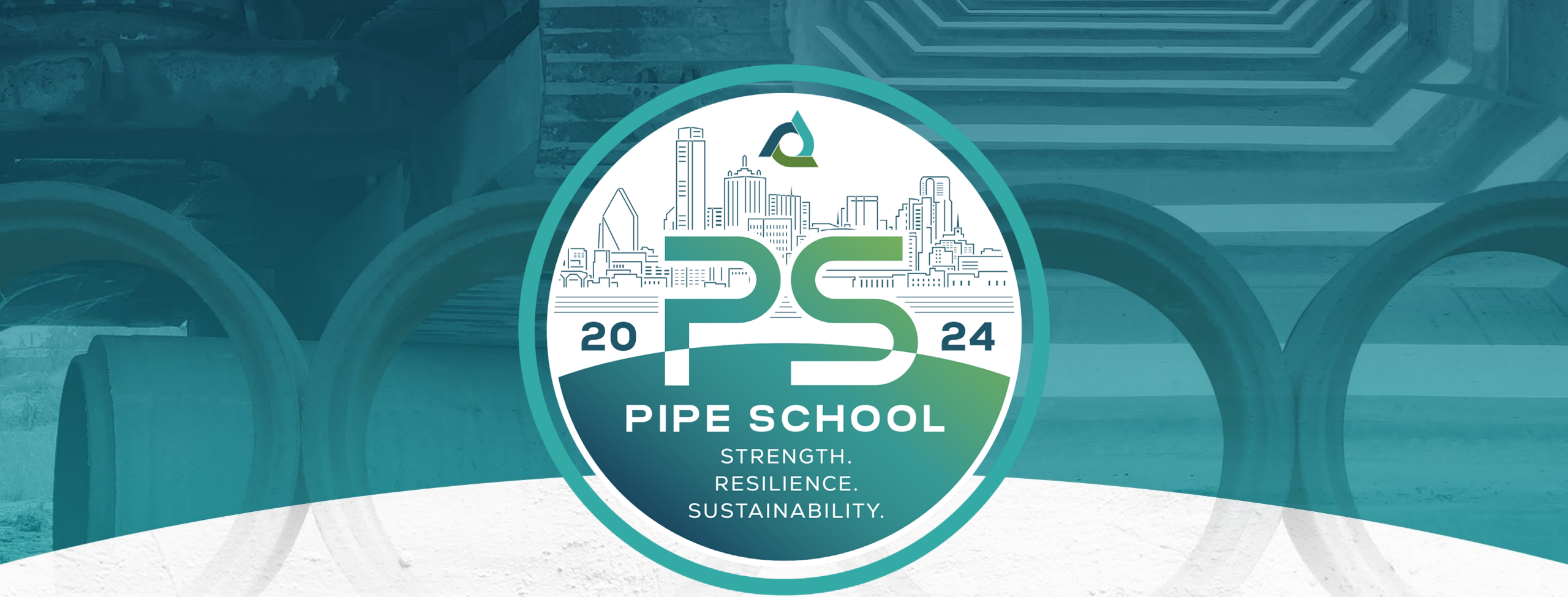


Post Installation Inspection

“Start Right = Stay Right”

Al Hogan, P.E.

ACPA Southeast Region Engineer

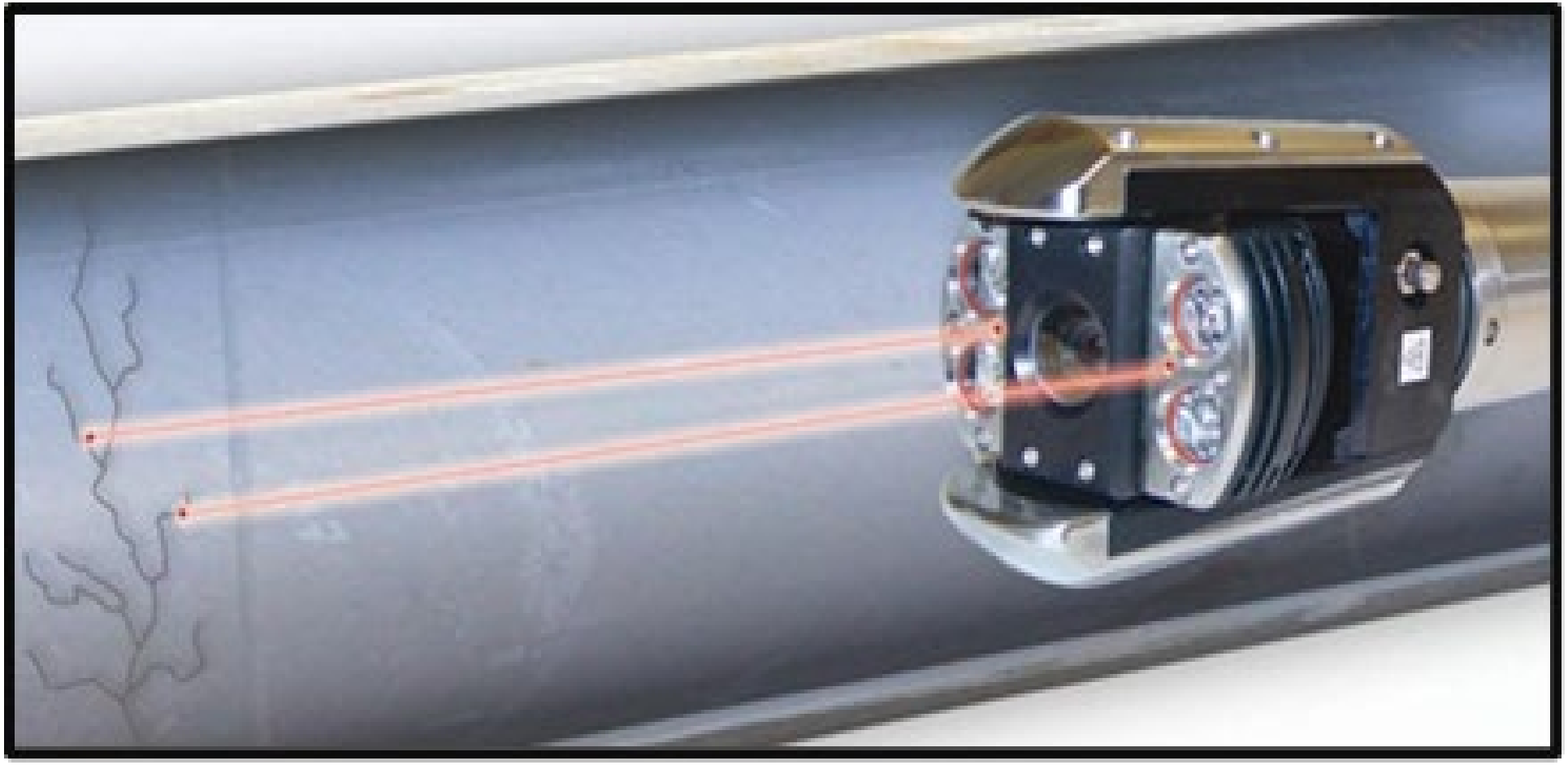
Outcome/Take-A-Ways

- Understand importance of PII & Proper Evaluation to all Infrastructure Stakeholders
- Gain an introduction to the Evaluation Tools available and how they are used
- Confirm Who is Responsible for What in the PII and Evaluation Process
- Be able to discuss/consider important specification language on the subject of PII…

Learning Modules

- Introduction/Overview of PII and Evaluation
- The Post Installation Inspection and Evaluation Process
- Review of available PII and Evaluation Tools
- The making of a good PII Specification

Overview and Importance of Post Installation Inspection



What the Heck is Post Installation Inspection (PII)

Here is my best Analogy…

Post Installation Inspection

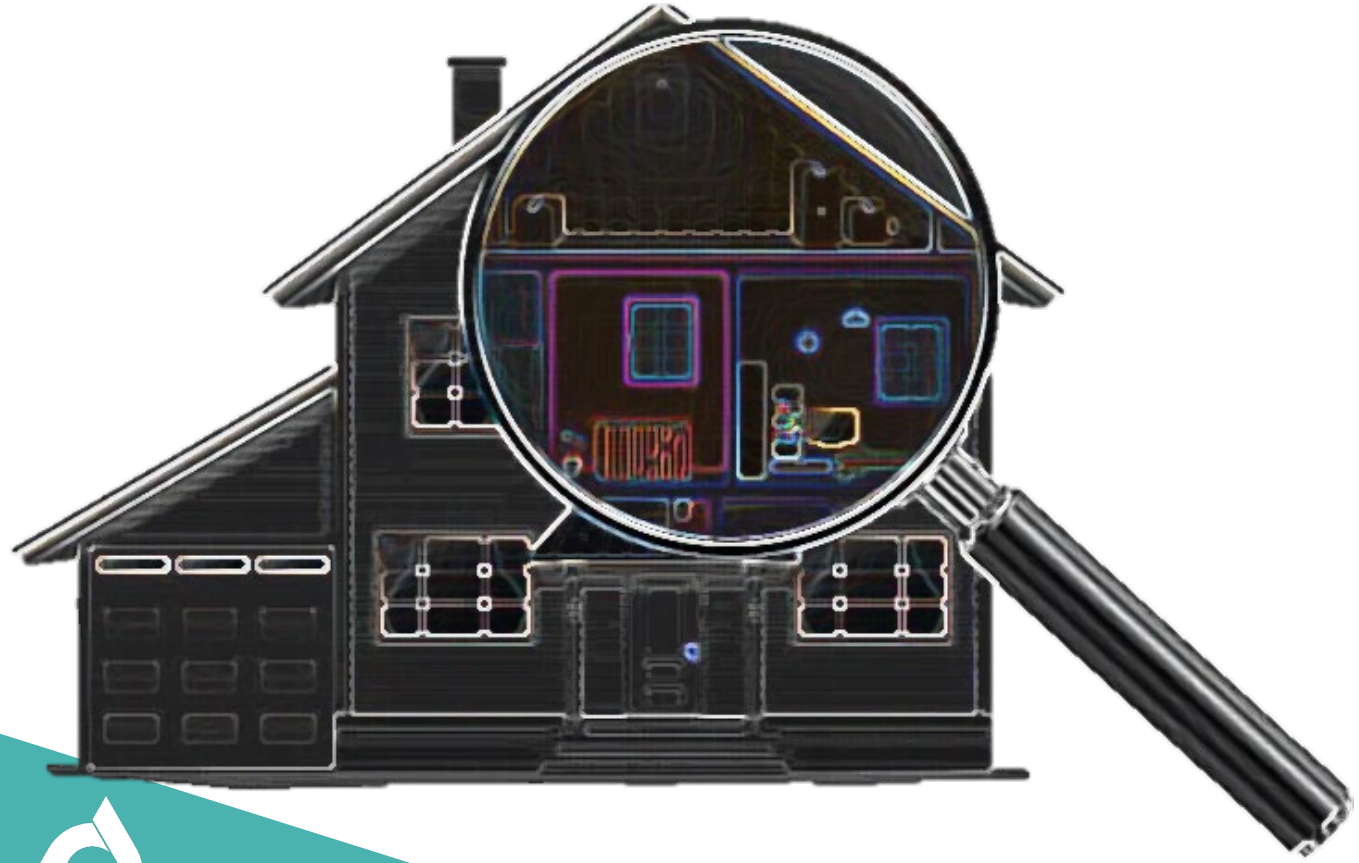
Post Installation Inspection is a thorough examination and evaluation of the interior of an installed pipeline

Proof of design & structural integrity

Confirm nothing concerning about proper operation of the system

And Simply a Final visual check for any construction damage

Post Installation Inspection
Why do it – Because AASHTO says so ?



All pipes shall undergo inspection during and after installation to ensure proper performance. … ***Final internal inspections shall be conducted on all buried thermoplastic pipe installations to evaluate issues that may affect long-term performance****.*

Source:
AASHTO LRFD Bridge Construction Specifications, Section 30: Thermoplastic Pipe

Why Do IT – More than just to follow AASHTO?

PII is a WIN-WIN-WIN for all Stakeholders

OWNER assumes a **Trust but Verify** Position

PII Provides Quality Assurance of the **Completed Pipe Installation**

- **Ensures Owner getting what they Pay For**
- Provides Confirmation of **Structural Integrity and Hydraulic Capacity**
- Realize **Reduced Risk for unanticipated Maintenance or Replacement**

Quality of installations IMPROVE

Reduces Lifetime Project Cost!

The What, How & WHO of the Post Installation & Evaluation Process

How and Who is responsible for The Process …..

What Is Inspection Specifically Looking for in Installed Pipe?

Rigid – RCP

- Joint Issues
  - Separations
  - Damage/Cracks/Chips
  - Infiltration
- Cracks
  - Size length & Width
  - Location
  - Pattern (Longitudinal, Circumferential, Star Multi directional,
- Other Items
  - Stains & Efflorescence

Flexible – CMP, Thermoplastics????

What Inspection Specifically Looking for in Installed Pipe?

CMP & Thermoplastic

- Deflection
  - X-Y Deflection
  - Ovality – Out of plane deformation
- Wall Deformation
  - Buckling
  - Dents/Local Deformation
- Cracking in pipe wall
- Joint Damage
  - Separations
  - Damage
  - Infiltration

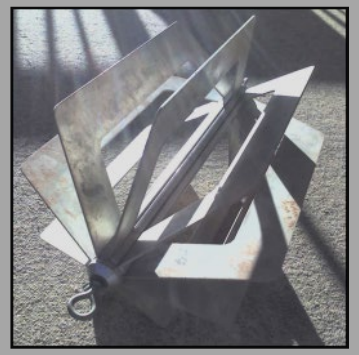
CMP

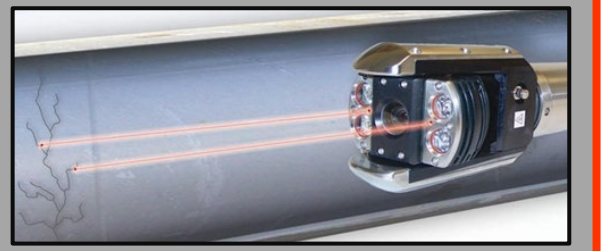
- Damage to any coatings

Inspection Tools

How do we See inside Pipe?

Visual	• Manual (Manway) • CCTV Video
Structural	• Manual (Manway) • Mandrel (Remote) • Laser Profiler / Micrometer (Remote) • 3D Scan (Remote)





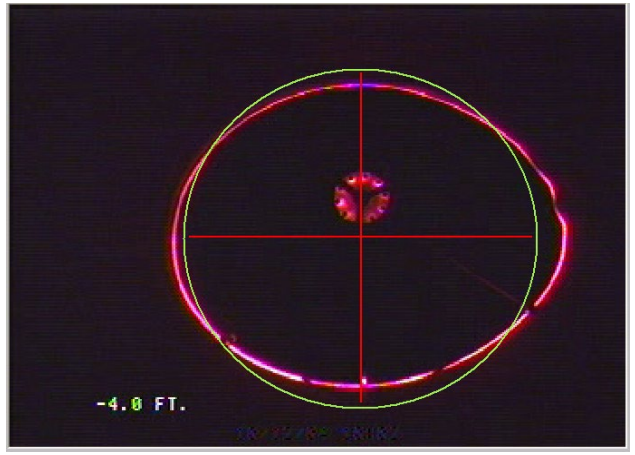
REMOTE INSPECTION TOOLS

Remote Access CCTV Camera

Laser micrometer

Sled mounted laser profiler’s

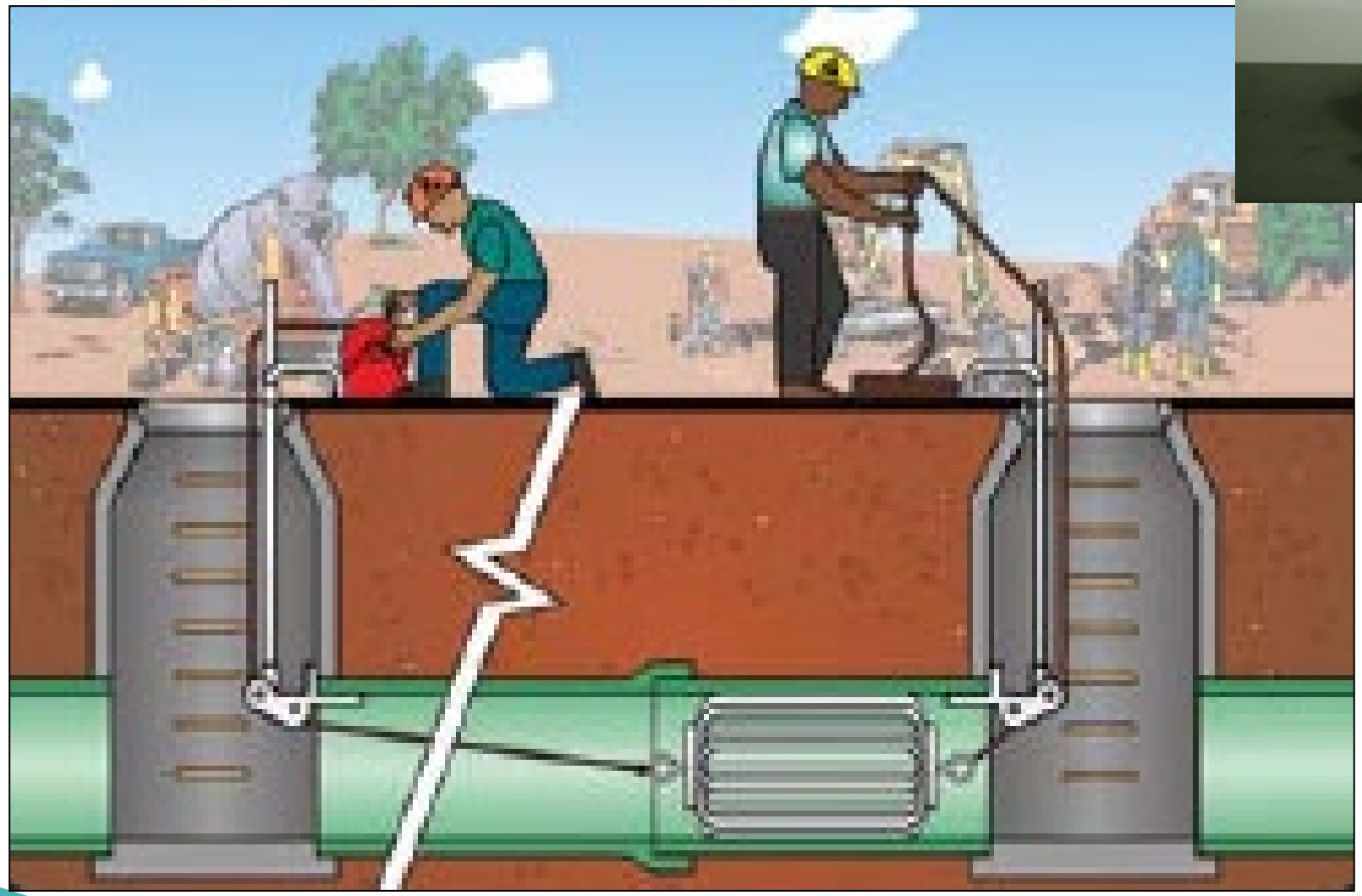
Still shot deflectometer inspection

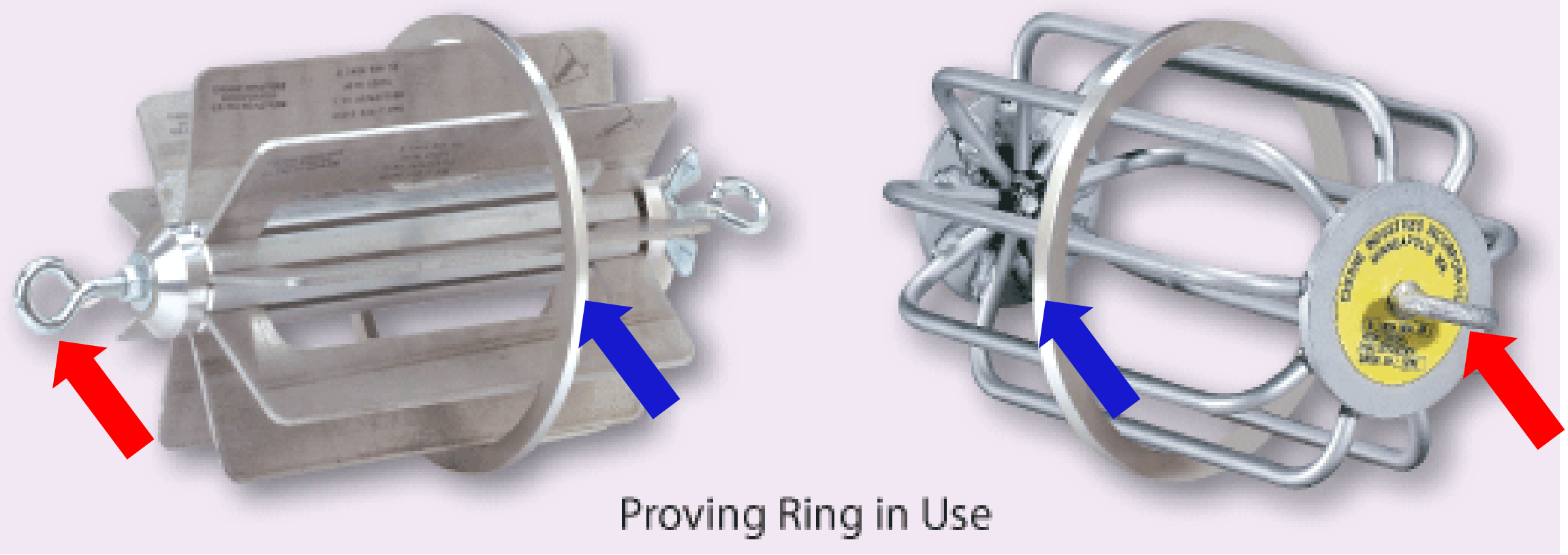



15.032523
1436+00
Crossline
Left - Right
18-inch RCP
BES - BES
12: 11
06. 06. 12
+01.2 %
LC1: 056.00 ft


2.0 FT

Inspection TOOLS
DEFORMATION/DEFLECTION





Proving Ring in Use

Major Work Items and Responsible Party for PII & Eval. Processes

Owner/Designer = Specification Development

(Details to Follow)

Inspection Company/Owner Team = PII Data Collection/Report

Owner/Engineer = Evaluate Data Collected/Report

Inspection Company or Installer = Repair & Remediation

TOOLS for PII & Evaluation Guidelines

Good ***National/State/Local Standards and Guidelines***

available for the PII process and evaluation guidelines.

Post Installation Inspection and Evaluation

Designation: C1840/C1840M – 17

Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe[1]

1. Scope

1.1 This practice covers the requirements for inspection and acceptance of installed reinforced concrete pipe by either person-entry, or remote inspection as shown in Figs. 1 and 2, respectively.

1.2 The scope of this specification is intended for installation related observations and assumes that pre-installation inspection has been completed.

1.3 The reinforced concrete culvert, storm drain and storm sewer pipe shall be manufactured in accordance with Specification C76, C506, C507, C655, or C1417 and accepted in accordance with AASHTO R073. This specification shall only be used for gravity, non-pressure storm drainage applications.

1.4 Person Entry shall be used unless extenuating circumstances preclude this type inspection. Remote inspection is acceptable for use for pipe diameters of 30 in. [750 mm] and smaller unless otherwise specified by owner or engineer.

1.5 Access of installed pipe for manual inspection shall follow OSHA 29 CFR PART 1926 SUBPART AA regulations for confined space entry. However, this standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.6 This practice does not cover deformation or deflection assessment. Concrete pipe is classified as a rigid structure because they do not bend or deflect appreciably under load before cracking. Due to these facts shape evaluation are of little or no value when evaluating concrete pipe.

1.7 The values stated in either Imperial/US or [SI units] are to be regarded separately as standard. The SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*
C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C506 Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C507 Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C655 Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
C822 Terminology Relating to Concrete Pipe and Related Products
C1417 Specification for Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design
D932 Practice for Filamentous Iron Bacteria in Water and Water-Formed Deposits

2.2 *AASHTO Standards:*
AASHTO LRFD Bridge Design Specification
AASHTO LRFD Bridge Construction Specification, Section 27
AASHTO PP63 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains
AASHTO R073 Standard Practice for Evaluation of Precast Concrete Drainage Products

2.3 *Occupational Safety and Health Standards:*
OSHA 29 CFR Part 1926 Subpart AA for the Construction Industry

2.4 *ISO/IEC Standards:*
ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 For definitions of other terms relating to concrete pipe not defined in this specification, see Terminology C822.

NCDOT Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe

NCDOT will require random video analysis on newly-installed drainage pipe to determine the condition of the pipe. Initial analysis should be performed if possible as soon as the pipe is installed to determine if any major problems exist with the contractor's installation methods. As the installation progresses, additional random inspections may be required to verify the quality of the installation and performance of the material. The video inspection may be performed by NCDOT or by an NCDOT-approved entity. However, the analysis of the video will be performed by an Engineer within NCDOT. The following criteria will be applied to all pipe material types and will be utilized to determine the course of action, if any, to be taken when there are cracks, deflections, bulges, creases, tears, spalls, or delaminations in the pipe. The final decision on course of action and acceptability will be determined by the NCDOT Engineer.

Cracks (Rigid Pipes):

- Cracks < 0.01" typically do not require repair or remediation.
- Cracks > 0.01" and < 0.05" are acceptable. However, multiple cracks of this size in an 8' section may require minor repair.
- In accordance with AASHTO LRFD Bridge Construction Specifications Section 27.6.4, record cracks greater than 0.01" wide. Monitor these cracks in any subsequent inspections.
- If the pipe is located in an area of the state that exhibits corrosive soils, minor repair may be required.*
- Cracks > 0.05" but < 0.10" are acceptable unless the following additional conditions exist:
  - Minor repair is required if the pipe is located in an area of the state that exhibits corrosive soils.*
  - If vertical offset across a crack is exhibited, the following guidelines shall be followed:
    When vertical offset is less than 0.10" provide minor repair.
    For vertical offset greater than 0.10" a determination will be made by the Department on the repair method or acceptability of the pipe.
- Cracks > 0.10" will be given consideration by the Department to replace the pipe or allow a Site Specific Major Repair. See the last section of these guidelines for details concerning Site Specific Major Repairs.

* For the following counties, Site Specific Repairs that fall outside the provided ranges may be necessary to prevent corrosion in the pipe's reinforcement: Beaufort, Bertie, Bladen Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, and Washington. Other areas throughout the state may require repairs if the pipe is determined to be installed in a corrosive environment (hot rock, very high soil pH levels, very low soil pH levels, etc.).

ASTM C1840 "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain & Storm Sewer Pipe"

- Pipe Inspection Equipment and Procedures
  - ***Excellent "How to Inspect" Tools and Techniques***
  - **Equipment and Operator Accuracy Verification**
  - **Inspection Report Requirements**
- Installed Pipeline Evaluation and Acceptance Criteria
  - ***Evaluation guidelines for cracks, joints and infiltration***
  - ***Establishes criteria for:***
    - ***Acceptable condition***
    - ***Products that require further evaluation***
    - ***Rejection of defective products***

•OBJECTIVE & MEASURABLE CRITERIA

Designation: C1840/C1840M – 17

Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe[1]

1. Scope

2. Referenced Documents

3. Terminology

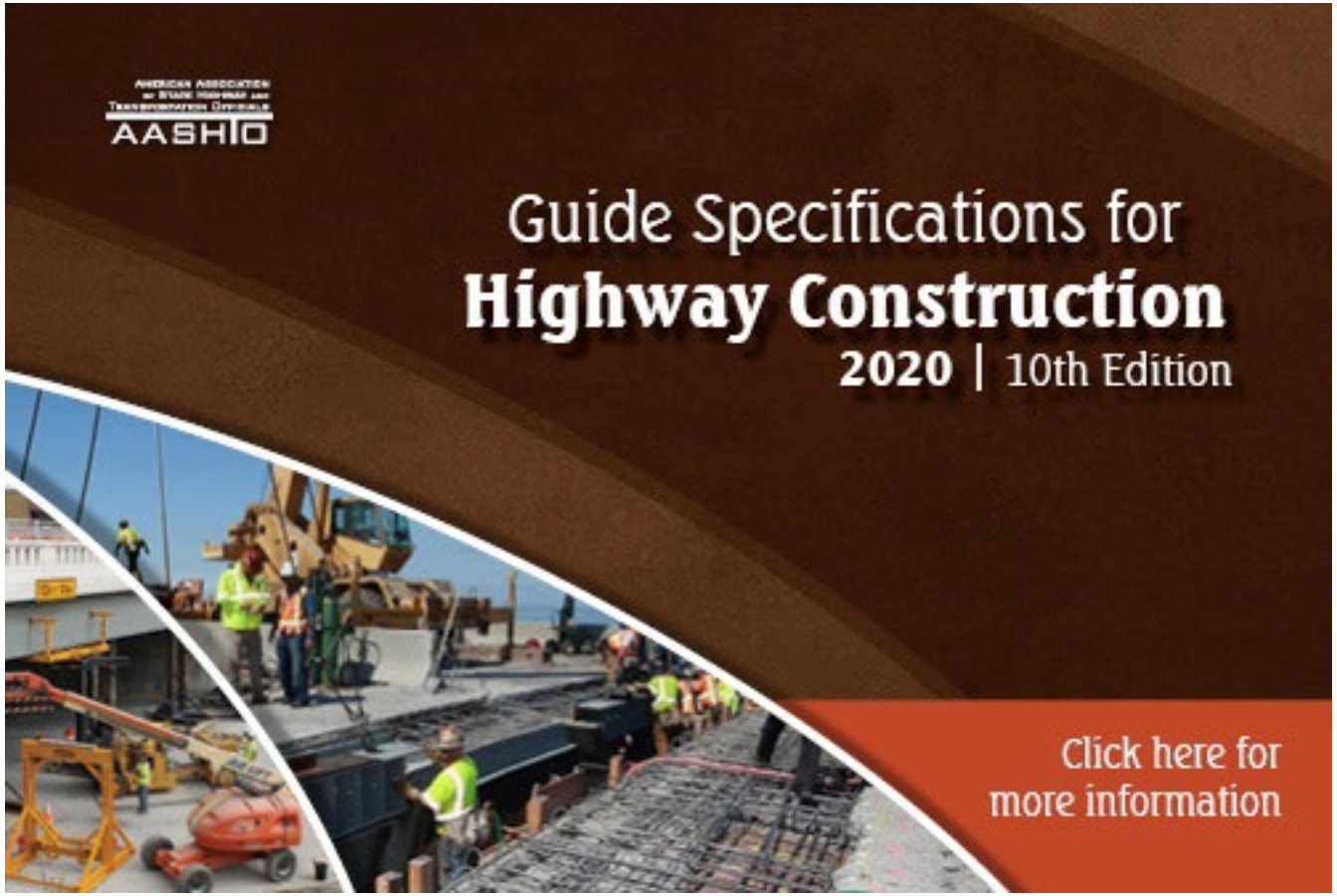
APPENDIX

(Nonmandatory Information)

X1. Summary of Crack Evaluation Criteria

Cracking	Width, in.	Maximum Length	Pattern, conditions	Section	Acceptance Criteria
longitudinal	≤ 0.01	entire pipe segment	N/A	8.2.1.1	not requiring remediation
	≤ 0.05		non-corrosive environment	8.2.1.2	
	0.01 < w < 0.05		hinge cracks more than 2 quadrants	8.2.2.1(1)	requiring further engineer evaluation
			> 0.1 in. vertical offset across crack	8.2.2.1(2)	
			allowing entry of backfill	8.2.2.1(3)	
	0.05 < w ≤ 0.1		corrosive environment	8.2.2.2(1)	
			hinge cracks more than one quadrant	8.2.2.2(2)	
		N/A	any vertical offset across crack	8.2.2.2(3)	
	> 0.1	< 3ft	N/A	8.2.2.3	
		> 3ft	N/A	8.2.3.1	requiring remediation
circumferential	≤ 0.10	full circumference	N/A	8.2.4.1	not requiring remediation
	> 0.10	> 50% of circumference	corrosive environment	8.2.5.1	requiring further engineer evaluation
	N/A	N/A	offset that impedes flow	8.2.5.2	
	N/A	N/A	allowing entry of backfill	8.2.6.1	requiring remediation
multi-directional	> 0.05	> 25% of circumference	more than one quadrant	8.2.7	requiring remediation
any	≤ 0.10	N/A	filled with calcium carbonate	8.2.8	not requiring remediation
	> 0.10	N/A	filled with calcium carbonate	8.2.8	requiring further engineer evaluation

Video Only Inspections…



“Guide Specification for Highway Construction” – To the Rescue

X5.2.5 REMEDIATION

A. *Camera-Only Remote Inspection Evaluation Criteria for Longitudinal Cracks in RCP.* Two longitudinal cracks the length of the pipe section is acceptable when the cracks are within 15 degrees of any quarter point of pipe, i.e., 11 o’clock to 1 o’clock, 2 to 4 o’clock, 5 to 7 o’clock, and 8 to 10 o’clock. Cracks at these points are signs of acceptable stress load cracks and are typically small cracks and do not allow soil infiltration and are not cause for concern unless the pipe is in an acidic condition (pH of soil/runoff less than 5). Pipes with more than two longitudinal cracks the length of the pipe at the quarter points or pipe with cracks at ±30 degrees from invert, i.e., 4 to 5 o’clock or 7 to 8 o’clock, should be further evaluated by an Engineer with experience in RCP pipe design and evaluation. Any crack exhibiting significant vertical offset should be remediated.

The Making of a Good PII Specification

The Instructions

PII Specific Issues to Cover

- How Much to Inspect – 100%, 10%, Risk Based (Owner Decisions)
- How to Inspect – Manway or Remote Entry or Both depending on pipe Size
- Who is responsible for Collecting PII Data and Required Qualifications
- Report Deliverables
- Clear Evaluation Criteria or Reference to appropriate National Standards
- Who Evaluates and makes acceptance/remediate Decisions
- Approval of Evaluation & Confirmation of Remediation (QA)

GDOT - PII Specifications

GDOT

- Section 550 – Storm Drain Pipe Specification
  - Requires Visual Inspection during Installation
  - Post Installation Video – all projects with ADT greater than 3000
  - 20% of Storm Drains and 10% of Side drains must be completed
  - In addition, Deflection Measurements must be taken for all Flexible Pipe inspected
- GDT 136 – Georgia Test Method for PII
  - Defines Inspection Equipment/Tools
    - Both Video and Deflection Tools
  - Describes Required Procedures
    - Video, Deflection, and Man Entry
  - Required Reporting Information
  - FORM TO RECORD AND CONFIRM PII COMPLETED!

NCDOT – Section 300-8

300-8 INSPECTION AND MAINTENANCE

Ensure proper jointing and that deformations do not exceed allowable limits as described in the Department's Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe. Maintain all pipe installations in a condition such that they will function continuously from the time the pipe is installed until the project is accepted by the Engineer. The Engineer will randomly video, deflection test, and/or manually inspect installations of completed pipelines prior to final acceptance.

NCDOT Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe

- Reiterates Specifications – When, where, how, etc.
- Evaluation Criteria for typical issues - All Pipe Product types
- Repair guidance

NCDOT Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe..Cont….

RCP Cracks

- Cracks ≤ 0.01” typically do not require repair or remediation.
- Cracks > 0.01” and < 0.05” are acceptable. However, multiple cracks of this size in an 8’ section may require minor repair.
- Cracks > 0.05” but ≤ 0.10” are acceptable unless the following additional conditions exist:
  - Minor repair is required if the pipe is located in an area of the state that exhibits corrosive soils.*
  - If vertical offset across a crack is exhibited, the following guidelines shall be followed:
    - When vertical offset is less than 0.10” provide minor repair.
    - For vertical offset greater than 0.10” a determination will be made by the Department on the repair method or acceptability of the pipe.
- Cracks > 0.10” will be given consideration by the Department to replace the pipe or allow a Site Specific Major Repair. See the last section of these guidelines for details concerning Site Specific Major Repairs.

NCDOT Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe…Cont….

Cracks or Tears (Flexible Pipes)

- HDPE, PVC, or CMP exhibiting any crack/tear
- Consideration will be given by the Department to replace the pipe or allow a Site Specific Repair for any tear that is through the liner of HDPE or for any tear in the wall of CMP or PVC. See the repair section of these guidelines for details concerning Site Specific Repairs.

Deflection (Flexible Pipes)

Base all deflection measurements on the inside pipe diameter supplied by the manufacturer or actual measurements obtained on the project.

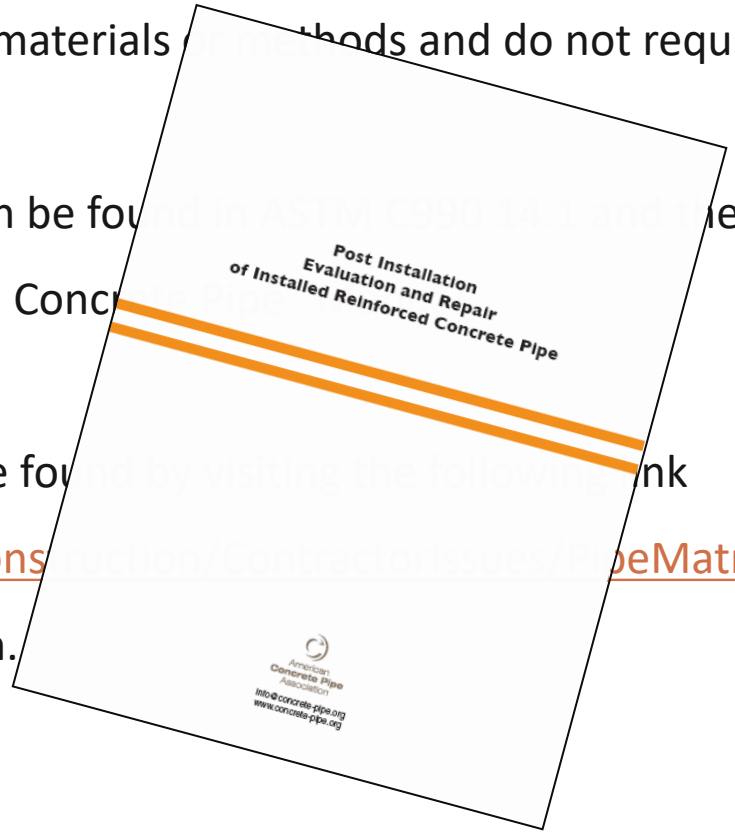
- Pipe deflections > 0% but $\leq$ 5.0% typically do not require repair or remediation.
- Pipe deflections $\geq$ 5.0% but $\leq$ 7.5% will be evaluated by the Department and a determination made as to acceptability or replacement.
- Pipe deflections > 7.5% require replacement.

Repairs (All Pipe Types)

Minor Repairs

Can be made with approved materials and methods and do not require a site specific analysis.

Examples of minor repairs can be found in ASTM C969 [43] and the ACPA "Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe".



Other repair resources can be found by visiting the following link http://www.dot.state.fl.us/construction/Contractors/RepairPipeMatrix/MatrixMain.shtm and choosing the type of pipe under evaluation.

City of Charlotte Post Installation Inspection (PII)

CCTV shall be performed on **all** storm drainage installations by a NASSCO-PACP certified contractor. Pipes 48" and larger may require manual entry and inspection.

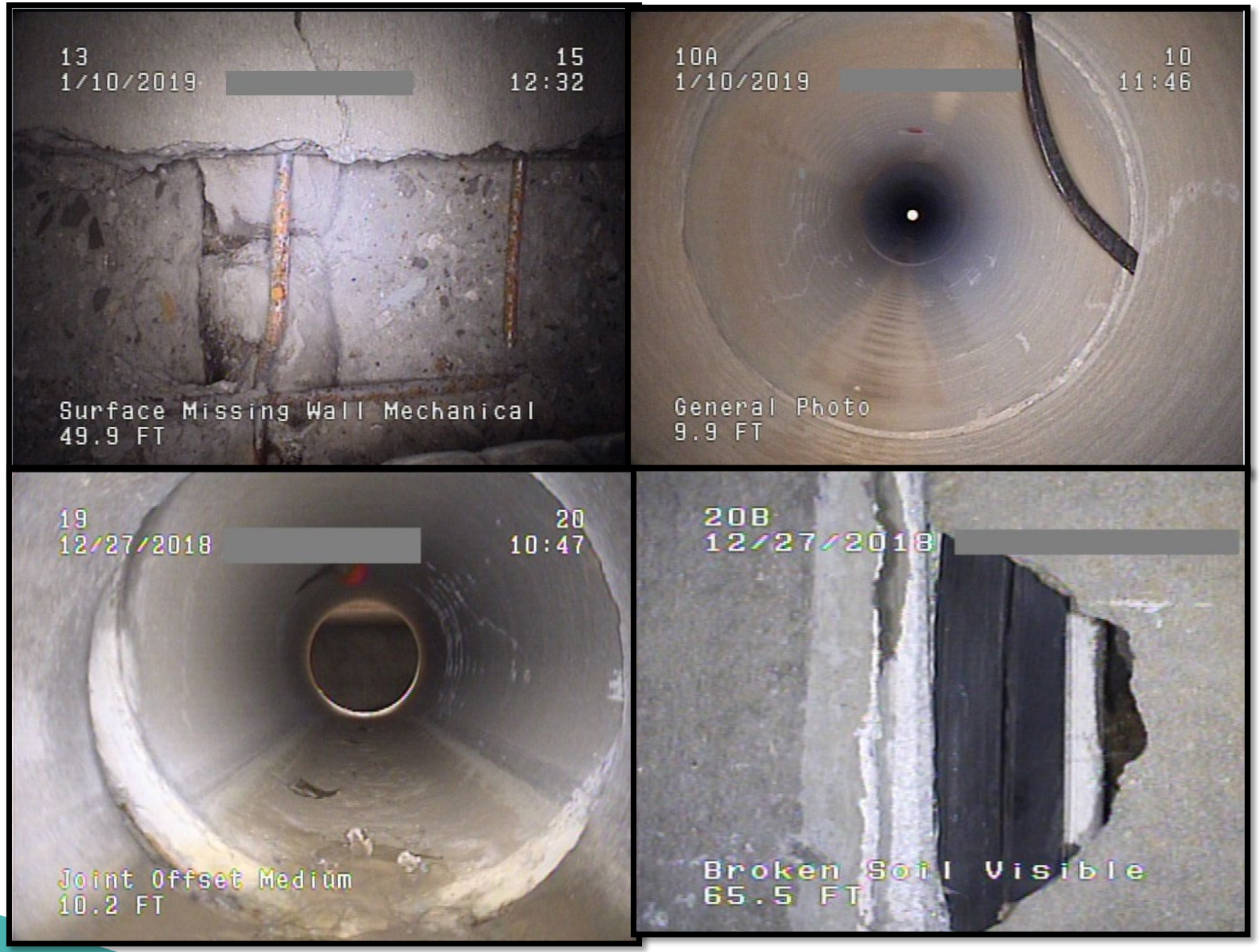
All storm drainage installation using flexible pipe shall require PII deformation evaluation as denoted in "*Third Party Testing for Flexible Pipe Installation*" (7/28/22 revised) by a NC licensed PE and shall provide a completed, stamped and sealed Post-Installation Certification Statement.

PP pipe shall be tested for up to 3% deformation and HDPE pipe for up to 5% deformation. Any pipe that exceeds 3%-5% respective deformation is to be replaced/re-installed by the Owner immediately with no exceptions.

Both CMP and RCP will also receive a PII and any defects will be required to be repaired prior to acceptance of the system by the City (if applicable).

Maybe best overall Install, Inspect, Eval. Specifications with respect to Flexible Pipe

Nashville, TN Case Study


13
1/10/2019
15
12:32
Surface Missing Wall Mechanical
49.9 FT
10A
1/10/2019
10
11:46
General Photo
9.9 FT
19
12/27/2018
20
10:47
Joint Offset Medium
10.2 FT
20B
12/27/2018
Broken Soil Visible
65.5 FT

RESPONSE in 2020 BY METRO Nashville FOR Continued Improvement!

Pipe Inspection & Evaluation Guidance Document from Metro Water Services

"**Intent:** Provide Guidance for the inspection and quality control requirements of pipe that is to become the responsibility of Metro Nashville to maintain.

To avoid or reduce issues discovered after the pipe is installed, it is important to inspect the pipe prior to installation. *Construction Installation Inspection requirements are the responsibility of a Grading Permittee representative* experienced in determining if storm infrastructure pipe has been installed appropriately.

Pre-Installation Inspection and Preparation: RIGHT BEFORE INSTALL = AASHTO R-73

Inspection during Installation: RIGHT DURING INSTALL = AASHTO R-73

POST Installation Inspection: CONFIRM RIGHT BEFORE ACCEPTANCE INTO METRO SYSTEM

Metro Guidance on PII….

WHY….

Who…..

How…..

When….

What…

PII REPORT DELIVERABLE….

Clear EVALUATION GUIDANCE

Emphasis on EOR Sign-off

WHO…from Metro Guidance Doc.

All post installation inspections are the ***responsibility of the Contractor/Owner's Representative***. ***These video inspections can only be completed by NASSCO PACP Certified inspection professionals.***

HOW…from Metro Guidance Doc.

Inspection firm will perform these inspections with a combination of either:

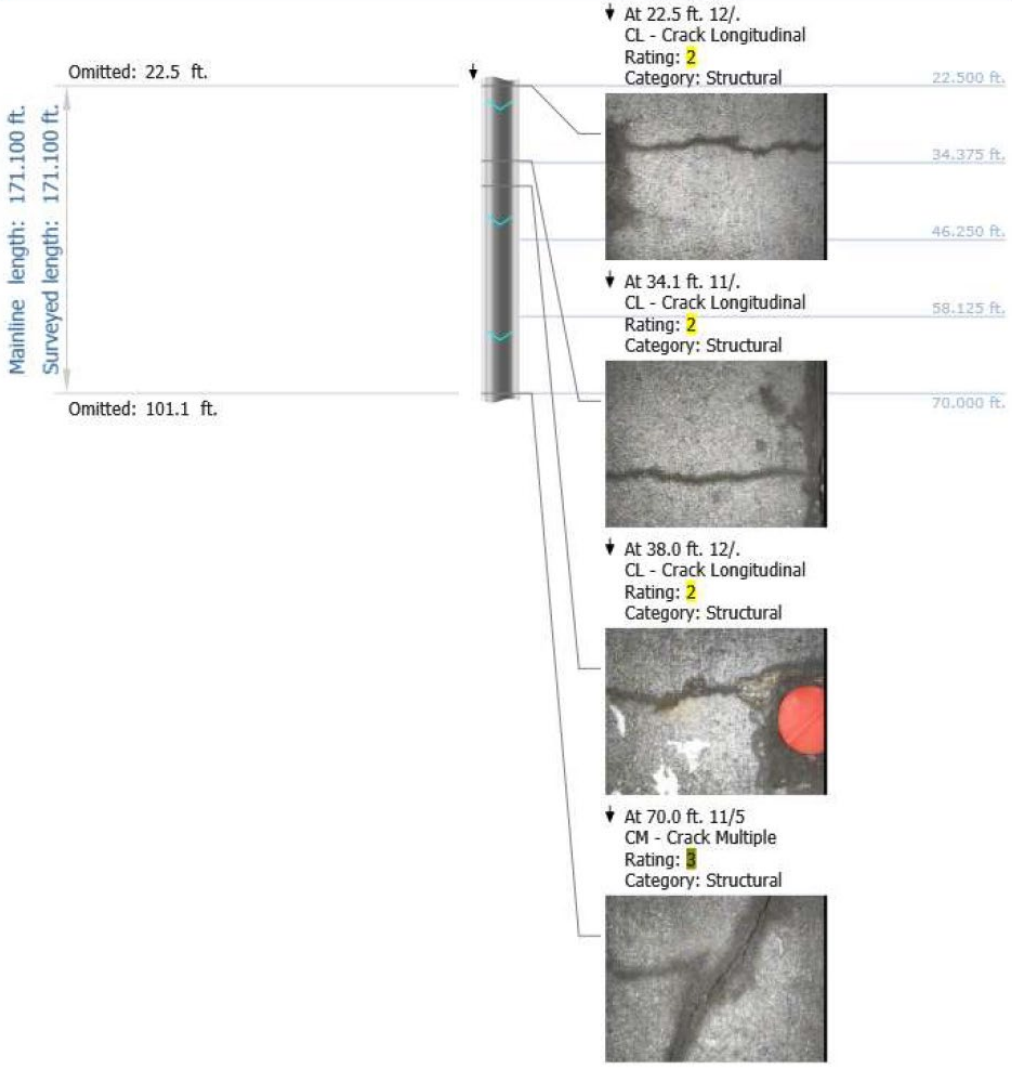
- Remote Video Camera (condition, jointing, obstructions, line & grade) for pipes 48-inch diameter and smaller, or
- Person Way Direct Measurement (see ASTM 1840 for guidance on Person Way Inspection and Reporting Guidance) for pipes larger than 48-inch diame

PII REPORT DELIVERABLE…from Metro Guidance Doc.

"Provide a written PII Report to the Engineer of Record along with corresponding video, pictures, and laser profiler data (LASER PROFILER FOR FLEXIBLE PIPE ONLY) on a digital media storage device. Inspection report shall note any Structural Defect Issue as defined in the NASSCO PACP Program. A still image must be provided for any issue observed with a NASSCO- PACP stormwater condition grade of 3 or higher along with all field inspection information that indicates why this area is noted shall be included in all reports. Each still image and description of condition for issues with a condition grade 3 or higher shall also have information that will allow the project's Engineer or Record (EOR) to locate and view this issue in the video recording if the inspection was a remote inspection.

Project name:	Mainline ID:	Start date/time:	Direction:
KIRKPATRICK PARK	**24_21**	**9/6/2019 12:10 PM**	**D**

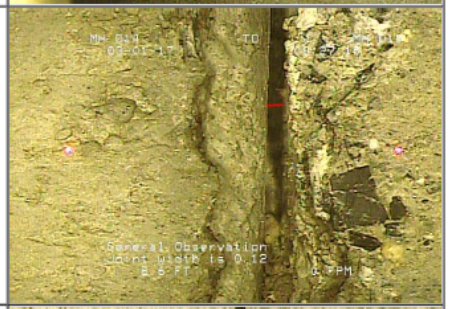
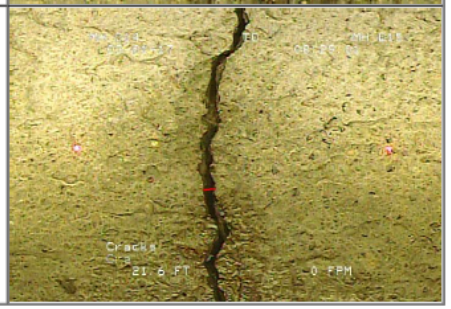
Weather:
1



Project Name: Lyndam Hill Phase II

Date: 3/1/2017 8:24:00 AM
Location: Chynoweth Street
Length Surveyed: 32.6
Run Number:
Pipe Size: 15

Asset ID:
Upstream MH Number: D15
Downstream MH Number: D14
Direction Of Survey: Upstream
Pipe Material: Reinforced Concrete Pipe

Distance	Fault Observation	Time	Picture
3.0	Start Inspection Severity: None Remarks: Inside pipe, pipe elevated in curb inlet D14	44	
8.6	General Observation Position: 5 Severity: None Remarks: Joint width is 0.12	01:50	
21.6	Cracks Position: 1 To 11 Severity: None Remarks: Crack width is 0.088	03:36	

EVALUATION – Metro Guidance….Got Report, Now What – Who Responsible for Acceptance/Remediate Decisions?

"It is NOT the responsibility of the inspection consultant (i.e. those doing the pipe video inspection work) to evaluate any issue of concern. It is the responsibility of the EOR to evaluate the video inspection to determine if any remediation is required. EOR Evaluation shall follow the guidelines below in "Guide for RCP Evaluation and Remediation" regarding installed pipe evaluation, acceptance, and remediation. Any repair or treatment to defects (prior to submittal of video or as observed by the City Agency) shall be corrected in compliance with Industry Standard approved methods. Example: By following the American Concrete Pipe Association's Post Installation Evaluation and Repair of Installed Reinforced Concrete Pipe."

NOTE CAUTION – NASSCO is subjective, Inspection Consultants may not be Engineers, perspective difficult, easy to waste $ on issues that are acceptable conditions that are not structural concerns or long-term operational issues….Most Inspection Companies also offer repair services…..

METRO NASHVILLE WATER SERVICES - Guide for RCP Evaluation:

Evaluation of report findings is the responsibility of EOR. Evaluation shall follow the following guidelines.

Evaluation Criteria for Longitudinal Cracks/Fractures (PACP CM, CH3, CH4, FL, FM, FS, FH2, FH3, FH4) in RCP: two longitudinal cracks the length of the pipe section (CH2 & FH2) is acceptable when the cracks/fractures are within 15 degrees of any quarter point of pipe ……Any crack exhibiting significant vertical offset should be remediated…..

Evaluation Criteria for Transverse Cracks in RCP (CC, FC); Circumferential cracks or fractures are acceptable unless the Crack/fracture is allowing migration of backfill into the pipe. Any crack allowing backfill migration shall be remediated……

Evaluation Criteria Soil/Silt Tight Joints for all Pipe Types (JOM, JOMD, JOL, JOLD, JSM, JSL, JAM, JAL): Note all joint offsets (JOM, JOMD, JOL), Separations (JSM, JSL), or angular irregularities (JAM, JAL). Remediate any joint with the following defects or damage: joints allowing soil infiltration…..

ASTM C 1840 “Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe” also provides good guidance on evaluation of installed RCP for items not included in Evaluation criteria above.

Engineering and/or Owner Checklist Specificatons

- **Selection/Application Criteria -** the proper pipe material (Policy)
- Ensure accurate **structural design and hydraulic capacity** (design criteria)
- **Provide clear and concise contract documents** (plans/specifications/details)
  - Lean on National or DOT Standards
  - Correct Material requirements
    - Pipe Materials
    - Joint Materials and performance requirements
    - **Pre-installation inspection and evaluation**
    - Installation Procedure
    - **Post Installation Inspection & Evaluation**
- **WE STAND READY TO ASSIST, REVIEW, MARK-UP, TECHNICAL GUIDANCE etc….**

Questions/Discussions

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