MIAMI-DADE COUNTY
miamidade.gov

Water and Sewer
PO Box 330316 • 3071 SW 38 Avenue
Miami, Florida 33233-0316
T 305-665-7471

VIA ELECTRONIC CORRESPONDENCE

September 8, 2016

CCN: 60535
File No: 8.DC.52 & 77

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
P.O. Box 7611
Ben Franklin Station
Washington, D.C. 20044-7611
RE: DOJ No. 90-5-1-1-4022/1
Tom.Mariani@usdoj.gov

Chief, Clean Water Enforcement Branch
Water Protection Division
Attn: Brad Ammons
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street, S.W.
Atlanta, Georgia 30303
Ammons.Brad@epa.gov

Rachael Amy Kamons
Environmental Enforcement Section
U.S. Department of Justice
P.O. Box 7611
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Washington, D.C. 20044-7611
Rachael.Kamons@usdoj.gov

Florida Department of Environmental Protection
Southeast District – West Palm Beach
3301 Gun Club Road, MSC 7210-1
West Palm Beach, FL 33406
Attn: Compliance/Enforcement Section
Diane.Pupa@dep.state.fl.us

RE: Consent Decree (Case: No. 1:12-cv-24400-FAM)
Reference DOJ Case No. 90-5-1-1-4022/1
Section XI, Paragraph 52 – Force Majeure
Section XVII, Paragraph 77 – Notices
Force Majeure Notification Letter for Consent Decree Appendix D-2, Capital Improvement Project 4.8, Rehabilitation of 54-inch PCCP FM in the City of Miami

Dear Sir/Madam:

In accordance with the provisions of Section XI, Paragraph 52 of the above referenced Consent Decree (CD), Miami-Dade (County) notified EPA and FDEP, via email, on August 26, 2016 of a potential delay in the Appendix D-2 Capital Improvement Project (CIP) 4.8 Rehabilitation of approximately 2 miles of 54 inch PCCP Force Main in the City of Miami between the intersection of NW 2nd St and NW 67th Ave and NW 37 Ave and NW 11th St. This Project has been delayed due to a Bid Protest.

In accordance with Section XI, Paragraph 52, this notification letter shall further describe and explain the reasons for the delay; the anticipated duration of the delay; all actions taken or to be taken to prevent or minimize the delay; a schedule for implementation of any measures to be taken to prevent or mitigate the delay or the effect of the delay; County's rationale for attributing such delay to a force majeure event

if it intends to assert such a claim; a statement as to whether, in the opinion of the County, such event may cause or contribute to an endangerment to public health, welfare or the environment, and documentation to support the force majeure claim.

Explanation and description of the reasons for the delay

CD CIP 4.8 provides for the rehabilitation of the County's C-1 transmission line. This project can only be accomplished during the Dry Season which runs for January 1 to May 31, 2017. In order to complete this project by the CD deadline of April 9, 2017, it was essential that we issue the "Notice To Proceed" to the awarded contractor on or before September 1, 2016. On August 19th the County issued the recommendation to award to the lowest responsive and responsible bidder and called for submission of their Bonding, Insurance, and other contractual documents. On August 24, 2016, the County received a "Letter of Intent to Protest", see Attachment A. In accordance with Miami-Dade County Code Section 2-8.4 "Protest Procedures" (see Attachment B), the County allows a three (3) working day window from issuance of the "Recommendation to Award" for any bidder to file a "Letter of Intent to Protest". Subsequent to filing the letter of intent, a "Formal Bid Protest" must be filed within three (3) working days to the Clerk of the Board. This "Letter of Intent to Protest" automatically places a hold on the award process pending the bid protest proceedings. The County anticipates it may take an additional sixty (60) calendar days before the award is approved by the Board of County Commissioners after the bid protest proceeding is concluded. Although the County believes there is little merit to the grounds cited for the bid protest, the process must run its course. The County Attorney has been in communication with the protesting firm to determine if this protest can be settled without proceeding to a Hearing Examiner. Unfortunately, on August 29, 2016 the Contractor filing the "Intent to Protest" has formalized their protest and as such we will be proceeding to a formal hearing, see Attachment C. The hearing has been tentatively scheduled for September 14, 2016.

Anticipated duration of the delay

The County anticipates successfully defending the award of the contract to the responsive and responsible low bidder and therefore is requesting a project delay of sixty (60) calendar days extending the completion date from April 9, 2017 to June 8, 2017. In the event that that the County is unable to issue a Notice to Proceed on or prior to November 1, 2016, then the County will provide an additional letter explaining all efforts utilized to mitigate the results of the hearing and a request for a four hundred seventeen day delay allowing the work to be completed during the 2018 dry season and be completed by May 31, 2018. It should be noted that the C-1 transmission line can only be bypassed during the dry season due to overall system flows and the position of this line in the system. The County reserves the right to seek additional time for completion.

Actions taken or to be taken to prevent or minimize the delay

We will continue to closely monitor this process and will continue to make every effort to mitigate this unanticipated project delay. The County is committed to successfully meeting the requirements of the CD. As with all Government Contracting, the need for a transparent and open procurement process is essential. With this transparency comes the risk of challenges to the process, such as the "Bid Protest".

Although the delays created by a "Bid Protest" may create scheduling delays, the public's right to a fair and open procurement process must be honored.

Schedule for implementation of any measures to be taken to prevent or mitigate the delay or the effect of the delay

	Measures taken	Implementation
1)	Strict adherence to the Bid Protest Policy timelines	Immediate
2)	Continued attempts to negotiate a settlement with the protesting company	Ongoing
3)	Ensure emergency spot repair contracts are in place in the event of a localized pipe failure	Ongoing

Rationale for attributing such delay to a force majeure event

As defined in Section XI, Paragraph 51, "Force Majeure," is defined as any event arising from causes beyond the control of the County. The filing of a bid protest by a consent decree project bidder is out of the control of the County, and therefore is by definition considered a Force Majeure event.

Cause or contribute to an endangerment to public health, welfare or the environment

The rehabilitation of this particular fifty-four (54) inch Force Main is necessary to ensure the continued integrity of our collection system however, there is no indication that it presents an immediate endangerment to the public health, welfare or the environment.

Should you have any questions regarding this matter, please call me at (786) 552-8571.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering such information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Hardeep Anand, PE
Deputy Water and Sewer Director

Attachments: Attachment A – Letter of Intent to Protest, Attachment B - Miami-Dade County Code Section 2-8.4 "Protest Procedures" and Attachment C – Letter of Protest

ec: Jonathan A. Glogau
Special Counsel
Chief, Complex Litigation
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850-414-3817
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Florida Department of Environmental Protection
Southeast District – West Palm Beach
3301 Gun Club Road, MSC 7210-1
West Palm Beach, FL 33406
Attn: Compliance/Enforcement Section
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Richard O'Rourke
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Robert Fergen
Al Galambos
Dan Edwards
Rolando Roque
Juan Bedoya
Lee N. Hefty (RER-DERM)
Carlos Hernandez (RER-DERM)
Rashid Istambouli (RER-DERM)
David Wood (CD PMCM)
Maricela Fuentes (CD PMCM)
Abby Diaz (CD PMCM)

Attachment A

Insituform
an AEGION company

17988 Edison Avenue
Chesterfield, MO 63005
www.insituform.com

Andrew Costa
Business Development Manager

Phone: (813) 309-0385
Fax: (813) 627-0006
Email: acosta@insituform.com

August 24, 2016

Miami Dade County
Clerk of the Board
Stephen P. Clark Center
111 NW 1st Street, Suite 17-202
Miami, FL 33128

Re: Letter of Intent to Protest: Miami Dade Water & Sewer Contract No. S-899: CD 4.8 – Rehabilitation of 54" Forcemain from NW 11th St. and NW 37th Avenue to NW 2nd St. and NW 67th Avenue

To Whom It May Concern,

Please accept this Letter of Intent to Protest from Insituform Technologies, LLC ("Insituform") regarding the bid submission of RicMan Construction of Florida, LLC ("RicMan") for the above referenced project. After a thorough technical review of both the performance specifications and the technical components of RicMan's submittal, we do not believe that RicMan's submittal, utilizing sliplining materials and methodologies, meets the AWWA Class IV component of the performance specification, or includes the structural calculations required to demonstrate its compliance with the performance specifications.

RicMan's proposed installation methodology involves the use of traditional HDPE sliplining, whereby an undersized HDPE pipe is inserted into the larger host pipe and the subsequent annular space is grouted in order to achieve either a semi-structural AWWA Class III system or fully structural AWWA Class IV system.

Based on the components of RicMan's bid submission and utilizing the design criteria specified in the performance specification (i.e. the -10 psi vacuum pressure requirement), neither the submitted size and class of HDPE pipe nor the combination of HDPE pipe and annular space grout meet the mandatory requirement for an AWWA Class IV fully structural lining system..

Additionally, RicMan's submittal failed to include structural calculations to demonstrate that the proposed HDPE pipe and/or HDPE pipe and grout combination comply with the AWWA Class IV fully structural lining system requirements, as outlined in the performance specification.

These grounds form the basis of our intent to protest.

(continued)

We greatly appreciate your prompt attention to this matter and welcome the opportunity to discuss this information further, should that be necessary.

Very truly yours,

Insituform Technologies, LLC.

Andrew Costa
Business Development Manager

Insituform
an AEGION company

cc: RicMan Construction of Florida
Kenny Construction
Lane Heavy Civil
Lanzo Lining Services
Miami Dade County Attorney
Isaac Smith
Ian Lancaster, Area Manager of Business Development

Attachment B

- **Sec. 2-8.4. - Protest procedures.**

This section shall govern any protest made by a participant in any competitive process utilized for selection of a person or other entity to construct any public improvement, to provide any supplies, materials or services (including professional or management services other than professional services whose acquisition procedure is governed by the Consultant's Competitive Negotiation Act, F.S. Section 287.055 et seq.), or to lease any county property.

The foregoing notwithstanding, the protest procedures contained in this section shall not apply to contracts and purchases which the County Manager has the delegated authority to award under Section 2-8.1(b) of this Code, and protests thereon shall be governed by procedures established by administrative order approved by the Board of County Commissioners.

A protest hereunder may not challenge the relative weight of the evaluation criteria or the formula specified for assigning points therefor contained in bid, request for proposals ("RFP") or request for qualifications ("RFQ") specifications which have been approved by the Commission.

(a)

Responsiveness. Prior to this Board or any committee thereof hearing any protests relating to a competitive bid, request for proposal or request for qualifications, the County Manager shall request the County Attorney to certify whether the bid or proposal in question is responsive. Upon receiving such request, the County Attorney shall, in consultation with the County Manager if necessary, determine whether the bid or proposal is responsive. This Board and any committee thereof shall be bound by the determination of the County Attorney with regard to the issue of responsiveness.

(b)

A written intent to protest shall be filed with the Clerk of the Board and mailed to all participants in the competitive process and to the County Attorney within three (3) working days of the filing of the Manager's recommendation. For purposes of calculating this period, the day of filing of the County Manager's recommendation with the Clerk shall not be counted. Such written intent to protest shall state the particular grounds on which it is based and shall be accompanied by a filing fee. The protester shall then file all pertinent documents and supporting evidence with the Clerk of the Board and mail copies to all participants in the competitive process and to the County Attorney within three (3) working days after the filing of a written intent to protest. No bid protest shall be accepted unless it complies with the requirements of this Section. Notwithstanding the above, in the event that a public records request is made within the first three days of the above referenced period, a protester may utilize any public records obtained as evidence or additional grounds for protest, provided that, a) the protester met all the deadlines set forth above, and, b) a supplementary filing is made with the Clerk of the Board within 48 hours of receipt of the records responsive to the request.

(c)

Protests filed in accordance herewith shall be referred to a hearing examiner. A hearing examiner shall be appointed not later than five (5) working days following the filing of a bid protest. The hearing examiner shall conduct a hearing in connection with the bid protest which shall be completed within ten (10) working days following his or her appointment. The hearing examiner shall, within five (5) working days of the hearing, file written findings and recommendations with the Clerk of the Board and shall submit or mail a copy of same to all participants in the competitive process and to the County Attorney. The hearing examiner may extend the deadline for completion of the hearing upon written petition for good cause shown, but such extension shall not exceed an additional five working (5) days. The hearing examiner shall consider the written protest and supporting documents and evidence appended thereto, the County Manager's recommendation, and supporting documentation, and all evidence presented at the hearing. The hearing examiner may also require written summaries, proffers, affidavits and other documents the hearing examiner determines to be necessary in order to conclude the hearing and issue the report and recommendation within the time limits set forth in this ordinance.

The hearing examiner shall be entitled to rely on evidence of a type commonly relied upon by reasonably prudent persons in the conduct of their affairs, whether or not such evidence would be admissible in a trial in the courts of Florida.

(d)

The hearing examiner shall allow a maximum of two hours for the protester's presentation of its protest and a maximum of two hours for the County's response to each protest. In the event of multiple protests, the hearing examiner shall allocate the time as necessary to ensure that the hearing shall not exceed one day.

(e)

The County Manager shall prepare an administrative order, to be approved by this Commission, amending Administrative Order No. 3-21 and setting forth a fee schedule for filing of bid protests. The fee shall be in the amount necessary to defray the cost of the bid protest process established in this Section. The administrative order shall also establish the amount of compensation to be paid the hearing examiner, and shall provide for a prorated reduction of that compensation in the event the hearing examiner fails to abide by the time limitations set forth in Section 2-8.4(c) above.

(f)

Hearing examiners shall be selected from a panel of retired judges who have served ten (10) or more years as Circuit Judges in the Eleventh Judicial Circuit in and for Miami-Dade County, Florida. Hearing examiners may be selected from alternate sources where the County Attorney recommends in writing that such action is necessary to achieve greater diversity.

(g)

The hearing examiner's findings and recommendation shall be presented to the Commission together with the recommendation of the County Manager. Notice thereof shall be mailed to all participants in the competitive process at least five (5) days in advance of such presentation. Notwithstanding any other provision of this Code or any prior resolution, the matter shall be heard by the Commission without prior presentation to any committee. The matter shall be resolved on the basis of the record before the hearing examiner and no evidence or issue which was not presented or raised at such hearing shall be considered. Presentations to the Commission by any participant in the competitive process or their representatives if authorized by subsection (h) below shall be limited to ten (10) minutes per side. The foregoing time limitation shall be inclusive of all speakers addressing the Commission on behalf of each side.

(h)

If the hearing examiner concurs in the County Manager's recommendation, a two-thirds (2/3) vote of the Commission members present shall be required to take other than the recommended action. Provided however, a two-thirds (2/3) vote shall not be required to reject all bids. If the hearing examiner concurs in the County Manager's recommendation, the Commission shall not allow presentations by any participants in the competitive process or their representatives at the time the matter is presented to the Commission. If the hearing examiner does not concur in the County Manager's recommendation, the participants in the competitive process and their representatives may make presentations to the Commission and the Commission shall decide the matter by majority vote.

(i)

The County Manager may provide different time periods for the taking of any actions required hereunder when the interest of the County so requires by including appropriate language in the specifications or addenda thereto.

(j)

The foregoing notwithstanding, the Commission, by two-thirds (2/3) vote of the members present, may waive the requirements of this section and entertain a bid protest, upon written recommendation of the County Manager.

(Ord. No. 93-135, § 2, 12-14-93; Ord. No. 94-26, § 1, 2-1-94; Ord. No. 95-22, § 1, 2-7-95; Ord. No. 95-126, § 1, 7-11-95; Ord. No. 95-201, § 2, 11-7-95; Ord. No. 99-146, § 1, 10-19-99; Ord. No. 00-86, § 1, 7-6-00; Ord. No. 01-68, § 1, 4-10-01; Ord. No. 04-77, § 1, 4-27-04; Ord. No. 06-124, § 1, 9-12-06)

Attachment C

Insituform
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Carrie M. Branson
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August 29, 2016

Miami Dade County
Clerk of the Board
Stephen P. Clark Center
111 NW 1st Street, Suite 17-202
Miami, FL 33128

Re: Letter of Protest: Miami Dade Water & Sewer Contract No. S-899: CD 4.8 – Rehabilitation of 54" Forcemain from NW 11th St. and NW 37th Avenue to NW 2nd St. and NW 67th Avenue

To Whom It May Concern,

Please accept this Letter of Protest from Insituform Technologies, LLC ("Insituform"), regarding the bid submission of RicMan Construction of Florida, LLC ("RicMan"), for the above referenced project. After extensive internal and 3rd party technical reviews of both the performance specifications and the technical components of RicMan's submittal, we are protesting the Recommendation to Award issued on August 19, 2016. Insituform is protesting on the grounds that RicMan's submittal, utilizing 48-Inch DIPS DR 32.5 HDPE sliplining materials and methodologies, fails to meet the AWWA Class IV component of the performance specification. Additionally, RicMan's bid submission failed to include the structural calculations required to demonstrate the proposed rehabilitation system's compliance with the bid's performance specifications.

To support our position, we engaged Mr. Brian C. Dorwart of Brierley Associates, a 3rd party engineer/firm specializing in these types of applications. Mr. Dorwart is an expert in the field of HDPE thermoplastics and pipe liner designs/rehabilitation and in his findings (see attached), Mr. Dorwart distinctly points out where RicMan's submittal fails to comply with the AWWA Class IV requirement. The letter also includes designs to demonstrate how RicMan's proposed HDPE pipe material is unable to meet the criteria of the AWWA Class IV requirement. As a result, RicMan's material submission clearly fails to meet the performance specification criteria the County required all bidders to achieve.

In addition, RicMan's submittal also omitted structural designs and calculations to support the claim that the chosen HDPE materials meet the Performance Specification. These designs were required to be included in RicMan's submittal based on Section 1.1 of the Performance Specification that reads:

"Bidders will be required as part of their bids to submit detailed design documentation prepared, signed and sealed by a professional engineer including design calculations demonstrating that the intended rehabilitation product or products meets or exceeds the requirements of this performance specification."

Although RicMan's submittal did provide some designs, Mr. Dorwart's letter identifies significant, critical flaws in those designs, particularly the default use of incorrect design temperatures. AWWA M28 states that in order to meet the criteria of Class IV, liners must be designed at 80 degree temperatures. RicMan's designs utilize a default of 73 degree assumptions for that variable. This temperature variable

has a significant influence on both design and performance, due to the huge impact that time and temperature has on HDPE pipe, particularly over long term periods of time.

Based on the aforementioned conditions, as well as the attached supporting 3rd party engineering documentation, we are respectfully requesting that you reject RicMan's submission for failure to comply with mandatory requirements of the bid and withdraw the pending Notice of Intent to Award.

As supporters and future participants of the County's RTQ process, our aim is to ensure that Miami Dade Water & Sewer is successful in this type of procurement approach which starts with ensuring the highest quality submissions that are fully compliant with the project specifications and mandatory requirements.

We greatly appreciate your prompt attention to this matter and welcome the opportunity to discuss this information further, should that be necessary.

Very truly yours,

Insituform Technologies, LLC.

Carrie M. Branson
Associate Counsel

cc: RicMan Construction of Florida
Kenny Construction
Lane Heavy Civil
Lanzo Lining Services
Miami Dade County Attorney
Isaac Smith
Daniel Schoenekase, Vice President and General Counsel
Ian Lancaster, Area Manager of Business Development
Andrew Costa, Business Development Manager

BRIERLEY ASSOCIATES
Creating Space Underground

Bedford Office
167 South River Road #8
Bedford, New Hampshire 03110
(603) 206-5775

August 29, 2016
File No.: 09107-260

Insituform Technologies
3016 North US Highway 301, Suite #900
Tampa, FL 33619

Attention: Mr. Andrew Costa
Business Development Manager

Subject: Review of RicMan Submittal
S-899 CD4.8 Rehab of 54 Inch Force Main
Miami, FL

Mr. Costa,

As requested, we have reviewed the RicMan submittal for the design-build S-899 project rehabilitation of the 54 inch diameter force main. RicMan has proposed a 48 inch DIPS DR32.5 HDPE slipline solution that would be grouted in place in their June 30, 2016 submital. The purpose of our review was to render an opinion regarding submittal compliance with Project Specifications and the long term performance of the proposed system.

It is our opinion that the proposed sliplining system does not meet the performance criteria of the project specifications that require meeting conditions of a Class IV rehabilitation. Additionally, the calculations provided by the RicMan submittal are both incomplete and are only valid at a temperature of 73 degrees F.

A Class IV designation rehabilitation needs to satisfy the following two conditions according to AWWA M28 Appendix A.

1. A long-term (50-year) internal burst strength, when tested independently from the host pipe, equal to or greater than the MAOP of the pipe to be rehabilitated.
2. The ability to survive any dynamic loading or other short-term effects associated with sudden failure of the host pipe due to internal pressure loads.

The following discussions presents the basis for our opinion.

1. No calculations were provided regarding AWWA Condition 2. Attached calculations indicate that the DR32.5 HDPE pipe does not support the external loads when it is not under pressure.

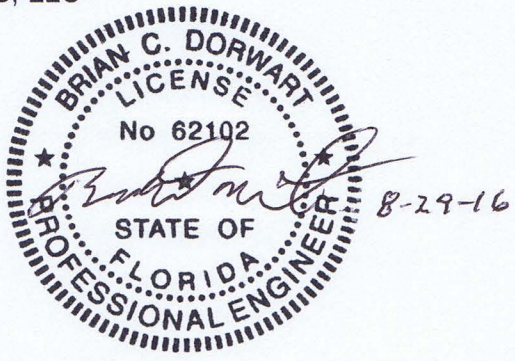
2. No calculations were provided regarding AWWA Condition 2. Attached calculations indicate that the DR32.5 HDPE pipe exceeds manufacturer's deflection limits under external loadings. Excessive deflection reduces long term load capacity, lifespan, and can result in street settlement.

3. Calculations by RicMan do not indicate the temperature where the calculations are valid. HDPE is a visco elastic plastic material with properties that change with time and temperature. Calculations need to specify the temperature and time assigned to the selected properties to assess suitability of the results.

4. AWWA M28 requirements for Class IV remediation is that calculations be based on a temperature of 80 degrees F. The RicMan calculations were all done at 73 degrees F; the difference is significant. The calculations that were completed thus do not meet AWWA M28 Class IV requirements.

We appreciate the opportunity to be of service to you on this project. Please call with any questions.

Sincerely,
BRIERLEY ASSOCIATES, LLC



Brian Dorwart, PE, PG
Senior Consultant

Attachments – Supporting Design Calculations
BCD CV

ASSESS SUBMITTED WALL THICKNESS CALCULATIONS FOR PIPE

BCD 8/28/2016

Proposed Pipe RicMan Page 59

Proposed Pipe - HDPE PE4710 DIPS DR32.5

DR	32.5		
D_{OD}	50.8	in	ISCO data sheet
Avg. D_{ID}	47.846	in	ISCO data sheet
Min Wall, t	1.563	in	ISCO data sheet

Calculation 1 - Pipe Pressure Class

Specification 1.2.3 Rehabilitation Design Criteria

Required: Design Working Pressure = 50 psi

Pressure Class C-906-07 **At 80 degrees F**

$PC = [2/(DR-1)][HDB \times DF * f_T]$

DF =	0.63	TR-41 PPI
DR =	32.5	
HDB =	1600	Hydrostatic Design Basis at 73.4 deg F
f_T =	0.94	80 deg F Required to meet AWWA C906-07

PC = 60.16 psi at 80 degrees F

< RicMan Rating of 65 psi

> Project required for working pressure of 50 PSI

Pipe is Class 60 not Class 65 per AWWA definition

Result **OK**

Calculation 2 - Vacuum Capacity (NO RICMAN CALCULATION PROVIDED)

Specification 1.2.3 Rehabilitation Design Criteria

Required: Vacuum Pressure = -10 psi

Assume simple analuses with no external pressure - VERY CONSERVATIVE

Vacuum capacity is calculated as unconstrained buckling with exptenal pressure

Uncoinstrained buckling capacity Short term, P_{CR}

$P_{CR} = 2Ef_o f_T/(1-\mu^2)[1/(DR-1)]^3$ PPI Chapter 6 Eq 3-39

E =	57,500	psi at 12 hrs at 73 deg F
μ =	0.45	
DR =	32.5	
f_o =	0.76	Ovality Compensation Factor at 3% (RicMan Page 63)
f_T =	0.93	Temperature compensation factor for 80 deg

P_{CR} = 3.261 psi

<10 psi specified vacuum capacity

B.1.1 – Design Values for the Base Temperature of 73°F (23°C)

TABLE B.1.1
Apparent Elastic Modulus for 73°F (23°C)

Duration of Sustained Loading	Design Values For 73°F (23°C) (1,2,3)					
	PE 2XXX		PE3XXX		PE4XXX	
	psi	MPa	psi	MPa	psi	MPa
0.5hr	62,000	428	78,000	538	82,000	565
1hr	59,000	407	74,000	510	78,000	538
2hr	57,000	393	71,000	490	74,000	510
10hr	50,000	345	62,000	428	65,000	448
12hr	48,000	331	60,000	414	63,000	434
24hr	46,000	317	57,000	393	60,000	414
100hr	42,000	290	52,000	359	55,000	379
1,000hr	35,000	241	44,000	303	46,000	317
1 year	30,000	207	38,000	262	40,000	276
10 years	26,000	179	32,000	221	34,000	234
50 years	22,000	152	28,000	193	29,000	200
100 years	21,000	145	27,000	186	28,000	193

(1) Although there are various factors that determine the exact apparent modulus response of a PE, a major factor is its ratio of crystalline to amorphous content – a parameter that is reflected by a PE's density. Hence, the major headings PE2XXX, PE3XXX and, PE4XXX, which are based on PE's Standard Designation Code. The first numeral of this code denotes the PE's density category in accordance with ASTM D3350 (An explanation of this code is presented in Chapter 5).

(2) The values in this table are applicable to both the condition of sustained and constant loading (under which the resultant strain increases with increased duration of loading) and that of constant strain (under which an initially generated stress gradually relaxes with increased time).

(3) The design values in this table are based on results obtained under uni-axial loading, such as occurs in a test bar that is being subjected to a pulling load. When a PE is subjected to multi-axial stressing its strain response is inhibited, which results in a somewhat higher apparent modulus. For example, the apparent modulus of a PE pipe that is subjected to internal hydrostatic pressure – a condition that induces bi-axial stressing – is about 25% greater than that reported by this table. Thus, the Uni-axial condition represents a conservative estimate of the value that is achieved in most applications.

It should also be kept in mind that these values are for the condition of continually sustained loading. If there is an interruption or a decrease in the loading this, effectively, results in a somewhat larger modulus.

In addition, the values in this table apply to a stress intensity ranging up to about 400psi, a value that is seldom exceeded under normal service conditions.

TABLE B.1.2
Temperature Compensating Multipliers for Determination of the Apparent Modulus of Elasticity at Temperatures Other than at 73°F (23°C)
Equally Applicable to All Stress-Rated PE's (e.g., All PE2xxx's, All PE3xxx's and All PE4xxx's)

Maximum Sustained Temperature of the Pipe °F (°C)	Compensating Multiplier
-20 (-29)	2.54
-10 (-23)	2.36
0 (-18)	2.18
10 (-12)	2.00
20 (-7)	1.81
30 (-1)	1.65
40 (4)	1.49
50 (10)	1.32
60 (16)	1.18
73.4 (23)	1.00
80 (27)	0.93
90 (32)	0.82
100 (38)	0.73
110 (43)	0.64
120 (49)	0.58
130 (54)	0.50
140 (60)	0.43

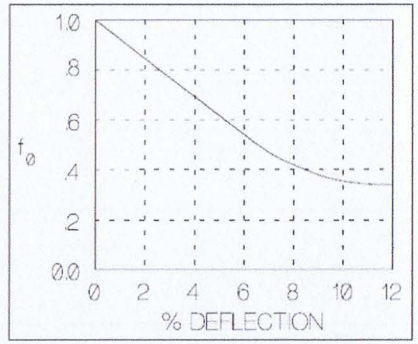


Figure 3-9 Ovality Compensation Factor, f_ϕ

Result **REJECT** **Pipe cannot withstand short term vacuum without some constraint provided**

Constrained Buckling below water - grouted pipe long term, P_{WC}

Luscher Equation PPI Chapter 6 Equation 3-15

$P_{WC} = 5.65[RB'E'E/(12(DR-1)^3)]^{1/2}$

R =	0.67		$R = 1-0.33H_{GW}/H$
H_{GW} =	11	ft	Height of groundwater above pipe crown at speciifed maximum cover
H =	11	ft	Height of cover above pipe crown at specified maximum cover
B' =	0.338207		$B' = 1/(1+4e^{-0.065H})$
E' =	700	psi	Soil Reaction Modulus Assumed
E =	29,000	psi	50 yr Long term modulus for HDPE
DR =	32.5		

P_{WC} = 19.786 psi

>10 psi specified vacuum capacity

Result **OK** Pipe can withstand long term vacuum condition when constrained

Calculation 3 - Allowable Pull Force (Assessment of Construction loadings)

$F_A = \pi(T_Y/FS)D^2[(1/DR)-(1/DR^2)]f_T$ PPI Handbook Ch 12 Eq 17

FS =	2.5	
T_Y =	3200	psi
D =	50.8	in
DR =	32.5	

F_A = 309,479 Pounds At 73 deg F

T (deg F)	f_T	F_A
50	1.17	362,090 pounds
60	1.1	340,427 pounds
70	0.99	306,384 pounds
80	0.94	290,910 pounds
90	0.86	266,152 pounds

All F_A > RicMan 265,958 Lb

Result **OK**

TABLE A.2
Temperature Compensating Multipliers for Converting a Base Temperature HDS or PR to HDS or PR for Another Temperature Between 40 and 100°F (4 and 38°C)

Maximum Sustained Temperature, °F (°C) [1]	Multiplier [2,3]
40 (4)	1.25
50 (10)	1.17
60 (15)	1.10
73 (23)	1.00
80 (27)	0.94
90 (32)	0.86
100 (38)	0.78

(1) Temporary and relatively minor increases in temperature beyond a sustained temperature have little effect on the long-term strength of a PE pipe material and thus, can be ignored.

(2) The multipliers in this table apply to a PE pipe that is made from a material having at least, an established hydrostatic design stress (HDS) for water, for 73°F (23°C). This HDS is designated by the last two numerals in the PE's standard designation code (e.g., the last two digits in PE4710 designate that the HDS for water, for 73°F (23°C), is 1,000psi - See Introduction and Chapter 5 for a more complete explanation.)

(3) For a temperature of interest that falls within any pair of listed temperatures the reader may apply an interpolation process to determine the appropriate multiplier.

TABLE 1
Safe Pull Tensile Stress @ 73° F

Duration (Hours)	Typical Safe Pull Stress (psi) @ 73°F		
	PE2xxx (PE2406)	PE3xxx (PE3408)	PE4xxx (PE4710)
0.5	1100	1400	1500
1	1050	1350	1400
12	850	1100	1150
24	800	1050	1100

The safe pull stress is the stress at 3% strain. For strains less than 3% the pipe will essentially have complete strain recovery after pullback. The stress values in Table 1 were determined by multiplying 3% times the apparent tensile modulus from the Appendix to Chapter 3 adjusted by a 0.60 factor to account for the high stress level during pullback.

Calculation 4 - Class IV Pipe Assessment

Specification 2.2 Relining Work

2.2 Relining Work

The design of the rehabilitation work shall include relining and/or replacement of all existing PCCP currently exposed to wastewater along project limits up to and including the wastewater pump station connection flanges at each outlet connection, each ARV location and each MH access

station connection flanges at each outlet connection, each ARV location and each MH access location The rehabilitation work shall provide for an AWWA Class IV fully structural lining system that will withstand all external pressures and loads and, in addition, the rehabilitation work shall provide a fully structural piping system that will withstand all internal pressures stated in paragraph 1.2.3 herein. The existing PCCP has a minimum depth of cover of 48 inches and a maximum depth of cover of 9 feet in localized areas with one area having a depth of cover of 11 feet.

Class IV linings are defined in AWWA M28 Appendix A

Class IV Linings

Class IV linings, termed fully structural or structurally independent, possess the following characteristics:

1. A long-term (50-year) internal burst strength, when tested independently from the host pipe, equal to or greater than the MAOP of the pipe to be rehabilitated
2. The ability to survive any dynamic loading or other short-term effects associated with sudden failure of the host pipe due to internal pressure loads

Class IV linings are sometimes considered to be equivalent to replacement pipe, although such linings may not be designed to meet the same requirements for external buckling or longitudinal/bending strength as the original pipe. Also, they may be of smaller internal diameters. Class IV linings can, of course, be used in circumstances similar to those for Class II and III, but their use is essential for host pipes suffering from generalized external corrosion where the mode of failure has been, or is likely to be, catastrophic longitudinal cracking. As explained later, some available renovation technologies can offer both Class II and III and Class IV linings, while a given lining system may be rated as Class IV for MAOP levels up to a threshold value and Class II and III for higher pressures.

Additional Design Considerations

In addition to internal pressure loads, linings may also be required to sustain external buckling loads during periods when the host pipe is depressurized, as well as transient vacuum loads. Some systems (Classes III and IV) can be designed to offer significant inherent resistance to such external loads, while others (Class II) depend solely on adhesion to the host pipe wall. Inherent resistance to external buckling normally varies with increased lining thickness and hence cost. Care should therefore be taken to ensure that such performance requirements are accurately defined.

The hydraulic performance of the lined pipe will be determined by the thickness of the liner, its closeness of fit to the host pipe, and its internal smoothness (C value). The lining process is usually preceded by extensive cleaning, which will itself restore the original flow cross section of the pipe. Liners of plastic materials are significantly smoother than the inner surface of a deteriorated host pipe, and they may even be smoother than the original pipe. In addition, many lining systems provide essentially joint-free coverage over long sections, so they offer less disturbance to flow than jointed sections of pipe. In general, close-fit plastic lining systems with SDR of 26 or more normally retain the original flow capacity of the pipe.

Supporting Calculations for verificaiton of Class IV rating

Test 1. Long term burst strength of HDPE > burst strength of host pipe

Test 2. Strucural capacity to withstand all static and dynamic loadings subjected to the host pipe

Test 1 assessment of burst strength (Calculations provided by RicMan)

Burst capacity of HDPE, P_B

$P_B = 2T_Yf_T/(DR-1)$ PPI chapter 6 Equation 1-1

T_Y = 3200 psi

f_T = 0.94 For 80 degrees working temperature

DR = 32.5

				Specification	
P_{BU} =	191	psi	Short term ultimate burst strength		
PC =	60	psi	See Calculation 1	>50psi	OK
POS =	120	psi	Occasional Surge allowed = 2*PC	>75 psi	OK
PRS =	90	PSI	Reoccuring Surge allowed = 1.5*PC	>70 psi	OK

Do not have the design of the PCCP pipe so do not know if the pressures exceed **the existing PCCP pipe capacity per Condition 1 of AWWA**

OK If specification provides the relevant PCCP data

Note that RicMan calculations are only valid at 73 degrees F

TABLE A.2

Temperature Compensating Multipliers for Converting a Base Temperature HDS or PR to HDS or PR for Another Temperature Between 40 and 100°F (4 and 38°C)

Maximum Sustained Temperature, °F (°C) [1]	Multiplier [2,3]
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(1) Temporary and relatively minor increases in temperature beyond a sustained temperature have little effect on the long-term strength of a PE pipe material and thus, can be ignored.

(2) The multipliers in this table apply to a PE pipe that is made from a material having at least, an established hydrostatic design stress (HDS) for water, for 73°F (23°C). This HDS is designated by the last two numerals in the PE's standard designation code (e.g., the last two digits in PE4710 designate that the HDS for water, for 73°F (23°C), is 1,000psi – See Introduction and Chapter 5 for a more complete explanation.)

(3) For a temperature of interest that falls within any pair of listed temperatures the reader may apply an interpolation process to determine the appropriate multiplier.

Test 2 assessment of structural capacity to support external loadings (No calculations provided by RicMan)

SEE SEPARATE CALCULATION TABLE BASED ON ASTM F1216-09

			Results
Minimum Wall Thickness to Support external loads	1.858 inches	>1.563" for DR 32.5	REJECT
Deflection of pipe under load	10.49%	>7.5% recommended by PPI	REJECT

TABLE 3-11

Safe Deflection Limits for Pressurized Pipe

DR or SDR	Safe Deflection as % of Diameter
32.5	7.5
26	7.5
21	7.5
17	6.0
13.5	6.0
11	5.0
9	4.0
7.3	3.0

*Based on Long-Term Design Deflection of Buried Pressurized Pipe given in ASTM F1962.

CURRICULUM VITAE
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Profession
Trenchless Engineer

Years of Experience: 30+

Professional Qualifications
M.S. Civil Engineering University of Massachusetts, 1979
Graduate Studies toward M.S.C.E., 1976-1978, State University of New York at Buffalo
B.A. Geology, University of Rochester, 1972
Graduate Studies toward M.B.A., Babson College

Professional Registrations
Professional Engineer:
Arizona (42154), Connecticut (16366), Delaware (19902), Florida (62102), Louisiana (36564), Maine (5970), Maryland 49332, Massachusetts (32116), Nevada (17771), New Hampshire (6714), New Jersey (GE04394700), New York (080342-1), Ohio (80817), Oregon (86793PE), South Carolina (33413),Texas (98845), Virginia (051076), Vermont (18.0120806), Washington (33505), Wisconsin (44486-6)

Professional Geologist:
New Hampshire (00162)

Professional Associations
ASCE, SME, NASTT, AWWA, AREMA

Board of Advisors of the Trenchless Technology Center at Louisiana Tech.

Program Committee for NASTT No-Dig conferences

Key Data

Mr. Dorwart has more than 40 years' experience as a geotechnical engineer and geologist in heavy civil projects. Projects have included underground utilities and transportation tunnels and drills, slope assessment and remediation, storm water system design, shoreline stabilization, and the interaction of subsurface conditions on construction activities.

He has special expertise in geologic and geotechnical engineering including design, implementation and interpretation of field studies evaluating overburden and bedrock engineering properties, constructability assessment, cost analyses, forensic studies, and mitigation/remediation design and construction. Mr. Dorwart has more than 20 years design and field experience with horizontal directional drills including subsurface characterization, pipe and drill path design, cost analyses, construction management, forensics, and construction.

In addition, Mr. Dorwart has served as technical expert to contractors and owners for claim negotiation and remediation for geotechnical and geological projects and as an expert consultant and witness in litigation support for tunnels, directional drills, shoreline development, landslides, and forensic studies for geologic and geotechnical cases in jury trials, hearings, and before public boards.

Experience:

6/2009 – Present Brierley Associates
Senior Consultant
National practice leader for trenchless projects and senior design engineer for trenchless projects focused on HDD, small diameter tunnels, pipeline rehabilitation.

6/2012 – Present DPS
Senior Engineer
Project engineer for site characterization, designs of pipeline tunnels, and horizontal directional drills.

7/2003 - 5/2009 – Haley & Aldrich
Associate
Project engineer for trenchless projects and pipeline rehabilitation projects.

11/1991 – 6/2003 Shannon & Wilson
Associate
Project engineer in railroad services group and project engineer for trenchless projects, pipeline rehabilitation projects, landslide mitigation projects.

6/1979 – 10/1991 GZA
Staff Engineer thru Sr. Project Manager
Geotechnical instrumentation specialist, foundation designs, site characterization, tunnel engineer.

1976 – 6/1979 Faculty Technical Consultants and Research Associate
Student, staff engineer, instrumentation specialists and soil lab instructor during Master Degree program.

Part Time 1973 – 1975 Rochester Drilling Company
Subsurface investigation driller, soils lab and field technician, field inspector for soil and structural projects.

Part Time 1973 – 1975 Hayhurst Const.
Carpenter

Selected Relevant Projects:

54" Force Main, City of Miami Beach, FL.
Pipe and directional drill designer of record for a design build team for a 54" diameter HDPE DR17 force main installed by directional drilling. Two drills were used in the construction: 3000 foot long and 1250 feet long. At the time of installation, these installations were the longest HDD installations of large diameter HDPE.

CIPP Lining Designs, Insituform United States
Completed designs for more than 200 CIPP projects throughout the United States with various felt, glass, and glass carbon composite tubes along with various types of resins, inversion methods, and cure processes. Additionally, has completed forensic assessments of CIPP systems and developed several design approaches for multiple pipe shapes.

CIPP Lining Designs, DayStar Composites, Southeast United States
Completed designs for numerous CIPP projects throughout the Southeast United States with various felt and glass tubes along with various types of resins. Installations are pulled in and inflated.

CIPP Lining Designs, BLD, Eastern United States
Completed designs for numerous CIPP projects throughout the Eastern United States with various felt and glass tubes along with various types of resins.

Geopolymer spincast pipe rehabilitation systems, IPR Corporation
Developed rigid liner design methodology for this product and completed designs for numerous EcoCast pipe lining projects throughout the United States. Installations are installed with spin casting geoplymer cements with fiber reinforcement. Typical projects are culvert rehabilitations and sewer rehabilitation.

Spiralwrap pipe lining rehabilitation systems, SAK construction, United States
Developed rigid design methodology for this product and completed designs for numerous Sakasui spiral wrap pipe lining projects throughout the United States.

Lateral Pipe rehabilitation National Water Main, Northeast, United States
Completed designs for numerous CIPP projects for sewer lateral pipe and connections throughout the Northeast United States with various felt tubes and various types of resins.

Water Supply Sliplining, Line Q3, Bonsall, CA.
In December 2009 the Rainbow Municipal Water District (RMWD) detected a falling water level in their large Morro Reservoir. Search crews discovered a significant leak in their 300 PSI Line Q3 pipeline, a 2,100 foot long, 24-inch epoxy-coated, steel pipeline installed under the San Luis Rey River in 1995 via horizontal directional drilling (HDD) methods. Closed circuit television (CCTV) found large amounts of sediment and sand within the casing. This sand and silt could only have come from a break, crack or perhaps an offset in the steel casing. Senior engineer for sliplining design and construction responsible for the analysis of the failed existing steel casing, the approach taken to clean and rehabilitate that existing casing and the design and construction of this new 300 PSI, pressure grouted sliplined pipe project.

MAYO RPS Force Main Trenchless Installations, Anne Arundel County, MD.
Senior Consultant providing design oversight for fourteen (14) separate HDD installations for new 20-in sewer force main. HDD installations range in plan length from 1,200 to 4,100 feet, and pass beneath roadways, parks, wetlands, and the South River.

Cinder Cove Force Main Replacement Anne Arundel County, MD. Senior Consultant providing technical oversight during design of three (3) separate HDD crossings for a 30-in HDPE force main, to be installed below marine embayment.

Utilidor, Private Developer, Fort Myers, FL.
Responsible for design, bid document preparation, and construction management of a 1,750 foot by 24 inch diameter utilidor crossing in fine grained soil under a sensitive river habitat to an island. The HDPE utilidor pipe contained electric, water, sewer, communications, and cable service HDPE ducts to supply a resort to be constructed on the island. Design and construction involved innovative drill rig and down hole pressure monitoring for pro-actively mitigating drill fluid loss in sensitive manatee habitat and design of a slag based grout for filling the annulus between the casing and the inner ducts without adding too much heat to the ducts that could result in duct collapse.

Exelon/BGE, 1500-103 BGE Russett to Tipton Duct Bank, Laurel, MD. Senior Consultant providing technical oversight during design of three of five (5) trenchless crossings, each involving three (3) parallel HDD installations of electric cable duct bundle (15 bores total). Each bundle consisted of 5, 10-in HDPE duct. Drill paths range from about 1,200 to 2,200 feet in length, located below wetlands, and the Pawtuxtent River.

Appeal Landfill Utility Improvements, Calvert County, MD. Senior Consultant providing technical oversight during design of two (2) separate HDD 8-in fusible PVC force main installations below a stream and adjacent wetlands adjacent to the Appeal Landfill.

Exelon/BGE, Russet East and Tipton 115 kV XLPE Cable Project, Baltimore, MD. Senior Consultant providing technical oversight during design of three (3) bundles each consisting of 6, 8-in HDPE duct. Drill paths ranged from about 1,200 to 2,200 feet in length, located below wetlands.

Water Supply Susquehanna River Crossing.
The purpose of the project was to connect Wysox and Towanda water systems in northeast Pennsylvania. The project included directional drilling to install a 14 inch DR11 DIPS HDPE pipe 1,550 feet long under the Susquehanna River. Responsibility included design of the HDD crossing and associated pipe along with preparation of plans and specification technical sections for bidding.

Water Supply Value Engineering Study for New Water Supply, Wrangell, AK.
Consultant to the City of Wrangell to provide a value engineering study including design and an engineer's comparative cost estimate with conceptual plans for a new water supply tap through an existing dam. Construction methods included pipe ramming, pipe bursting, and directional drilling. Ground conditions consisted of fill materials, timber, and rock rubble used to construct the dam.

Water Supply River Crossing, Ledyard, CT.
Responsible for design and technical aspects of construction for constructing a 20 inch HDPE pipe crossing under the Thames River that was installed by HDD methods. The crossing was approximately 1,400 feet long and was drilled through soil and rock under environmentally sensitive shellfish harvest areas. Environmental mitigations were a major component of this design and included drill rig and drill fluid monitoring and full time construction management.

Water Supply TWMP Segment 4, JEA, Jacksonville, FL.
Designed a multi curved 30 inch HDPE pipe and 2,060 foot long directional drill for pipe installation including drill fluid management and pipe design for the contractor and ultimately for the Owner.

Force Main Installation, Enfield, NH.
Provided senior oversight of design, bid support, and construction management for installation of 14-in diameter, dual containment HDPE pipe for wastewater transmission. Installation was completed below potable water supply lake and wetlands, using 1,400 feet of horizontal directional drilling.

Force Main, Annisquam River Crossing, Gloucester, MA.
Senior Consultant during design of parallel HDD installations of fusible PVC pipes for potable water transmission. Drill paths cross below active marine channel, and are each approximately 1,200-ft in length. Provided drill path geometry, pull force and annular pressure calculations.

Force Main, City of Middletown Sewer Force Main, Middletown, CT.
Senior Consultant during design of three (3) parallel, 30-in diameter fusible PVC pipes for use as sewer force main, by means of horizontal directional drilling (HDD). Drill paths located below active roadways and streams. Provided drill path geometry, pull force and annular pressure calculations.

Force Main, Cole Junction Pump Station, Missouri River Crossing, Jefferson City, MS.
Technical oversight of the geotechnical data acquisition and designer for the 2,300 foot HDD crossing of the river for the 30 inch diameter HDPE pipe. Provided field construction oversight and resident engineering services for construction.

Force Main, Kemper Pipeline, Meridian, MS.
Designed four crossings for installation of 36 inch DIP using HDD means and methods for an

approximate 60 mile pipeline for effluent water. Crossings were the longest to date for this diameter ductile iron pipe. Developed a new pull force calculation method for industry use using design and construction data from this project.

HDD Litigation Support and Expert Services and Testimony, Mississippi River Crossing, LaCrosse, MN. Granite RE v. City of La Crescent in Federal Court. Provided expert consulting and testimony services during litigation and trail for the contractor in defense of a changed condition and inadequate plans and specification claim. The project involved several directional drill installations that had failed because of buoyancy induced displacement of the HDPE pipe in very soft soil. Expert services included assessment of soil mechanics for pipeline stability is soft soil and assessment of contract document technical sections for standard of care and industry practice. Court found for the contractor.

Example Projects:

Horizontal Directional Drilling

- Water Supply River Crossing, Pipeline Q3 for Rainbow Water District, Bonsall, CA.
- Nacimiento Water Project, Whitaker Contractors, California.
- Raw Water Supply Elizabeth River Crossing, Norfolk Department of Utilities, Virginia.
- Utilidor for Water, Sewer, Power, Telecom, Private Developer, Fort Myers, FL.
- Raw Water Supply Intake Pipes, City of Grand Forks, ND.
- Force Main Effluent Transfer Pipeline Under Interstate I-5, Marysville, WA.
- Water Supply Thames River Crossing, Uncasville, Connecticut
- Water Supply Susquehanna River Crossing, PA.
- Raw Water Supply Merrimack River Crossing, Franklin Water District, NH
- Mary Rhodes Raw Water Supply, TX.
- Force Main, Kemper Pipeline, Meridian, MS.
- Force Main Water Elizabeth River Crossing, Hampton Roads Sewer District.
- Outfall Discharge Pipeline, Alaska Electric & Energy Cooperative, Inc. Nikiski Generation, Anchorage, AK.
- Force Main, Annnisquam River Crossing, Gloucester, MA.
- Force Main, City of Middletown Sewer Force Main, Middletown, CT.
- Telecommunications, Port Orchard, WA.
- Telecommunications Ocean Outfall and Conduit Bundle Channel Crossing, Boca Raton, FL.
- Telecommunications Boston Harbor Crossing, Boston, MA.
- Telecommunications Interstate 93 and Dorchester Harbor Crossing, MA. Telecommunications Corridor Interstate 495 Route Study, Boston, MA
- Telecommunications Relocation Interstate 495 and Route 3 Intersection Crossing, MA
- Telecommunications Multi-Track Railroad Crossing, Medford, MA.
- Telecommunications Crossing Under Interstate I-495, Boxborough, MA.
- Telecommunications Presidential Way Crossing, Woburn, MA.
- Telecommunications Ducts Steel Casing Crossing, Rainier, OR to Longview, WA.
- Telecommunication HDD Remediation, Santa Barbara, CA.

Tunnels

- Multi Drive Cambridge 12 Alewife Reservation Crossing, Cambridge, MA.
- Sewer, Upper Maline Creek Trunk Sanitation Relief Phase IV, St Louis, MO.
- Sewer, Upper Sugar Creek Sanitary Relief, St Louis, MO.
- Power Transmission Progress Energy Bartow-Northeast 230kV Underground Transmission Line HDD and Jack and Bore Crossings, St Petersburg, Florida.
- Power Transmission Nevada Power I-15 Sinatra 230/138/12kV Substation Crossing, Las Vegas, Nevada.
- Storm Water, Tunnel Remediation, Claremont, NH.
- Water Supply, Multiple Microtunnels, Wichita, KS.
- Water Supply, Randall's Island Water Main, New York City, NY.
- Country Club District Sewer Separation, Omaha, NE.
- Sewer, Auger-bored Tunnels, Everett, WA.
- Telecommunications, Level 3 Link, Boston, MA.
- Utilidor, First Street Tunnel, Seattle Engineering Department Instrumentation Data Monitoring, Seattle, WA.
- Water Supply, Second Supply Water Line, Tacoma WA.
- Soft-ground Tunnel Construction, Tacoma, WA.
- Sewer, St. George Interceptor Project, Metropolitan Sewer District City of St. Louis, MO.
- Sewer, Pipe Jacking Sewer Pipe, New York City, NY
- Cedar River Utility Crossing, Renton, WA.
- Department of Defense (DOD) Fuels, Whittier, AK.
- Davenport College Storm Drain Relocation, New Haven, CT
- Kirkwood 5 Pump Station Supply Tunnel, St Louis, MO
- Massachusetts Water Resources Authority (MWRA) New Neponset Valley Tunnel, Boston, MA.
- MWRA Sudbury Aqueduct Tunnels and Rehabilitation Project, Boston, MA.

Relevant Publications and Papers

"Risk-Based HDD Design and Construction," Point of View, *Trenchless Technology Magazine*, 2004

"Directionally Drilled Raw Water Intakes, Grand Forks, North Dakota," with G.R. Fischer, W. L. Gerszewski, M. K. Yavarow, Paper No. 6.19, Proceedings 5th International Conference on Case Histories in Geotechnical Engineering, New York, NY, 2004.

"Risk-Based Design Process For Directionally Drilled Raw Water Intakes, Grand Forks, North Dakota," with G. R. Fischer, W. L. Gerszewski, and M. K. Yavarow, NASTT No-Dig 2004, New Orleans, LA, 2004.

"WHITE PAPER-Risk Based Design Approach for Horizontal Directional Drilled Bores - A Pro-Active Project Approach to Facilitate Project Success," DCCA Conference Presentation, 2004

"Enough Subsurface Information?" *Tunnel Business Magazine,* 1999.

"A Contract is a Mutual Agreement not an Insurance Policy", With Osbak, Manley, "Northwest Trenchless Technology", 2007

"Horizontal Directional Drilling An Emergency Water Main Replacement Under Matlacha Pass – Challenges and

Innovation", with M. McGee, I Hossain, J. Wilson, and B. Thacher, AWWA Florida Section Conference Proceedings, November 26-30 2006.

"Risk Managed HDD Design Method", NASTT No-Dig 2006, Nashville, TN, March 26-28, 2006

"Recommended Site and Subsurface Characterization Methods for a Successful Directional Drilling Project", with N. Strater and M. Brownstein, NASTT No-Dig 2006, Nashville, TN, March 26-28, 2006.

"Engineering Properties and Pitfalls of soft Sediments in Long Island Sound", with J. Lambrechts, Geo-Strata, May/June 2007.

"Risk Managed Design Method Applied to an HDD Utilidor", BSCES – Geo-Institute Recent Advances in Geotechnical Engineering, 2005.

"Thermal Ground Treatment For Power Cables Installation", with S. T. Ariaratnam, NASTT No-Dig 2007, Nashville, TN San Diego, California, April 16-19, 2007.

"Design and Risk Management for a Multiple Crossing Project", with N. H. Strater, P. J. Ambrosio, and Ron Halderman, NASTT No-Dig 2007, Nashville, TN San Diego, California, April 16-19, 2007.
"Managing Expectations", With Ariaratnam, S, "Trenchless World", March 2008.

"Managing Expectations on HDD Projects", With Ariaratnam, S, Underground Construction Technology International Conference & Exhibition January 29-31, 2008, Atlanta, Georgia.

"Use Of Optically Guided, Large Diameter Downhole Hammers To Complete Trenchless Installation Of Electric Cables", With N. H. Strater, L. Puls, T. Crofts, D. J. Dobbels, Proceedings of the The North American Society and the International Society for Trenchless Technology (ISTT) International No-Dig Show 2009, Toronto, Ont, Canada

"HDD Crossing of Lake Austin Generates Data and New Model for Calculating Pull Force for Ductile Iron Pipe", With R. Carpenter, Proceedings of the ASCE Pipelines 2010 Conference, Keystone, CO.

"Ten Myths Regarding Installation Of Underground Power Transmission Lines With Trenchless Construction Methods", Proceedings North American Society for Trenchless Technology (NASTT) No-Dig Show 2010, Chicago, IL.

"Is Your "Small" HDD Simple Or Not?", Proceedings North American Society for Trenchless Technology (NASTT) No-Dig Show 2011, Washington, D.C.

"Are you receiving the CIPP thickness you're paying for?, With T. Porzio, NASTT No-Dig Show 2012, Nashville, TN.

"Line Q3 Pipeline_Slipline Rehabilitation" With J. Heden, B. C. Lee, NASTT No-Dig Show 2012, Nashville, TN.

"Trenchless Ducts Installation and Thermal Grouting for the Hackensack River Project", With F. Hooper, T. Marti, J. O'Leary, NASTT No-Dig Show 2013, Sacramento, CA.

"HDD Using Ductile Iron Pipe_New Pull Data Helps Refine Dorwart Method", With R. Carpenter, NASTT No-Dig Show 2013, Sacramento, CA.

"Grout Engineering for Directional Bores", NASTT No-Dig Show 2015, Denver, CO.