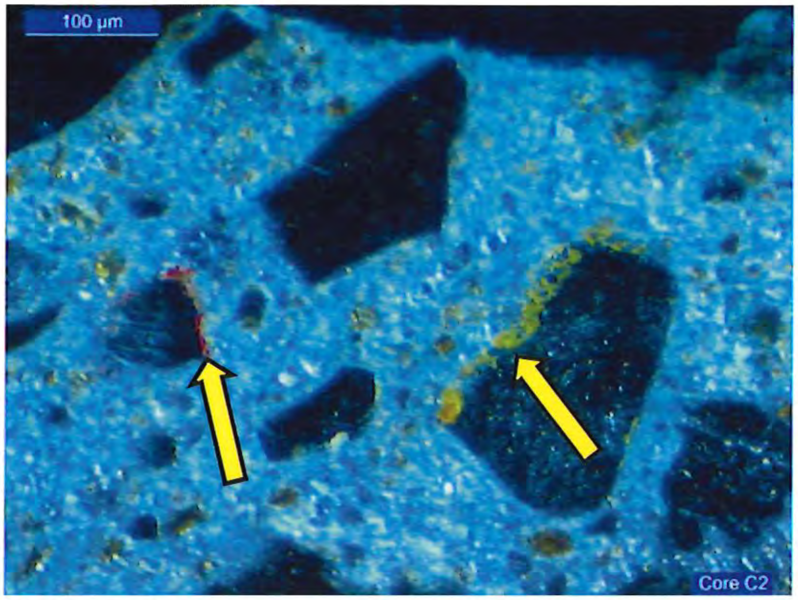

Figure 16. The skim coat in Core C2 is pictured in thin section using reflected light. Material around the edge of two sand particles is red and yellow in color (arrows). Similar colored material has been detected in high alumina cements, although additional studies would be required for confirmation.

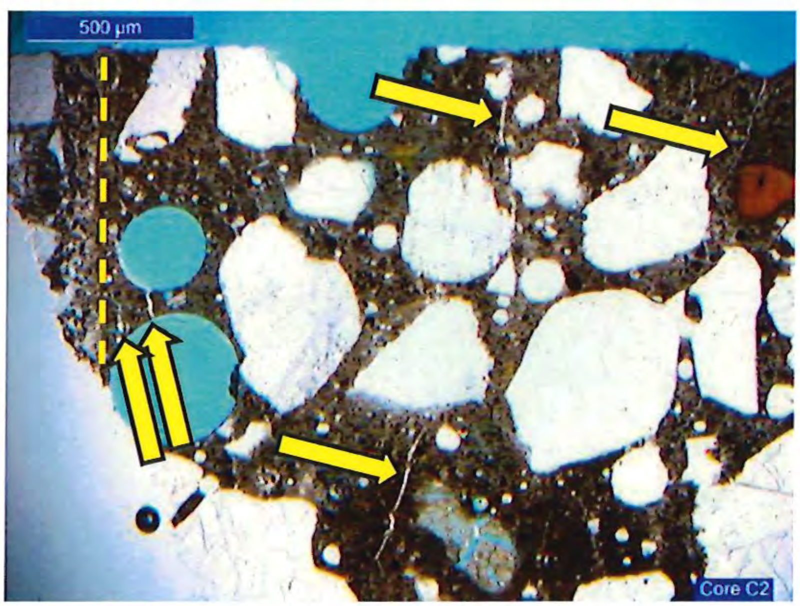

Figure 17. Microcracks (arrows) oriented parallel to the exterior surface of the concrete (represented by the dashed line) were detected in thin section of Core C2 in plane-polarized light.

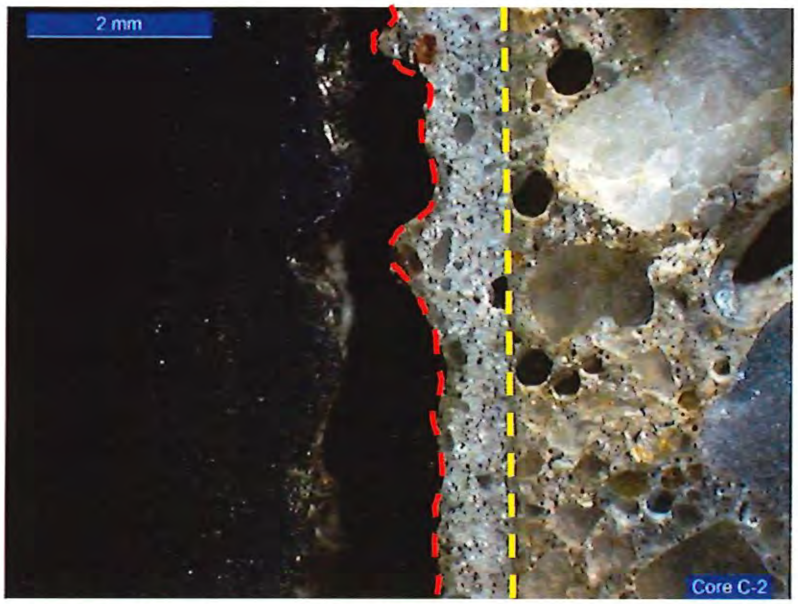

Figure 18. The exterior surface of the concrete (yellow dashed line) is smooth and was not scarified prior to application of the skim coat. The exterior profile of the skim coat (red dashed line) has an irregular surface profile. Adhesive separation between the coating and the skim coat is pictured in Core C2.

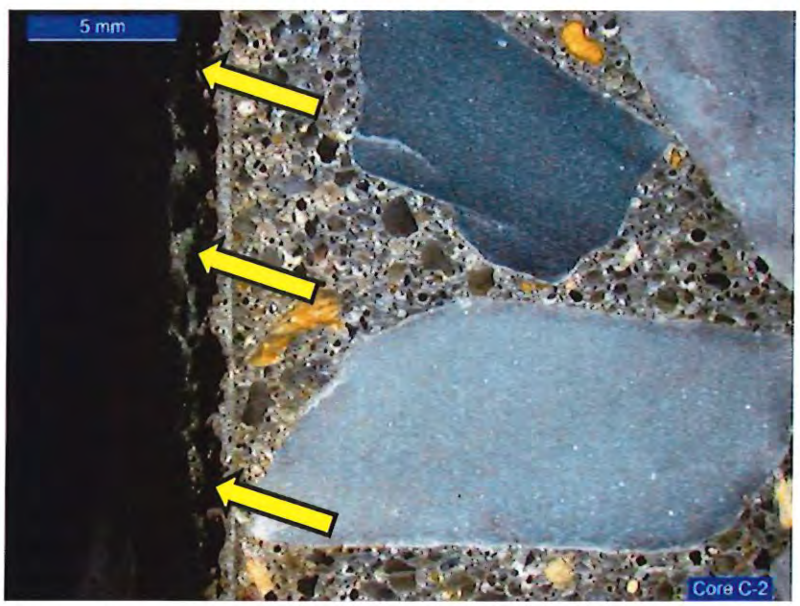

Figure 19. The CIM 1000 coating has adhesively separated (arrows) from the exterior surface of the skim coat in Core C2.

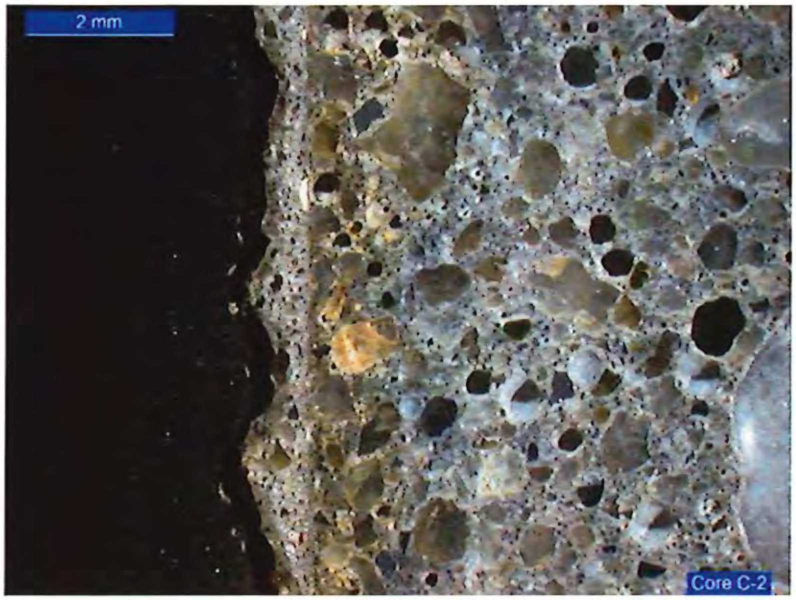

Figure 20. The irregular exterior profile of the skim coat is reflected on the debonded surface of the coating. This feature indicates the coating had been in contact with the skim coat prior to separation.

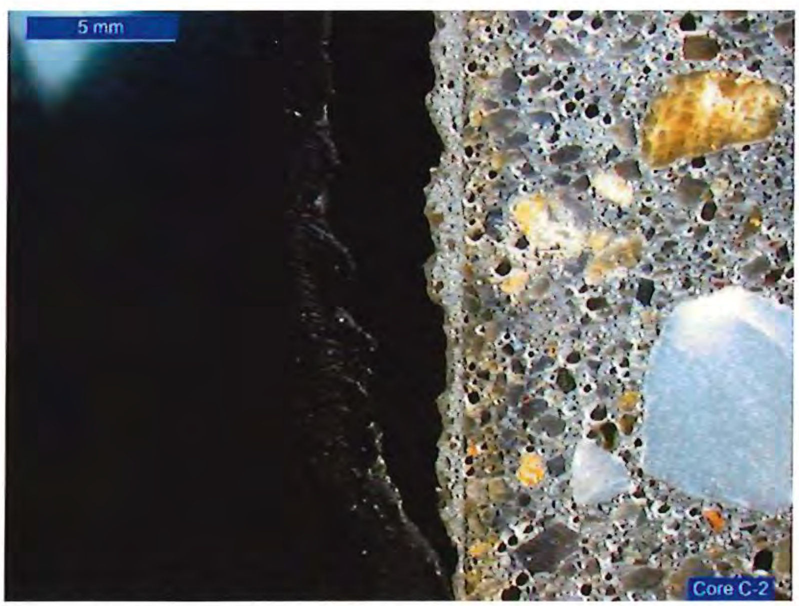

Figure 21. The irregular surface profile of the skim coat is reflected on the inboard surface of the coating at the blister, indicating that the materials had been in contact prior to the blister formation.

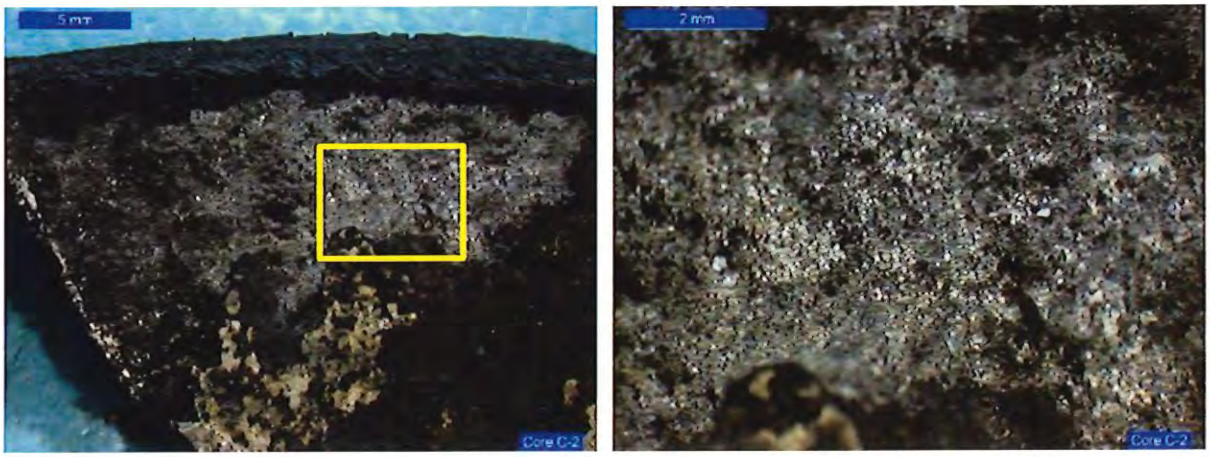

Figure 22. The inboard surface of the coating in Core C2 is pictured on the left after it had been peeled from the core. The area pictured represents the blister location. The boxed region is pictured at higher magnification on the right. White deposits are observed lining the coating at the blister location.

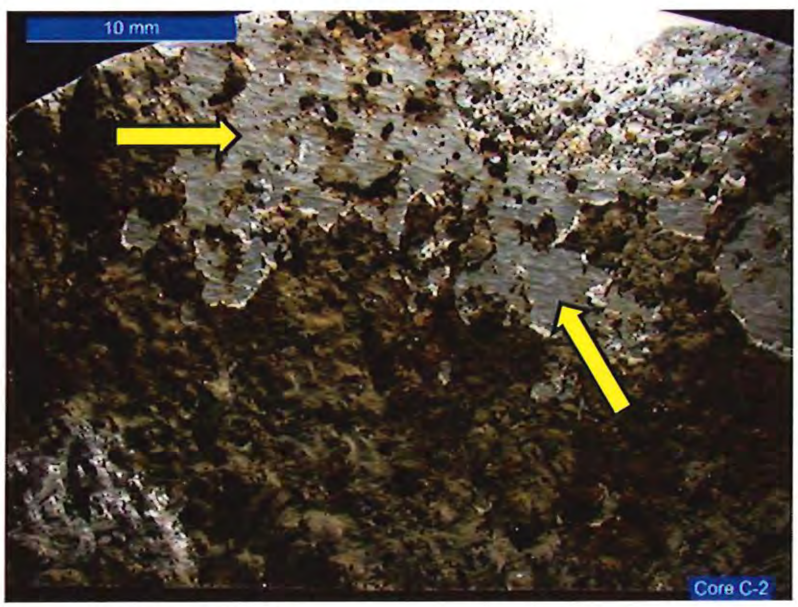

Figure 23. The CIM 1000 coating was peeled from the surface of Core C2. The resulting surface of the core is pictured. The laboratory-induced failure location represented primarily adhesive separation between the coating and the skim coat (bottom half of the image), although the skim coat adhesively separated from the smooth, formed concrete surface near the top of the image (arrows).

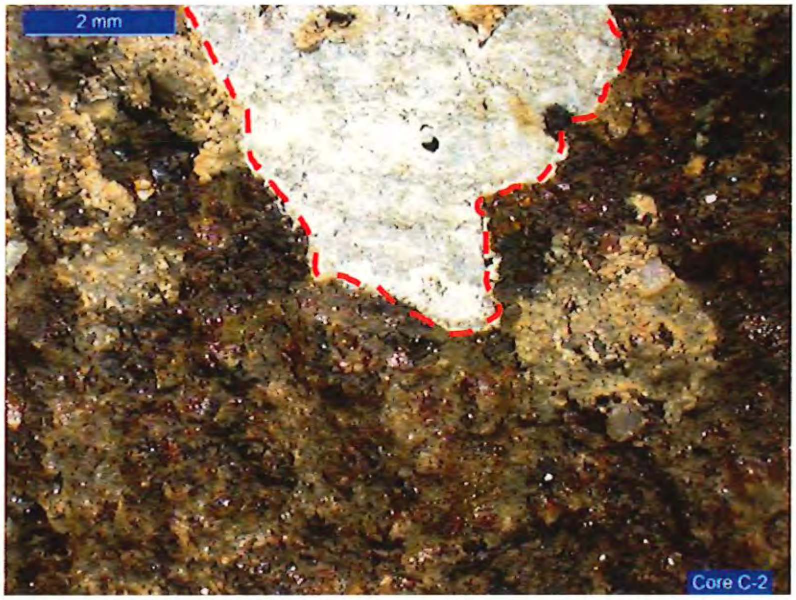

Figure 24. Red-brown and dark brown discoloration is located along the exterior surface of the skim coat that had been in contact with the coating. The outlined region represents the exterior, formed surface of the concrete.

Figure 25. The concrete contains crushed limestone coarse aggregate (arrows) and manufactured siliceous sand fine aggregate.

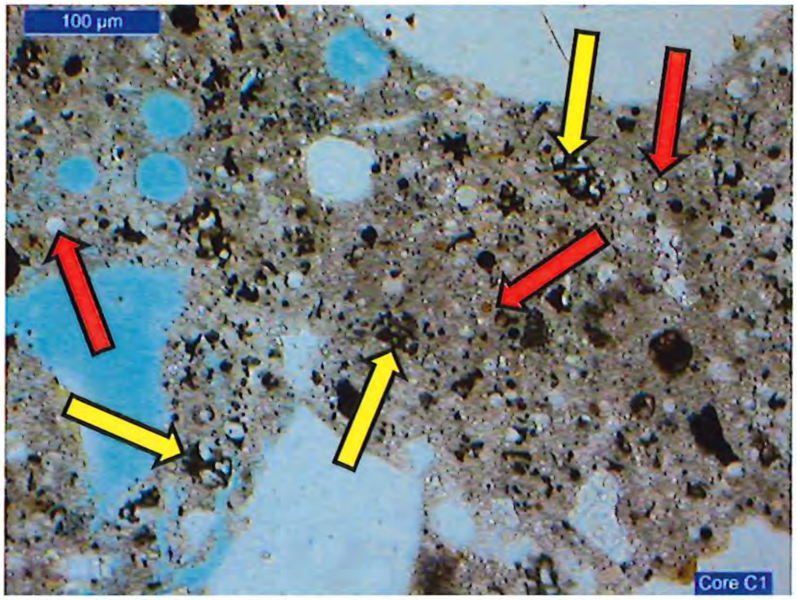

Figure 26. Residual portland cement particles (yellow arrows) and fly ash (red arrows) were detected in the concrete, pictured in Core C1 thin section using plane-polarized light.

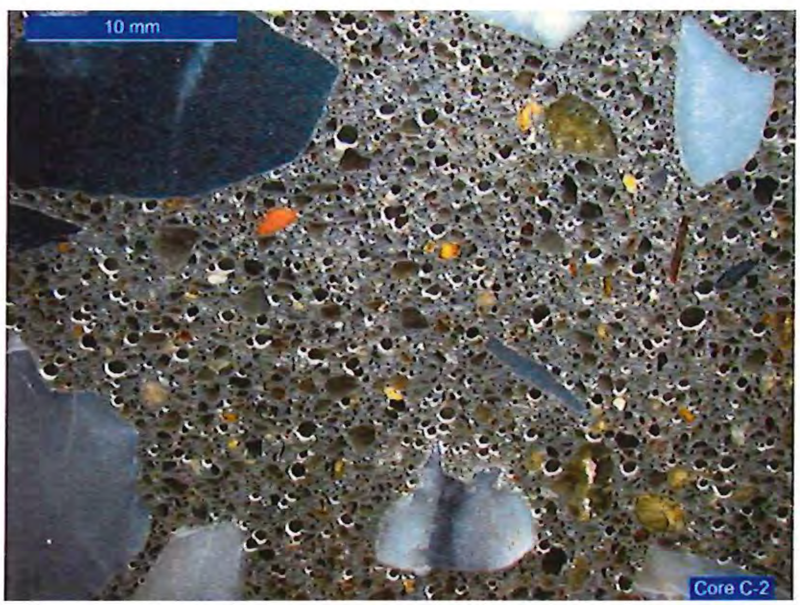

Figure 27. The concrete in both cores, pictured for Core C2, is highly air entrained. Voids appear as dark circles in the image due to the use of low-angle lighting.

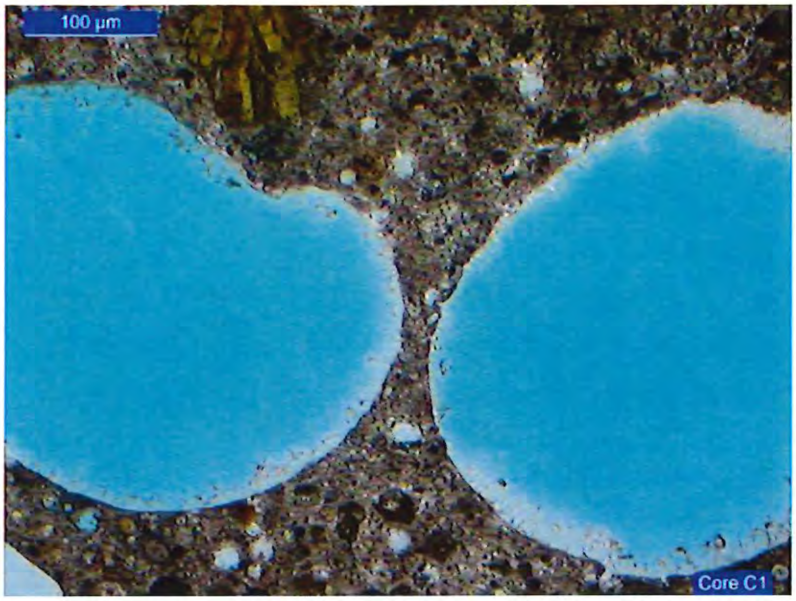

Figure 28. Needles of ettringite are pictured lining two air voids in Core C1 thin section, pictured in plane-polarized light.

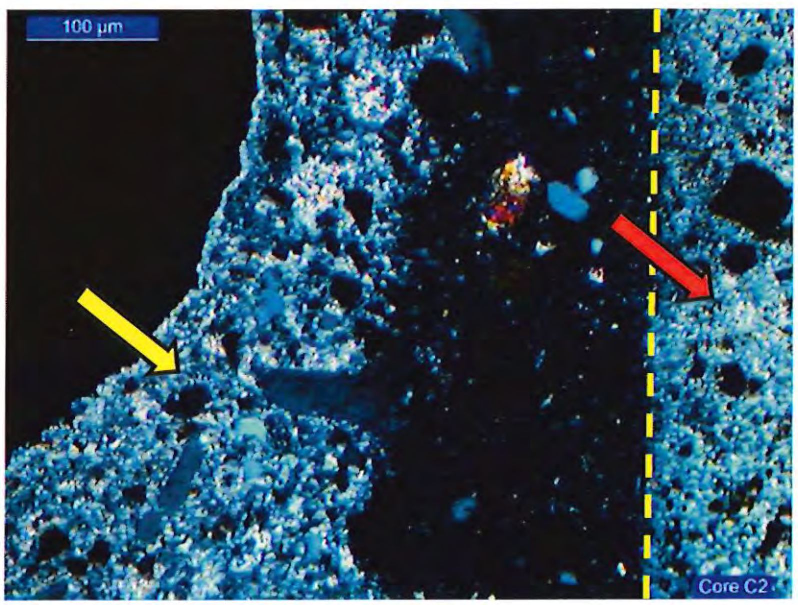

Figure 29. The exterior portion of the skim coat (yellow arrow) and the exterior portion of the concrete substrate (red arrow) are carbonated, or brightly colored in the image, in Core C2. The skim coat is located to the left of the dashed line, and the concrete to the right of the dashed line.

Appendix E:

Timeline of Crack Repair Correspondence

ATTACHMENT 5 Ridley 8

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

Date	Action
05/06/09	Leaks were discovered in leak test between tanks 2 and 3.
05/08/09	Evan Andrews of Pennoni emailed Jeff Beach requesting a special on site meeting regarding the cracks to be held on Monday, May 11th.
05/08/09	Jeff forwarded the email request to Dave Beiler at Dutchland who forwarded it to Mark Falcone.
05/08/09	Mark Falcone of Dutchland responded to Jeff Beach that Dutchland will forward a written report to Jeff prior to Monday's special meeting
05/11/09	Mark Falcone emailed a letter from Nazar Sabti, PE of Dutchland to Jeff Beach stating that the cracks are neither severe nor structural and proposing 2 fixes including Sika 1A and Sika 107
05/11/09	Jeff emailed a response that Pennoni will want to know the reason for the leaks.
05/11/09	A special meeting occurred on site with Worth, Dutchland, Pennoni, Brickhouse/Artesian, Sika and Authority members - Dutchland stated that these were not structural cracks and that coating the cracks would solve the issue. The Sika representative concurred.
05/11/09	Authority Meeting Held - Brickhouse stated that the latest work schedule will be completed sooner rather than later at no cost to the township; minor weeping was found at the leak test and a meeting occurred on site today. Bowing was 1/16" compared to allowable 1/4". Pennoni to look into doubling the life of the warranty and no direction will be clear until subsequent leak tests; $100,000 is to be held from Dutchland invoice pending final engineer's report. Pennoni's fees have run over and Evan Andrews expects 1,300 construction observation hours plus additional 700 hours after contract date billable to Worth over and above liquidated damages and additional observations, inspections, etc. are reimbursable through the Contractor (Worth). Discussion was had as to whether or not to 'put Worth on notice'.
05/12/09	Mark Falcone emailed Jeff Beach a letter reiterating that the cracks are not structural and stated that the handling of the panels was not the cause as thought at first glance at the special meeting. Research of pour reports proved that it was not handling.
05/13/09	Fred Papiernik with Worth emailed Jeff Beach, Mark Haskell at Worth and Mark Falcone and Amos Ebersol at Dutchland that the wall between tanks 1 and 2 was also leaking.
05/13/09	Project Status Meeting held

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

05/14/09 Evan Andrews issued meeting minutes from the Special Project Meeting held on 5/11. The notes included: Sika representative stating that the cracks are approximately 0.002" in width and too narrow for pressure injection. He recommends applying Sika 107 as a protective waterproofing cover; The Township's opinion was that all interior walls and the exterior walls below grade should be waterproofed and will be looking for an extended warranty from Dutchland. Action tasks were assigned: The Township is to review the reports and documentation provided by Dutchland. Post meeting notes stated that the 3 tank walls that separate the chambers seem to be of the same design and were all leaking.

05/14/09 Laura Carpenter of Dutchland emailed a letter from Nazar Sabti to Worth and Pennoni representatives stating that the cause of the cracks was deflection of the flange side of the walls due to flexural stress and again the cracks were not structural. The repair procedure including Sika 1A and Sika 107 was again proposed. Dutchland awaits Pennoni/Township review.

05/18/09 Frank Ciufo of Pennoni distributed through email the bi-weekly progress meeting minutes from the 5/13 meeting. Notes stated that Dutchland's report is under Pennoni's review and the Brickhouse/Artesian recommended possibly laser mapping and testing one tank when the 2 tanks beside it are filled would also be considered.

05/21/09 Jeff Beach emailed Mark Falcone stating that valuable time is being lost and that additional water testing will be done by Dutchland. He also requested deflection data for Pennoni and stated that Pennoni will not allow Dutchland to proceed with a fix until they receive that report.

05/21/09 Mark Falcone emailed Jeff Beach back that a binder was being put together for Pennoni and would be delivered to Pennoni as it was too large to mail. It included the deflection data, QA/QC information pre-pour, post-pour, and concrete breaks for all panels.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

05/26/09 Jeff Beach emailed Mark Falcone a letter from Evan Andrews to Jeff with the comments: Dutchland needed to provide calculations that the panels meet ACI code; that autogenous healing of cracks will not occur on these cracks if they are active; the Sika sealant proposed is only short-term; requested the time needed to install the Sika products, the Sika 1A calls for a bond breaker; Sika 100 cut sheet was attached to Dutchland letter in error; asked if the Sika 107 will prevent autogenous crack healing; and stated that the township's position is that the entire interior of the tanks be coated with sealant acceptable to the township and that the warranty be extended from 10 to 20 years.

05/27/09 Project Status Meeting held - Mark Falcone presented a letter and report from Nazar Sabti in response to Pennoni's May 26 letter including calculations, and statements that Dutchland did not rely on autogenous healing rather the Sika products, that there is no need for a bond breaker of the cracks before the Sika 1A is installed, and states that the township's position is excessive and sealing the entire tank and extending a warranty were not necessary and requested that Pennoni allow Dutchland to make the repairs without such unreasonable requirements attached to them.

05/29/09 Frank Ciufo of Pennoni distributed through email the bi-weekly progress meeting minutes from the 5/27 meeting.

06/03/09 Evan Andrews emailed Dave Beiler and asked for clarification on whether or not Dutchland is counting on autogenous healing of the cracks as part of the repair. Dave forwarded the question to Mark.

06/03/09 Mark Falcone emailed Even Andrews and stated that Dutchland did not rely on autogenous healing of the cracks and that Dutchland had proposed remedial methods in lieu of the healing twice already and was eager to make the repairs.

06/04/09 Dutchland began pressure washing the interior of tanks in preparation for, and in hope of, getting approval to begin repairs.

06/05/09 Mark Falcone emailed Evan Andrews requesting a status of Pennoni's review as Dutchland would like to include it in next weeks field crew schedule.

06/05/09 Evan Andrews responded by email to Mark Falcone that Dutchland's calculations and proposed solutions would be presented to the Board Monday Night.

06/08/09 Mark Falcone and Jeff Beach emailed back and forth regarding both attending the Board Meeting.

06/08/09 Mark Falcone emailed Jeff Beach a letter from Nazar Sabti regarding Pennoni's request for a fix of corbel crack.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

06/08/09 Monthly Board Meeting occurs at 7:00 p.m., Mark Falcone and Jeff Beach attended. The Authority members were not in agreement on sealing the entire tank nor the 20 year warranty. One Authority member wanted Dutchland to meet the original design intent. Scott Tower of Artesian/Brickhouse brought up the 20 year warranty and an Authority member asked him if Dutchland had agreed to that, and he admitted that Dutchland had not. Another Authority member stated that he understood that Dutchland is reserving judgment at this time. Evan Andrews stated that the warranty is not a Pennoni issue, rather it is an Authority issue. Evan Andrews stated that he would send Dutchland a letter and that they could begin repairs as soon as Wednesday if all of the items in the letter were addressed and accepted. The Authority told Jeff Beach and Mark Falcone that this was an informational meeting only and no negotiation was to be done there. One Authority member was upset that Dutchland was power washing the tanks the day prior as he thought Dutchland was beginning repairs on their own. Mark Falcone assured him and the group

06/09/09 Evan Andrews emailed Jeff Beach and others with the letter promised at the Board Meeting. The letter asked for more updates from Dutchland on its calcs and a detail of the repair along with calcs for it. It also stated that the township's stance is still that the entire interior of the tanks be coated with a sealant acceptable by the township and the tanks warranty be extended to 20 years.

06/09/09 Kevin Collins with Sika sent a letter to Mary Ann Stoltzfus for Dutchland to use in answering certain items in the Pennoni letter. This letter explained Sika 1a and its installation requirements and Kevin stated that Sika would expect a minimum life expectancy of 10 years on the product. The letter listed other Pennoni projects on which the product was used. The letter stated that the SikaTop 107 has about the same life expectancy and is added protection to both the Sika 1a and the concrete itself.

06/10/09 Mark Falcone emailed Jeff Beach, Evan Andrews and others with a response letter to Pennoni's including calcs and requesting a quick turnaround because Dutchland was eager to remedy the situation.

06/10/09 Project Status Meeting held - Rick Smith with Township suggested a meeting so that all parties can agree to repairs and other issues.

06/12/09 Mark Falcone emailed Evan Andrews and Perry Shram of Pennoni with additional information requested including more calcs clarification, an email from the Sika representative stating that a bond breaker was not needed with the Sika 1A in this application and the repair procedure written as an official procedure. The end of the email requested Pennoni's okay to send the email to all and requested permission to schedule the repair.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

06/12/09 Evan Andrews emailed Mark Falcone that he received the information and would review it expeditiously and return with a telephone call that afternoon. (No such call occurred)

06/15/09 Mark Falcone emailed Evan Andrews looking for a status of the review and stated that Dutchland was still ready to go on the repair.

06/15/09 Mark Falcone emailed Evan Andrews and Perry Shram clarifying that the Sika 107 would be a 6 foot band centered over the areas that cracked.

06/16/09 Evan Andrews emailed Jeff Beach stating that the repair is acceptable, but not approved pending resolution of the warranty. Backfill cannot be done until SBR issues are resolved.

06/17/09 Nazar Sabti emailed Perry Shram with 3 clarifications of calculations and stated that the design did meet the ACI-350 code. Perry responded with a need for more clarification.

06/18/09 Nazar Sabti emailed Perry Shram with revised calculations addressing Perry's concerns with the conclusion that the design did meet ACI-350.

06/18/09 Authority Meeting Held - Rick Smith stated that Dutchland had recommended that the Authority authorize them to proceed with the repairs (Sika 1a cracks and seal portion below the lowest crack and above the highest crack). If Pennoni and Dutchland engineers agree that the tanks do meet code, then the warranty will stay at 10 years, if not, it will be extended to 20 years. Also, if they disagree on the calculations, a third party engineer may make the determination. The consensus of the members preferred to wait until Pennoni finished their review of the walls before taking action.

06/19/09 MaryAnn received a call from Fred Papiernik with Worth reporting on the previous night's Board Meeting. Rick Smith suggested that the township allow Dutchland to move ahead with the repair and discuss warranty at a later date, but his recommendation did not pass. The Authority wanted to wait for Pennoni's review.

06/22/09 Rick Smith wrote a letter to Jeff Beach explaining the Authority's decision on 6/18 not to allow Dutchland to proceed with the repair until Pennoni's review was complete.

06/24/09 Project Status Meeting held - Mary Ann Stoltzfus attended representing Dutchland and was prepared to address repairing the cracks, however she was handed a letter from Rick Smith along with a Pennoni letter dated 6/23 stating that the tanks did not meet specification. Mr. Smith's letter directed Worth to remove and replace the tanks.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

06/26/09 The Township requested that Mary Ann Stoltzfus attend a special meeting with the Authority regarding information from Pennoni and Brickhouse/Artesian making a statement of the tanks needing to be replaced.

06/29/09 Jeff Beach writes a letter to Rick Smith requesting a special authority meeting and lists the agenda based around the Dutchland tank repair, and stating that Mary Ann Stoltzfus will represent Dutchland at the meeting.

07/02/09 A Special Meeting was held with Authority, Jeff Beach and Mary Ann Stoltzfus attended. Mary Ann gave a presentation regarding the tank cracks and repairs including a letter from Jorgensen & Close, a third party engineer, stating that the design does comply with ACI 350. The Authority requested that Dutchland meet with Pennoni and if they can agree that the tanks meet ACI 350, then the tank would be acceptable to the Authority. If not, a third party engineer may be consulted. Dutchland may begin repairs at its own risk if they wish to do so.

07/06/09 Mark Falcone emailed Jeff Beach and Fred Papiernik Dutchland's schedule to perform the repairs

07/06/09 Dutchland begins repairs with grinding of cracks for Sika 1a installation.

07/07/09 Rick Smith wrote a letter to Jeff Beach with the action items from the 7/2 Authority meeting. Dutchland was to forward to Pennoni the Jorgensen & Close information; Pennoni (State College office) would meet with a Dutchland engineer, and if Pennoni concluded that the walls did comply wit ACI 350, then the tank would be deemed acceptable to the Authority, and if not a third party engineer would review the data.

07/08/09 Project Status Meeting held - A meeting was also held this date at Pennoni's State College office with Dutchland, Brickhouse and Pennoni to review the design. Both parties agreed that it was not a structural issue and that the serviceability of the tank was all that was in question.

07/14/09 Mark Falcone emailed Perry Schram of Pennoni and Jeff Beach a letter from the Sika representative stating that the Sika 1A and 107 are the products to use on this repair and even better than necessary.

07/16/09 Kevin Collins of Sika wrote Amos Lapp of Dutchland regarding his site visit that day and stated that the application appeared to meet recommendations.

07/16/09 Mary Ann Stoltzfus emailed Evan Andrews and copied Jeff Beach detailing all that happened while Evan was on vacation the past 2 weeks.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

07/22/09 Project Status Meeting held - Pennoni was to follow up with a determination of exterior coating material to be used. It was stated that the tanks do meet ACI 350 and will stay. Bonding or escrow will be pursued by the Authority.

07/24/09 Fred Papiernik emailed Evan Andrews requesting resolution to exterior coating and asked whether the tanks all need to be filled at once for a test

07/24/09 Evan Andrews emailed Fred Papiernik and stated that the bitumastic coating specified will be acceptable and a leak test while all tanks were filled was not required.

07/24/09 Mark Falcone emailed Even Andrews with a submittal of bitumastic coating for review requesting a quick turnaround so that the work could begin the next week.

07/24/09 Evan Andrews emailed approval of the bitumastic coating submittal and stated it shall be installed approximately 12 inches below the finished grade.

07/24/09

Scott Towler writes a letter to Steve Cantrell stating that the design meets ACI 350 code structurally and needs to meet certain criteria for serviceability per the Authority, extend the warranty to 20 years, inspect the tanks at years 2, 10 and 20 at the least, Worth will power wash walls and prepare for inspection, a leak is defined by visible seepage or passage or moisture, a letter of credit or an escrow account for tank repairs at a cost of $187,000 per the Authority's estimate.

07/27/09 Leak test of basin 4 was approved.

07/28/09 Frank Ciufo emailed the form created for approval of leak tests for this project.

07/28/09

Frank Ciufo sent an email of the Meeting Minutes from 7/22 Meeting including the Worth introduction of new personnel, Jeff Bush being main point of contact in lieu of Jeff Beach; Tank repairs were complete in basin 4 and leak testing was occurring; bituminous coating was determined after meeting for the exterior coating; the Sika 107 was reviewed and approved including 7/13 letter from Sika and approval from Perry Shram. There was discussion as to why Dutchland was not using that which was recommended by Jorgensen & Close.

07/28/09 Mark Falcone emailed the group a letter from Steve Close explaining that although Dutchland had already begun a repair with a product other than he had suggested, Dutchland's repair is equal to or better than the one proposed by Jorgensen & Close and Dutchland's repair is less economical.

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

07/28/09 Fred Papiernik sent out the Leak Test sign-off sheet approving basin 4.

07/30/09 Mark Falcone emails current version of the Timeline to Steve Cantrell

07/30/09 Mark Falcone emails Steve Cantrell Dutchland's warranty clarifications

08/03/09 Mary Ann Stoltzfus emailed Steve Cantrell stating that basin 2 had some leak spots and proposed that Dutchland install CIM over the Sika 107 and that Dutchland proceed immediately.

08/04/09 The damp spots shown from the tank 2 leak test are gone.

08/04/09 Frank Ciufo of Pennoni distributed through email the bi-weekly progress meeting agenda for the 8/5 meeting. Agenda states that basin 4 has passed the leak test and basin 2 is in progress (seeps observed).

08/04/09 Mary Ann Stoltzfus emailed Evan Andrews and copied Steve Cantrell and Jeff Bush stating that the Dutchland foreman, Bruce, was told by Matt McAloon of Pennoni not to continue with the sealant. There is question regarding products from Sika and CIM working together. Attached a letter from CIM explaining how to use CIM over Sika or other products. A small test area was recommended and a procedure for adhesion testing was attached.

08/05/09 Project Status Meeting held

08/05/09 Mary Ann Stoltzfus emailed Steve Cantrell explaining that she, Mark Falcone, Evan Andrews and Dave Evans met after the progress meeting and Mary. The following were points of discussion per Mary Ann: We are to go ahead with the test areas which will cover and areas above the 107, on the 107, and below the 107. We will perform the adhesion test on Monday on the three areas. The township will meet on Monday night. They are expected to require us to coat the entire tank interior. I stated that we will not be coating the entire interior as we cannot stand behind the adhesion to the walls. Also, it is unnecessary. I stated that we have not provided a product or performed any work that does not meet specification. I read portions of ACI350-06, introduction, page 3 to show that all we have done is within the expectations of the code. I asked for written approval of tank 2 passing the leak test. They stated that Matt has said it is still beading. I asked them to look at it themselves as that is not the case and has not been so for 48 hours. I asked them to advise their client of the weight of their decisions in light of the job time line and associ

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

08/05/09 Mary Ann Stoltzfus sent an email to Evan Andrews after the meeting stating: "As a follow up to our conversation at the township building: The occurrence was on Thursday, May 6, 2009 and by the following Monday, May 11 (two working days later), we proposed in writing two options for a fix. We went with option 2. By May 12 we wrote that the cracks were not a structural concern. On May 14 we stated the cause. I appreciate the sentiment that it moved faster when I showed up, but in reality, the team had all the correct answers within eight days of the occurrence. I assume they have seen our letters. Let me know if you need any copies."

08/07/09

Mark Falcone emailed Evan Andrews stating that the Dutchland foreman and Matt McAloon had set up a date and time for the adhesion test, Friday, August 10th at 8:00 a.m. Dutchland planned to install the CIM on top of the Sika 107 of the 3 dividing walls depending on adhesion results, and requested a response by Monday, August 10th at 1:00 p.m. if there were a reason this work should not begin.

08/10/09 CIM adhesion test did not get the lbs. required. Amos Lapp, Matt McAloon and Fred Papiernik agreed to not consider the test failing and that a CIM representative would be on site the following day to make a determination.

08/11/09

Frank Ciufo of Pennoni distributed through email the bi-weekly progress meeting minutes from the 8/5 meeting. Notes stated that Dutchland submitted a letter proposing CIM be installed over the Sika 107.

08/12/09 Mary Ann Stoltzfus emailed Steve Cantrell stating there is good adhesion on the CIM. For that reason we will move ahead with coating the bands on Friday. We discussed the run-off created when painting the bands in our meeting with CIM on site yesterday, and have concluded that we will be sandblasting the 6 ft. below the bands to help the run-off to adhere. This will provide approximately 18 ft. of coated area starting from the base and going vertically up the wall. Our path forward begins by ordering the equipment and materials today. On Thursday we will be removing rain water from tanks 1 and 3. On Friday we will sandblast and coat tank 1 (as a minimum). Water will be moved to tank 1 on Monday and the process will continue in advance of the remaining leak testing. As discussed in the last progress meeting, this material is already approved for use on the project, and the only question was if adhesion could be reached. We have completed our due diligence on the adhesion test and are moving forward as discussed. The work of sandblasting will be done by CIM Eastern, and the coating may be a joint venture. The purpose for

RIDLEY CREEK WWTP - TIMELINE OF CRACK REPAIR CORRESPONDENCE

08/12/09 Steve Cantrell emails Mary Ann Stoltzfus and tells her to proceed and that he will inform all parties.

08/13/09 Dutchland orders material and sets up CIM to be on site the next day.

08/13/09 Scott Towler emailed Stave Cantrell telling him that performing the CIM repair would be at Worth and Company's own risk until previous issues raised by the Design Engineer and Authority are resolved to the Authority's satisfaction..

08/13/09 At 6:01 p.m. Scott Towler of Artesian emails Steve Cantrell and attaches a letter stating that Dutchland may not proceed with the CIM coating the next day.

08/13/09 at 6:34 p.m. Mary Ann Stoltzfus calls CIM and CIM calls their workers to inform them that they will not be going to Ridley Creek.

08/13/09 At 7:22 Mary Ann Stoltzfus contacts CIM that Scott Towler has retracted his 'Stop Work Order'.

08/14/09 Sandblasting and CIM installation begin in basin 1.

Appendix F:

CIM 1000 Product Data

C.I.M. Industries Inc.

CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

COATING PROFILE

DESCRIPTION CIM 1000 is a liquid applied urethane coating that cures in hours to form a tough elastomeric liner that adheres to most substrates, forming a chemical and abrasion resistant barrier for waterproofing, corrosion protection, and containment of water and most aqueous chemicals.

ADVANTAGES CIM 1000 has over 25 years of proven performance in demanding environments. It remains flexible and resilient and provides exceptional service in a broad range of applications.

- •Forms a tough elastomeric liner able to bridge cracks.
- •Impervious to water and most aqueous chemicals, providing a long lasting tank and pond liner.
- •Asphalt extended urethane formula provides superior wear and weatherability for parking decks and containment areas.
- •Adheres to and bridges between common construction materials such as concrete, steel and other metals, asphalt pavement, glass, wood, and most coatings.
- •Environmentally sound, complying with the toughest VOC regulations.
- •Can be repaired when damaged.
- •Excellent abrasion resistance for severe wear applications.
- •UV stable.
- •Liquid, two-component urethane can be applied to complex shapes, multiple penetrations or to most geotextiles.

SURFACE PREPARATION

GENERAL: Substrates must be **clean and dry** with no oils, grease or loose debris. CIM Bonding Agent is recommended on all non-porous substrates. Perform adhesion tests to confirm adequacy of surface preparation. See C.I.M. Industries' specific substrate Instruction Guide for specific guidelines.

CONCRETE: ICRI-CSP 4-6 surface profile exposing aggregate. Concrete must exhibit minimum 3,000 psi compressive strength and be free of release agents and curing compounds. The substrate must be clean and dry (see CIM Instruction Guide IG-2), and free of contaminates.

STEEL: Minimum 3 mil profile.
Immersion service – SSPC-SP10 / NACE No. 2 Near White Blast.
Non-Immersion service – SSPC-SP6 / NACE No. 3 Commercial Blast.
Use CIM Bonding Agent for greater adhesion.

OTHER METALS: SSPC-SP1 solvent clean and abrasive blast to roughen and degloss the surface. Use CIM Bonding Agent for greater adhesion.

GLASS: Thoroughly clean. CIM Bonding Agent must be used for increased adhesion. For immersion service roughen the surface.

WOOD: Substrate must be clean, dry and free of surface contamination.

PREVIOUS COATINGS AND LININGS: CIM 1000 may be applied over some existing coatings and linings and achieve acceptable performance. CIM Bonding Agent is recommended for greater adhesion. Finished system rosults vary due to a variety of project specific factors, including the service conditions to which the system is exposed. Therefore, C.I.M. Industries does not accept responsibility for determining the suitability of an existing coating as a substrate for CIM products. Owner shall perform adhesion tests on any existing coating or lining to determine suitability.

EARTH: Use CIM Scrim.

COLOR CIM 1000 is initially shiny black, turning dull over 3 to 6 months when exposed to direct sunlight. For a colored or reflecting surface finish, see C.I.M Industries' Instruction Guide, "Topcoats" (IG–7) for further instructions.

SOLIDS BY VOLUME 88% (1413 dry mils x sq. ft./gal.)

RECOMMENDED COVERAGE Recommended minimum thickness at all points of the coating is 60 wet mils.
Higher coverages may be specified, but extended time is required to insure proper solvent release prior to placing the liner in service. Contact C.I.M. Industries for additional information.

VOC 92 g/l (0.76 lb./gal.). CIM 1000 complies with the toughest VOC regulations.

C.I.M. Industries Inc.

CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

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TYPICAL PROPERTIES

Abrasion Resistance-Wt. Loss, Taber Abraser CS-17 Wheel 1000 gr./1000 rev. ASTM D4060	1.2 mg. Loss
Adhesion to Concrete (dry)	
Elcometer	350 psi
Deflection Temperature ASTM D648	below -60°F
Density (Approx.)	
Premix	8.0 lbs./gal.
Activator	10.1 lbs./gal.
Mixed & Cured	8.3 lbs./gal.
Elastomeric Waterproofing	
ASTM C836	exceeds all criteria
ASTM C957	exceeds all criteria
Extension to Break ASTM D412	400%
Flammability	
ASTM D2859	pass/combustible substrate
UL790	Class A[1]
Hardness, Shore A ASTM D2240 @ 77°F	60
Jet Fuel Resistance FS SS-S-200D	pass for joints
Liner Performance	
Crack Bridging	
10 cycles @ -15°F	greater than 1/8"
After heat aging	greater than 1/4"
Liner Weight (60 mil wet film thickness)	31 lbs./100 sq. ft.
Mix Ratio	
Weight	7:1
Volume	9:1
Mullen Burst Strength ASTM D751, 50 mil	150 psi
Permeability to Water Vapor ASTM E96 Method E, 100°F, 100 mil sheet	0.03 perms
Recovery from 100% extension:	
after 5 minutes	98%
after 24 hours	100%
Salt Spray ASTM B117	pass 2000 hrs.
Service Temperature	-60°F to 220°F
Softening Point, Ring & Ball ASTM D36	>325°F
Tear Strength ASTM D624 (Die C)	150 lbs./in.
Tensile Strength ASTM D 412, 100 mil sheet	900 psi
Weathering ASTM D822	pass 5000 hrs.

[1]Contact C.I.M. Industries for details regarding UL fire ratings

CHEMICAL RESISTANCE

CIM 1000 is resistant to a broad range of acids and alkalis. Consult C.I.M. Industries for additional information regarding chemical resistance after reviewing CIM 1000 Chemical Resistance Chart.

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C.I.M. Industries Inc.

CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

GENERAL APPLICATION INFORMATION

USE **FOR PROFESSIONAL USE ONLY.**

PRECAUTIONS Avoid contamination with water or moisture. Keep all pails and jugs tightly closed until ready for use. All equipment, air supplies, and application substrates must be **ABSOLUTELY DRY.** Do not apply in wet weather or when rain is imminent or when the CIM 1000 or the substrate may become wet within 4 hours after coating. Use caution when applying CIM 1000 in confined spaces. See C.I.M. Industries' Instruction Guide, "Applying CIM Within Confined Spaces" (IG-9).

TEMPERATURE Surface should be at least 50°F (10°C) and must be 5°F (3°C) above the dew point. **DO NOT APPLY WHEN THE SUBSTRATE OR AMBIENT TEMPERATURE IS RISING OR COATING IS IN DIRECT SUNLIGHT.** CIM 1000 should be at least 60°F (15°C) when mixed and applied. CIM 1000 may be preheated to facilitate application at low temperatures, but working time will be reduced. See C.I.M. Industries' Instruction Guide "Applying CIM Liners in Cold Weather" (IG-11).

EQUIPMENT Spray equipment requires large diameter hose and air supplied mastic gun or plural component spray equipment. See "Spray Application of CIM" (IG-12) or contact C.I.M. Industries for specific recommendations. Roller, squeegee, and trowel may also be used.

POT LIFE About 30 minutes. Working time depends on temperature and method of application. Working time for spray application will be significantly shorter.

PRIMING Porous substrates such as wood and concrete may be primed with CIM 61BG Epoxy Primer to minimize outgassing. The recoat window for CIM 61BG Epoxy Primer shall be no longer than 48 hours. See CIM 61BG Epoxy Primer Coating Profile for additional information. Perform adhesion tests to confirm adequacy of adhesion to primer.

MIXING **DO NOT THIN. DO NOT HAND MIX.** Begin mixing each pail (4.5 gal.) of CIM 1000 Premix using a power mixer (e.g. ½" drill and an eight inch mud mixer). Do not draw air into the mix. While mixing, slowly add one jug (0.5 gal.) of CIM 1000 Activator to the pail. Once the CIM 1000 Activator has been added, mix thoroughly for **3 FULL MINUTES.** The proportions are premeasured. **DO NOT ESTIMATE.** Mixing Jigs and Timers from C.I.M. Industries help eliminate mixing errors and increase productivity on the job. See C.I.M. Industries' Instruction Guide, "Mixing CIM Premix and Activator" (IG-8).

APPLICATION Apply CIM 1000 directly to a clean and dry substrate. Vertical surfaces will require multiple coats. See C.I.M. Industries' specific substrate Instruction Guide for additional guidelines.

RECOATING CIM 1000 may be recoated in 1 hour and must be recoated soon after the coating no longer comes off on polyethylene (typically within 4 hours of mixing). If the liner has cured longer than this time, the surface must be severely abraded using surface grinder or other mechanical means, and be free of dust and debris. Use CIM Bonding Agent for better adhesion. For immersion conditions, all coats shall be applied within 4 hours of each other, except at joint lines.

SPREAD RATE **Note: Coverages are theoretical and do not account for waste, spillage, irregular surfaces, or application technique. Consult CIM 1000 Coverage Chart for additional coverage information.**

CURING TIME CIM 1000 may be placed in service within 24 hours for non-aggressive service. Severe service applications may require a cure time of 72 hours or more. Contact C.I.M. Industries for specific recommendations.

CLEAN-UP Use mineral spirits for clean-up of uncured material. Spray equipment must be flushed regularly during application to prevent material from setting up in the hose and pump. Cured material is very difficult to remove. Soaking in solvent will soften the material and may assist in its removal.

CONTACT C.I.M. INDUSTRIES FOR SPECIFIC RECOMMENDATIONS AND INSTRUCTION GUIDES.

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C.I.M. Industries Inc.

CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

SHIPPING, STORAGE AND SAFETY DATA

WARNING **Flammable. Use only in well ventilated areas. Do not store or use near open flame, sparks or hot surfaces. Keep tightly closed. Avoid contact with moisture or water. Keep out of reach of children.**

SAFETY INFORMATION This product contains petroleum asphalt, petroleum distillates, amine compounds and/or other chemical ingredients. Adequate health and safety precautions should be observed during the storage, handling, application and curing. Refer to C.I.M. Industries' Material Safety Data Sheets for further details regarding the safe use of this product.

PACKAGING CIM 1000 is available in mixed units of **5** gallons. Each unit consists of a container of premix and a smaller container of activator. Quantities have been premeasured to provide the proper mixing ratio, leaving sufficient room in the premix container to facilitate adequate mixing. **Do not estimate proportions.**

SHIPPING	**Premix**	**Activator**
Weights		
5.0 gallon units	40 lbs. per pail	5.5 lbs. per jug (33 lbs. per case of 6)
Properties		
Flash Point	101°F	>250°F
Shipping Name	Coating Solution	Not Regulated
DOT Class	Class 3, UN1139, PG III	Not Regulated
STORAGE		
Temperature	20°F to 110°F	70°F to 95°F
Shelf Life	2 years	6 months
NFPA	Class II	Non Flammable

WARRANTY & LIMITATION OF SELLER'S LIABILITY

C.I.M. Industries Inc. (C.I.M.) warrants that for a period of five (5) years from the date of shipment to the initial purchaser, the products, when mixed in proper ratios for the proper length of time, (a) will not become brittle or crack and (b) will provide a water barrier. Due to application variables beyond C.I.M.'s control which may affect results, C.I.M. makes no warranty of any kind, expressed or implied, including that of merchantability, other than that the products conform to C.I.M.'s current quality control standards at time of manufacture. If breach of warranty is established, the buyer's exclusive remedy shall be repayment of the purchase price of the non-conforming CIM membrane product or, at C.I.M.'s option, resupply of conforming product to replace the non-conforming product. The buyer expressly waives any claim to additional damages, including consequential damages.

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www.cimindustries.com

C.I.M. Industries Inc.
23 Elm St., Peterborough, NH 03458
Tel: (800) 543-3458 (603) 924-9481
Fax: (603) 924-9482
Web site: www.cimindustries.com

C.I.M. Industries Inc.

CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

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CHEMICAL RESISTANCE

The following chart is a general guide to the resistance of CIM 1000 to various types of exposure. Although we believe this information to be reliable, C.I.M. Industries Inc. has no control over any particular application, installation, or exposure of CIM 1000; and suitable tests should be carried out by the user.

Where chemical concentrations are listed, the designated rating applies to all concentrations up to and including the concentration indicated.

Except as indicated by a footnote, the maximum service temperature is 140F (60C) for continuous service.

Consult C.I.M. Industries for additional information regarding chemical resistance.

Acetic Acid, Glacial	S
Acetic Acid, 25%	R2
Acetic Acid, 10%	R
Ammonium Hydroxide, 10%	R2
Biological Oxidation Ponds	R
Chlorine, Saturated Solution in Water	R1
Citric Acid, 10%	R
Copper Sulfate (Sat.)	R
Crude Oil	S
Diesel Fuel	S
Ethylene Glycol (Antifreeze Solution)	R1
Ferric Chloride, 42%	R
Hydrochloric Acid, 10%	R2
Hydrofluoric Acid, 10%	R2
Hydrogen Sulfide, Saturated Solution in Water	R
Hydrogen Sulfide, Vapor Over Sat. Solution	R
Methanol	R1
Nitric Acid, 10%	R2
Nitric Acid, 40%	S
Outdoor Exposure	R
Phosphoric Acid, 10%	R
Phosphoric Acid, 40%	S
Sewage Disposal Plant (Act. Sludge Sed. Tanks)	R
Sodium Hydroxide, 10%	R
Sodium Hydroxide, 50%	R1
Sodium Hypochlorite, 15%	R
Soil Burial	R
Sodium Silicate, 34%	R
Strawberry Juice	R
Sulfuric Acid, 30% or less	R
Trisodium Phosphate, 10%	R
Water, Salt	R
Wine (for floor protection)	R

Footnote:

R Suitable for continuous immersion.
S Suitable for splash and spillage conditions.
R1 Maximum service temperature limited to 80F.
R2 Maximum service temperature limited to 120F.

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CIM 1000

HIGH PERFORMANCE COATINGS AND LININGS

COVERAGE CHART — MIXED GALLONS

Dry Thickness (mils)	Wet Thickness (mils)	Gal/SF	SF/Gal	Dry Thickness (mils)	Wet Thickness (mils)	Gal/SF	SF/Gal
20	23	0.014	71	18	20	0.012	80
25	28	0.018	57	22	25	0.016	64
30	34	0.021	47	26	30	0.019	53
35	40	0.025	40	31	35	0.022	46
40	45	0.028	35	35	40	0.025	40
45	51	0.032	31	40	45	0.028	36
50	57	0.035	28	44	50	0.031	32
55	62	0.039	26	48	55	0.034	29
60	68	0.042	24	53	60	0.037	27
65	74	0.046	22	57	65	0.041	25
70	79	0.050	20	62	70	0.044	23
75	85	0.053	19	66	75	0.047	21
80	91	0.057	18	70	80	0.050	20
85	96	0.060	17	75	85	0.053	19
90	102	0.064	16	79	90	0.056	18
95	108	0.067	15	84	95	0.059	17
100	114	0.071	14	88	100	0.062	16
105	119	0.074	13	92	105	0.065	15
110	125	0.078	13	97	110	0.069	15
115	131	0.081	12	101	115	0.072	14
120	136	0.085	12	106	120	0.075	13
125	142	0.088	11	110	125	0.078	13

COVERAGE FORMULAS

$$\text{Gallons Required} = \frac{\text{Theoretical Wet Film Thickness (Mils)} \times \text{Sq.Ft. To Be Covered}}{1604} = \frac{\text{Theoretical Dry Film Thickness (Mils)} \times \text{Sq.Ft. To Be Covered}}{1413}$$

1 MIL = .001 of an inch

Coverages are theoretical and do not account for waste, spillage, irregular surfaces, or application technique.

CIM BONDING AGENT

Porous Surface	1 gallon = 300 sq.ft. or .00333 gal/sq.ft.
Non Porous Surface	1 gallon = 600 sq.ft. or .00166 gal/sq.ft.

C.I.M. Industries Inc.
23 Elm St., Peterborough, NH 03458
Tel: (800) 543-3458 (603) 924-9481
Fax: (603) 924-9482
Web site: www.cimindustries.com

C.I.M. Industries Inc.
A Chase Corporation Company
23 Elm St., Peterborough, NH 03458
Tel: (800) 543-3458 (603) 924-9481
Fax: (603) 924-9482
Web site: www.cimindustries.com

Instruction Guide
APPLICATION OF CIM TO CONCRETE

1.0 DESCRIPTION

This guide covers the installation of a CIM coatings and linings (CIM) over a structurally sound concrete base such as a deck, roof or tank. The CIM shall consist of a minimum of 55 dry mils (see CIM Technical Data Sheet and appropriate coverage chart) applied by spray, squeegee, roller, or trowel. Actual coverage rates may differ from theoretical rates depending on surface profile and application method.

2.0 MATERIALS

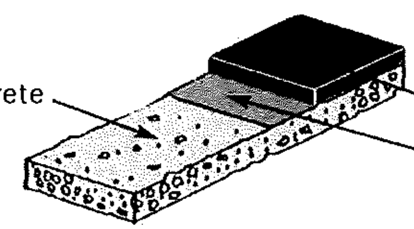
- **2.1 CIM Premix & Activator**
- **2.2 Optional Materials**
  - **2.2a. CIM 61BG Epoxy Primer**
  - **2.2b. CIM Bonding Agent**
  - **2.2c. CIM Scrim**
  - **2.2d. CIM 1000 Trowel Grade Premix & Activator**

3.0 SAFE PRACTICES

Use equipment and procedures designed to minimize danger to personnel and materials. Special attention should be made to provide adequate ventilation and respirators for personnel applying CIM in confined spaces or operating spray equipment. See C.I.M. Industries' Instruction Guides, "Applying CIM Within Confined Spaces" (IG–9) and "Spray Application of CIM" (IG-12) for more detailed information.

4.0 SURFACE PREPARATION

All areas adjacent to those being coated with CIM which are not intended to be coated should be protected with suitable temporary splash covers such as polyethylene, carpenters paper, or masking tape. CIM shall be applied to clean, dry, structurally sound concrete.[1] Concrete shall only be coated while the concrete is in a temperature declining mode (usually late afternoon). CIM 61BG Epoxy Primer may be used to minimize outgassing.[2]



Notes:

[1]If surfaces are not completely clean, CIM will achieve poor adhesion to the concrete and may experience blistering and possible failure.

[2]CIM 61BG Epoxy Primer shall be applied at a minimum rate of 5 wet mils. Additional applications of CIM 61BG Epoxy Primer may be required to achieve a pinhole free primer coat. The maximum recoat window for CIM 61BG Epoxy Primer is 48 hours. Please see CIM 61BG Epoxy Primer Technical Data Sheet for additional information.

C.I.M. Industries Inc.
A Chase Corporation Company

NOTES:

CONCRETE SHOULD NOT BE COATED WHILE IN DIRECT SUNLIGHT!
Concrete should be coated only while in a temperature declining mode. CIM, because it is black, is a solar absorber and can increase the surface temperature of the concrete by as much as 90°F. This, in turn, heats up the air trapped within the concrete's pores. The air expands and tries to push its way out of the concrete, creating hundreds of bubbles, otherwise known as outgassing. Therefore, if concrete is coated in direct sunlight (e.g. a temperature rising mode), outgassing will generally occur.

4.1 New Concrete

New concrete must have a minimum compressive strength of 3,000 psi, be dry, and be free of release agents or curing compounds prior to the application of CIM. CIM may be applied directly to concrete laitance but good adhesion is unlikely. Due to the poor tensile properties of concrete laitance, it is recommended to remove the concrete laitance and expose the tops of the underlying aggregate. This condition is typically represented by an ICRI Concrete Surface Profile of 4 to 6 to expose aggregate. In order to properly prepare the concrete, and remove any release agents or curing compounds, any one of the following can be performed:

1. Abrasive blasting (ASTM D 4259-88)
2. Water blasting (ASTM D 4259-88) (generally at 5,000 psi minimum), allow concrete to dry
3. Shot blast (ASTM D 4259-88), horizontal surfaces

4.2 Old Concrete

Old concrete must be clean and dry, and free of oil, grease and loose powder or debris. It is highly recommended to remove the existing concrete laitance on the surface and expose the tops of the underlying aggregate. This condition is typically represented by an ICRI Concrete Surface Profile of 4 to 6. In order to properly prepare the concrete, and remove contaminants, any one of the following can be performed:

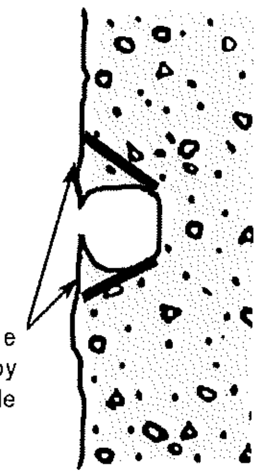
1. Abrasive blasting (ASTM D 4259-88)
2. Water blasting (ASTM D 4259-88) (generally at 5,000 psi minimum), allow concrete to dry
3. Shot blast (ASTM D 4259-88), horizontal surfaces

NOTES:

4.3 Bugholes

Bugholes appear as small holes in concrete. These holes often lead to larger holes under the surface of the concrete (see Figure 2). It is important to blast all concrete surfaces where bugholes are present to expose the full view of the hole (no "blind" side surfaces). Bugholes should be filled with appropriate repair materials and may require an abrasive blast to remove any loose powder or debris.

Figure 2



Expose bughole to full view by removing blind side surfaces.

4.4 Testing for Moisture

Although concrete may appear to be dry on the surface, there is often an abundance of moisture below the surface. An abundance of moisture in the concrete during application will result in poor adhesion and eventually blisters in the coating. Consistent with industry standards, C.I.M. Industries recommends performing two or more of the following tests to confirm appropriate moisture levels for properly prepared substrates:

1. Plastic Sheet method (ASTM D4263)	Pass/Fail
2. Relative Humidity test (ASTM F2170-09)	<85%
3. Calcium Chloride test	<5 lb/1,000 sq ft per 24 hr
4. Radio Frequency test	< 5 % moisture

(as outlined in "Drying Concrete" by Lew Harriman in the March 1995 issue of *The Construction Specifier* Magazine)

5.0 APPLICATION

5.1 Cracks in Concrete (all applications)

Cracks less than $^1/_{16}$" wide typically do not require special treatment. All cracks $^1/_{16}$"to ⅛" wide shall be stripe coated and filled with CIM prior to the application of the CIM. Vertical and sloped walls require the use

NOTES:

of CIM 1000 Trowel Grade to fill cracks. If cracks are more than ⅛" wide or experience movement, refer to manufacturer for patch/fill details. Proper joint design shall be used. CIM Scrim may be used to reinforce cracks and joints. See section 5.4 for further details.

5.2 Penetrations
Penetrations must be coated with CIM 1000 Trowel Grade at all horizontal to vertical transitions. CIM 1000 Trowel Grade should be applied at least 60 wet mils thick, 2" onto and 2" beyond the penetration. Please see section 5.8 for application procedures for multiple coats. If work stoppage is unavoidable see sections 5.9 and 5.10.

CIM will adhere to most clean construction materials. When coating substrates other than concrete, please see the C.I.M. Industries' specific substrate Instruction Guide for detailed information of application procedures.

5.3 Sharp Edges
CIM 1000 Trowel Grade may be used on sharp edges to prevent thin spots from occurring. The entire area should be coated with the specified thickness of CIM coating within 4 hours after troweling sharp edges. Do not allow CIM 1000 Trowel Grade to cure more than four (4) hours at 70°F before coating with additional applications of CIM. If work stoppage is unavoidable see sections 5.9 and 5.10.

5.4 Using CIM Scrim
CIM Scrim may also be used on sharp edges to prevent thin spots from occurring. After the substrate is properly prepared apply a thin tack coat, 10–20 mils, of CIM. Push scrim evenly into tack coat and allow to cure for 1–4 hours. Apply 60 wet mils of CIM directly over scrim. CIM Scrim acts as a coverage gauge to insure thickness.

5.5 Cant Strips
Cant strips should be made with CIM 1000 Trowel Grade Cartridges wherever horizontal surfaces meet vertical surfaces. This is crucial in applications such as tanks which experience wall movement when filled, and where concrete shifts due to expansion and contraction. Cant strips are generally ½" or more wide by ½" or more tall. Allow the cant to cure for a minimum of 12 hours at 70°F. Contact C.I.M. Industries for specific design details.

NOTES:

5.6 Horizontal Surfaces
CIM should be applied to concrete at a film thickness of 60 wet mils, depending on application type. This can be achieved in a single coat on horizontal surfaces.

5.7 Vertical and Sloped Surfaces
CIM can be applied to a vertical or sloped surface with a roller, brush or spray equipment. Small walls are often coated with rollers or brushes. Large walls should be sprayed using an air assisted airless spray system or plural component spray system. See C.I.M. Industries' Instruction Guide, "Spray Application of CIM" (IG-12) or contact C.I.M. Industries for suggested equipment configuration. When working with CIM, vertical or sloped surfaces require a minimum of two (2) applications of approximately 30 mils each to obtain the required thickness. If a coating thickness of more than approximately 60 wet mils is specified on a vertical or sloped surface, additional coats will be required to achieve desired thickness.

5.8 Multiple Coats
Second/multiple coats can be applied as soon as the previous coat can be touched lightly without coming off on your finger. For CIM at 70°F, the tack free time is typically one (1) hour but no longer than four (4) hours after the previous coat has been applied. Higher temperatures speed up the curing time, and tack free time, therefore significantly shortening the 1–4 hour recoat window. Colder temperatures have the opposite effect. As soon as the coating becomes tack free, the second coat should be applied. For immersion or traffic service, apply all coats within the recoat window, except at joint lines

If it is necessary to walk on the first coat of CIM in order to apply multiple coats, such as when coating a parking or pedestrian deck, polyethylene boots may be worn to prevent sticking to the coating.

5.9 Recoating After the Recoat Window
If second/multiple coats cannot be applied within the recoat window (1–4 hours under standard conditions), the previous coat must be abraded. Abrading shall be performed by surface grinder or other mechanical means. The CIM must be solvent wiped (MEK or xylene) to clean up any loose debris. After the solvent flashes off, a light mist of CIM Bonding Agent must be applied. Allow the Bonding Agent to flash off and recoat within one (1) hour. See CIM Bonding Agent Technical Data

NOTES:

Sheet for additional guidelines. For immersion or traffic service, minimize areas to be recoated outside the recoat window, severely abrade the areas to be recoated and test recoated areas for acceptable adhesion. Acceptable adhesion may only be achieved through aggressive abrading.

5.10 Overlap at Joints

Should rain or other conditions require work stoppage, prepare for joint lines. Joint lines shall be clean and straight. The overlap shall be a minimum of 6" to insure an impervious joint. All areas to be coated where more than a four (4) hour cure has taken place shall be treated per section 5.9, "Recoating After the Recoat Window."

6.0 TOPPINGS

The CIM may include toppings of aggregate, decorative coatings, protective coatings, or combinations of the above. See C.I.M. Industries' Instruction Guide, "Topcoats" (IG-7) for more detailed information.

7.0 GENERAL LIMITATIONS

Applying CIM under any of the following conditions is likely to result in poor or unsatisfactory performance:

- Use of improper mixing equipment. See C.I.M. Industries' Instruction Guide "Mixing CIM Premix and Activator" (IG-8).
- Material temperature at the time of application is below 60°F.
- Use of standard application procedures when substrate temperature is below 50°F. See C.I.M. Industries' Instruction Guide "Applying CIM Coatings in Cold Weather" (IG-11).
- Substrate moisture is present or rain is imminent.
- Substrate temperature is less than 5°F above the dew point.
- Substrate is in a temperature-rising mode or exposed to direct sunlight.
- Other conditions which are obviously unsuitable.