ALLIANCE FOR pe pipe

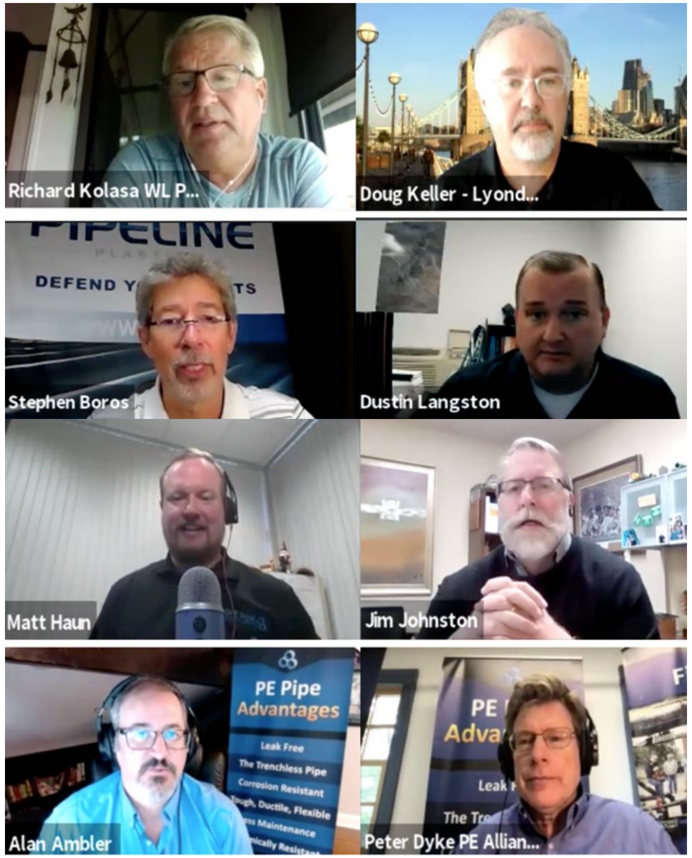
HDPE 301

www.pepipe.org

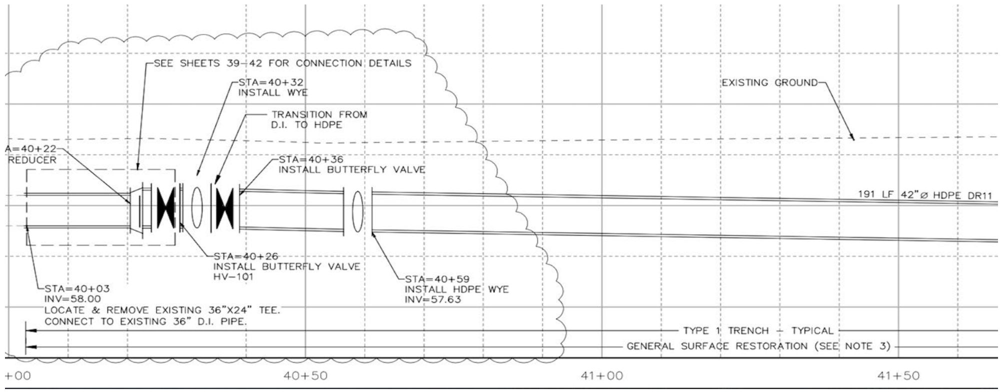
Free Resources

dlandy@pepipe.org

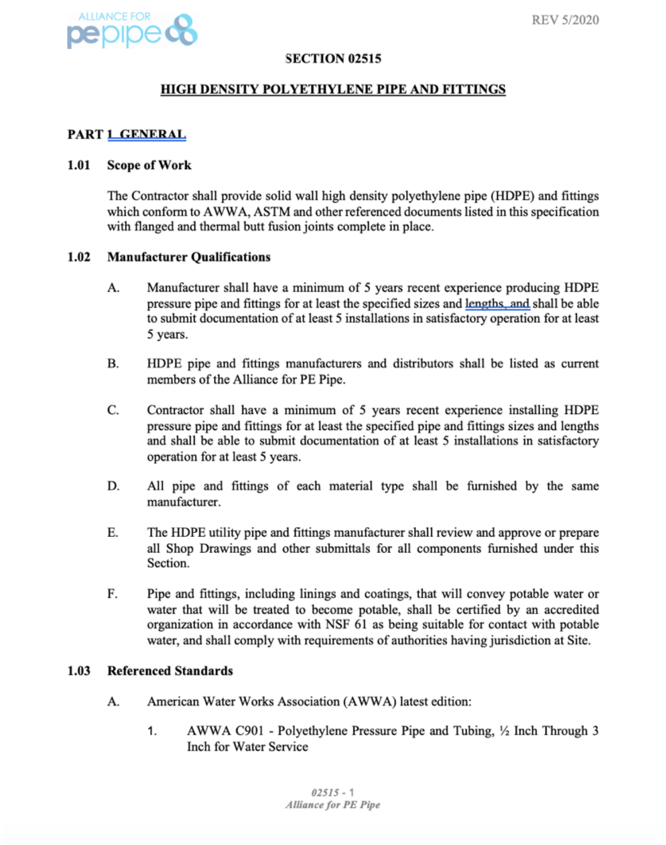
Schedule A Seminar



Project Review & Assistance



Spec Writing / Editing



ALLIANCE FOR pepipe

REV 5/2020

SECTION 02515

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 GENERAL

1.01 Scope of Work

The Contractor shall provide solid wall high density polyethylene pipe (HDPE) and fittings which conform to AWWA, ASTM and other referenced documents listed in this specification with flanged and thermal butt fusion joints complete in place.

1.02 Manufacturer Qualifications

A. Manufacturer shall have a minimum of 5 years recent experience producing HDPE pressure pipe and fittings for at least the specified sizes and lengths, and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least 5 years.

B. HDPE pipe and fittings manufacturers and distributors shall be listed as current members of the Alliance for PE Pipe.

C. Contractor shall have a minimum of 5 years recent experience installing HDPE pressure pipe and fittings for at least the specified pipe and fittings sizes and lengths and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least 5 years.

D. All pipe and fittings of each material type shall be furnished by the same manufacturer.

E. The HDPE utility pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

F. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.03 Referenced Standards

A. American Water Works Association (AWWA) latest edition:

1. AWWA C901 - Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service

02515 - 1
Alliance for PE Pipe

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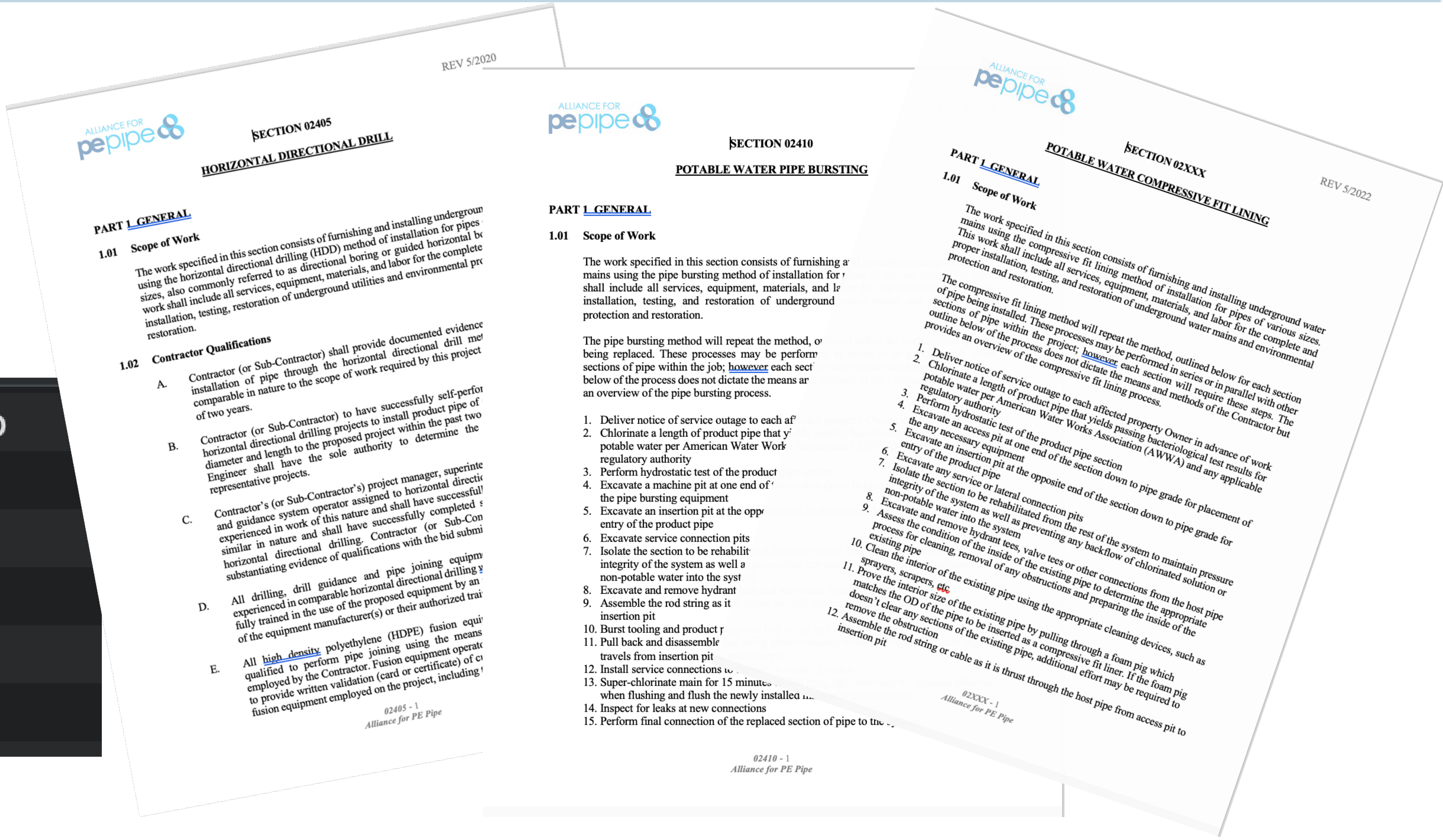
Specifications

dlandy@pepipe.org

1. AllianceforPEPipeSpecsinWORD copy.zip
2. ExcavationBackfillandCompaction.docx
3, PolyethylenePipeandFittings.docx
4. PipeBursting.docx
5. HorizontalDirectionalDrill.docx
6. CompressiveFitlining.docx



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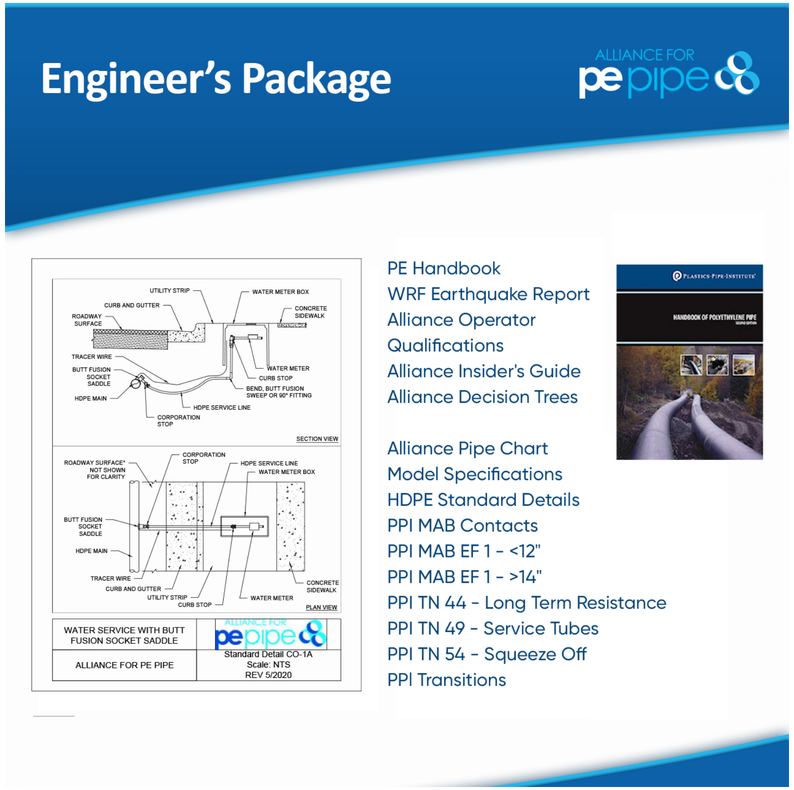
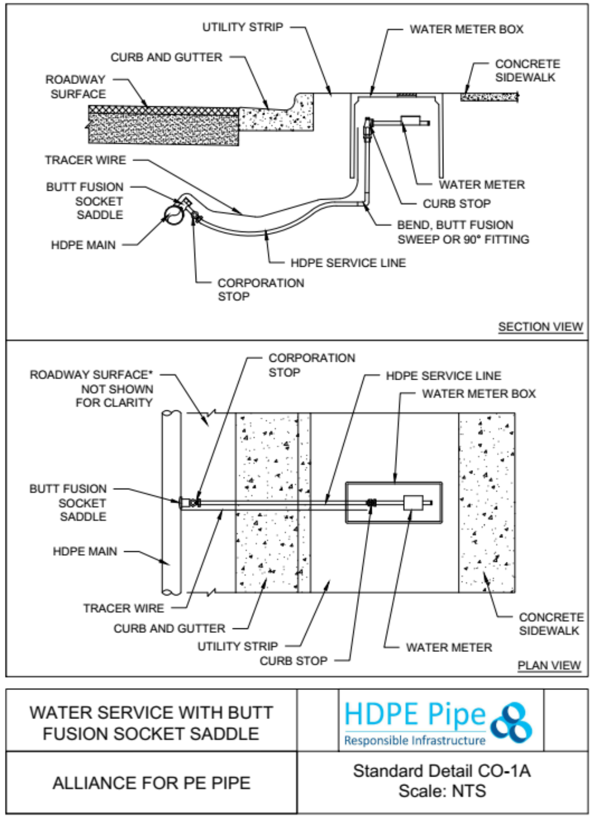
Engineer's Package



Standard Details



Case Studies

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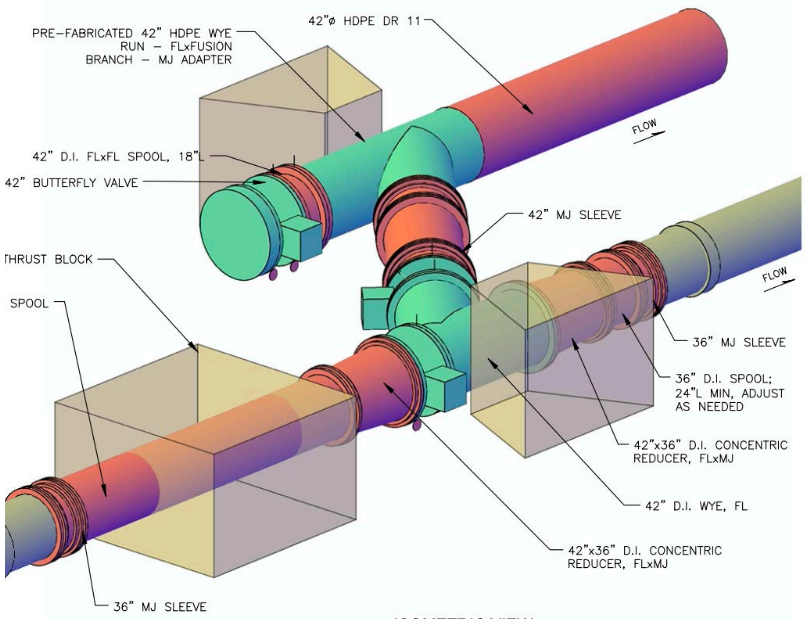
Material

Installations & Design



Resources

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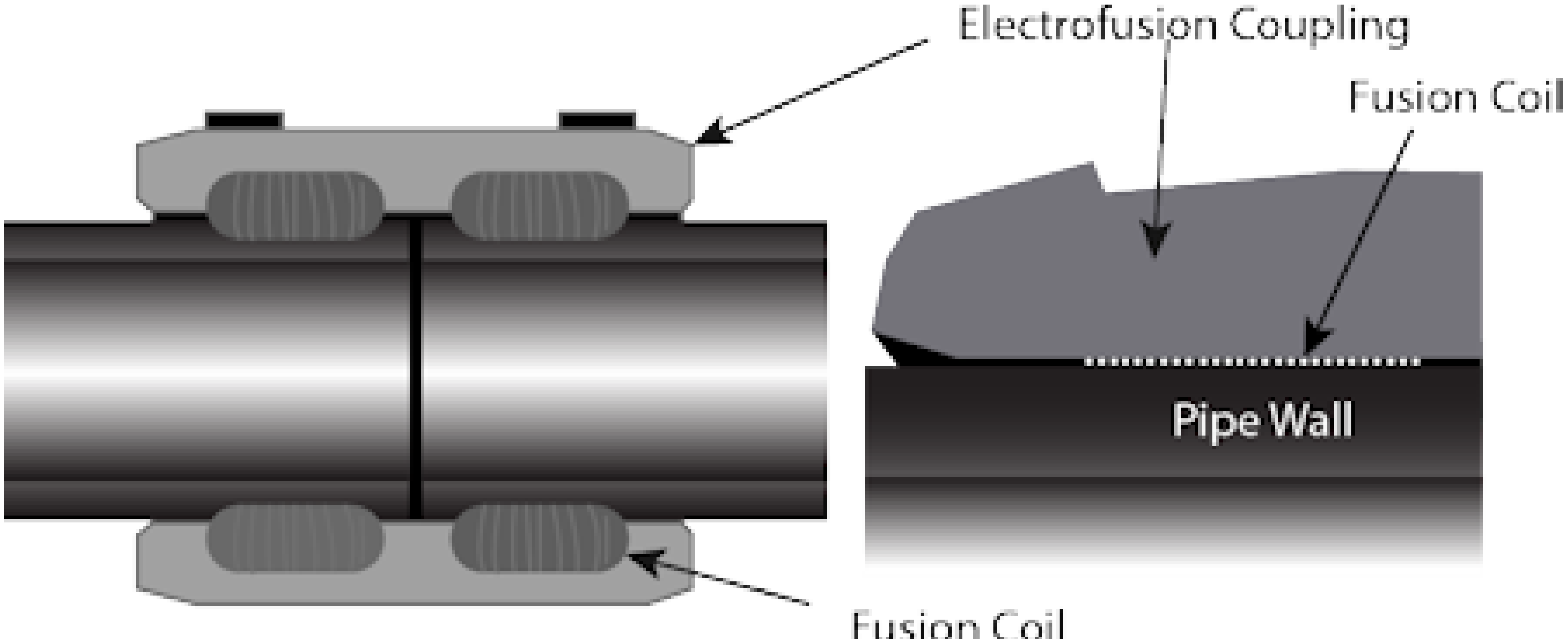
RESOURCES

Material

Material

Butt Fusion Forensics

Electrofusion



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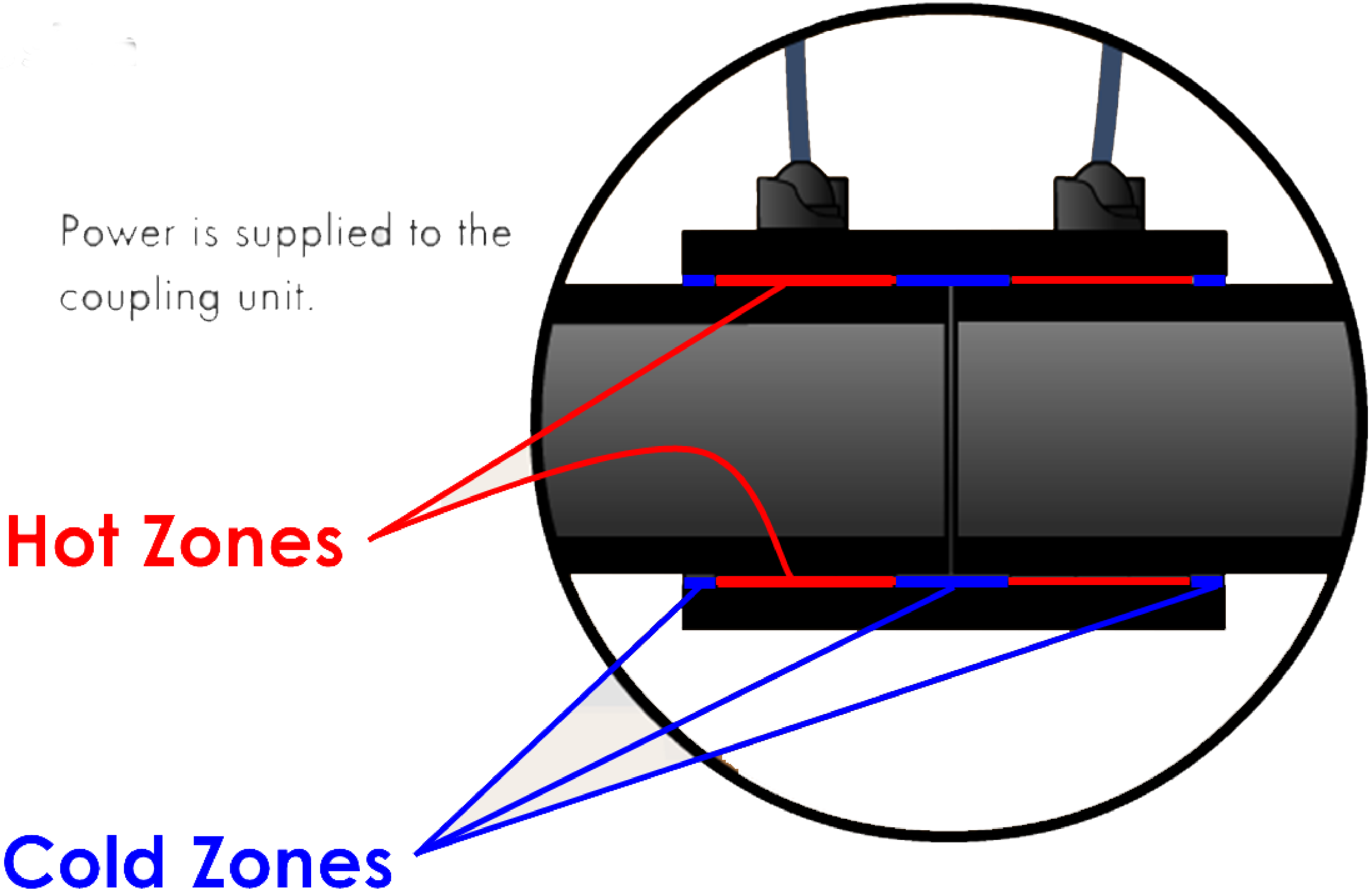
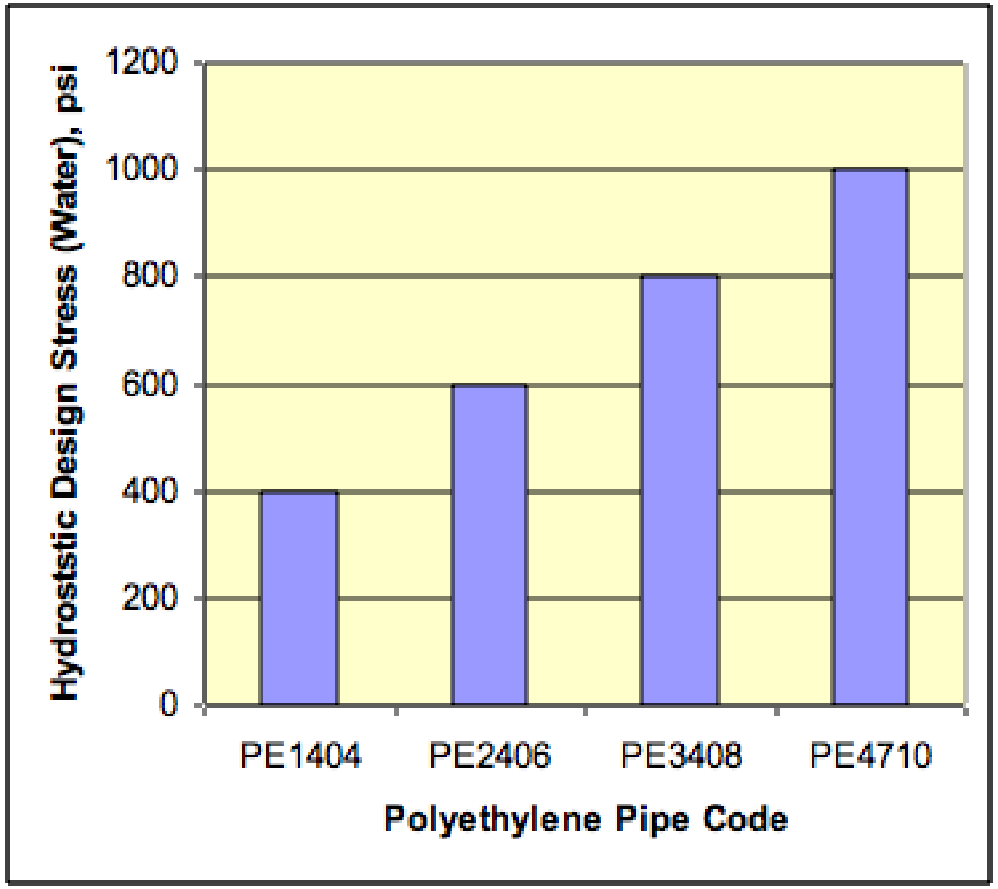
Electrofusion

Power is supplied to the coupling unit.



PE Material Designation

PE	Material
4	Density 0.947 – 0.955 g/cm^3
7	Slow Crack Growth (SCG) Resistance >500 PENT hours
10	Hydrostatic Design Stress (HDS) 1000 psi



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Steel and DIP with Age

Flow restriction and velocity increase

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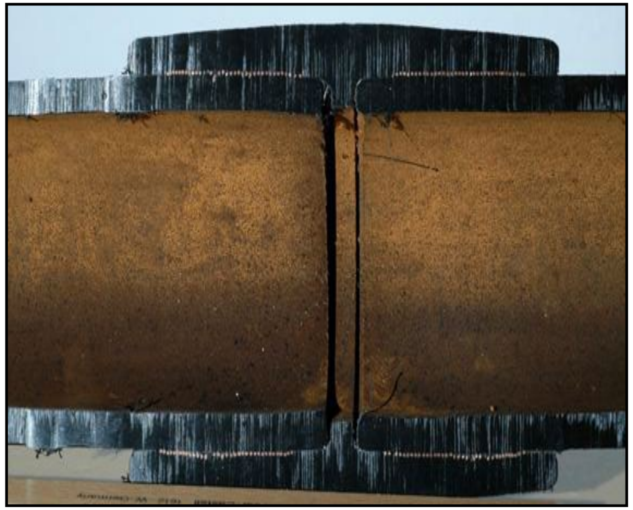
Flow Design

	12" CL350 Cement-Lined Ductile Iron Pipe	12" Steel Pipe Sch. 40	12" DIPS DR 17 HDPE Pipe
Wall Thickness (in.)	0.28	0.41	0.78
Inside Diameter (in.)	12.64	11.94	11.55
Hazen Williams Coefficient	120	100	150
Flow (GPM)	996	710	989
Flow % Difference	+0.6%	-28%	-

Steel pipe 9 years **Steel pipe 6 months**

HDPE Water Pipe – 41 years



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Chlorine & Chemical Resistance

PPI TN-44 and TN-49

- Defines Pipe Disinfectant Index (PDI) calculation
- PDI estimates PE pipe's long-term resistance to chlorine oxidation for a particular potable water system
  - PDI ≥ 1 ~ 50 years or more resistance to chlorine
  - PDI ≥ 2 ~ 100 years or more resistance to chlorine

$$\boxed{PDI = F_{Temp}F_{Press}F_{WQ}F_{Mat}F_{Size}}$$

F_{Temp} ~ Average Annual Water Temperature
F_{Press} ~ Operating Pressure, Pressure Class of PE Pipe
F_{WQ} ~ ppm Chlorine Residual, pH of Water
F_{Mat} ~ CC rating of PE Pipe (Chlorine Resistance Rating)
F_{Size} ~ OD of Pipe

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Calculator #1: Chlorine Resistance

**Results developed utilizing PPI HDPEApp*

Pipe Disinfectant Index (PDI)

Inputs	Average	Aggressive	Aggressive
Average Annual Temperature	57°F	75°F	80°F
Water pH	7.75	6.5	6.5
Disinfectant Residual (ppm)	2	4	4
Working Pressure	70 psi	90 psi	100 psi
Pipe OD	4” IPS	4” IPS	4” IPS
Pipe DR	DR21 (PC100)	DR17 (PC125)	DR11 (PC200)
CC Rating	CC2	CC3	CC2
PDI*	**9.9**	**2.2**	**2.5**
Predicted Oxidative Resistance	**≥100 years**	**≥100 years**	**≥100 years**

Key Takeaway:

Chlorine disinfectants in potable water systems are rarely an issue for the latest PE4710 piping resins

Pressure Rating

DR	PE4710 PRESSURE RATING
7	333
9	250
11	**200**
13.5	160
17	**125**
21	100
26	80
32.5	63

$$PR = \frac{2 * HDS * f_E * f_T}{DR - 1}$$

Pressure Rating

$$PR = \frac{2 * HDS * f_E * f_T}{DR - 1}$$

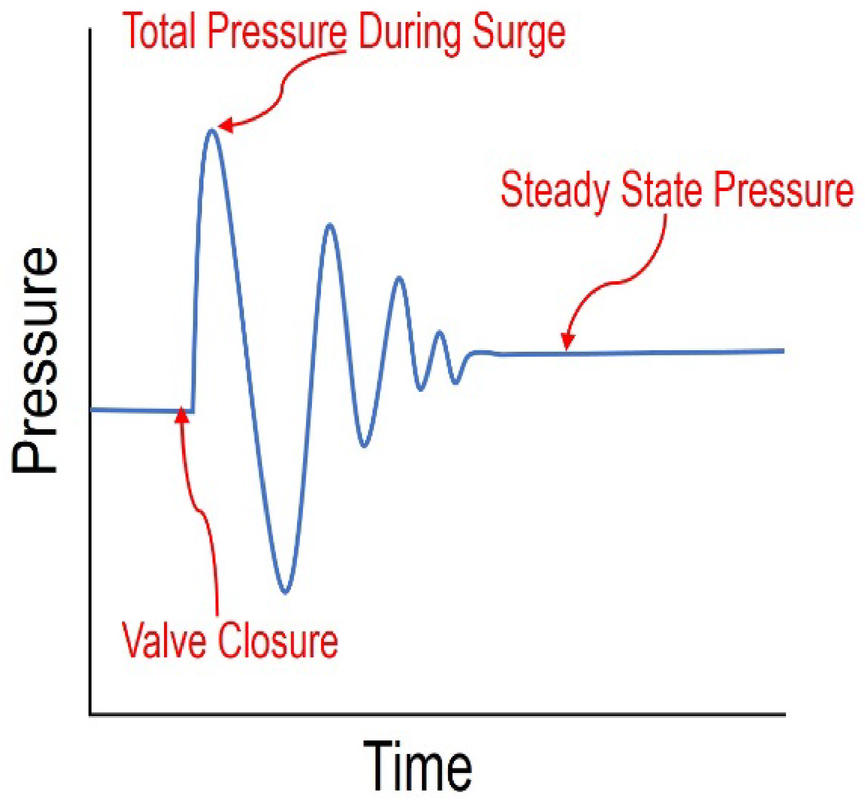
Average Annual Operating Temperature	Temperature Compensating Factor (f_T) for PE4710
≤ 80°F (27°C)	1.0
≤ 90°F (32°C)	0.9
≤ 100°F (38°C)	0.8
≤ 110°F (43°C)	0.8
≤ 120°F (49°C)	0.7
≤ 130°F (54°C)	0.7
≤ 140°F (60°C)	0.6

f_E	Media and Environment Conditions
1.00	Internal liquids, gases and external soils or liquids that are chemically benign to polyethylene such as water (potable, raw, grey, waste, reclaimed), sewage, salt/brine solutions, glycol/antifreeze solutions, alcohol; dry natural gas[A], landfill gas, nitrogen, air, oxygen, carbon dioxide, hydrogen sulfide
0.64	US – Buried distribution, gathering or transmission systems for US Federal and State regulated dry fuel gases such as natural gas, LP gas, propane, butane, landfill gas (use an HDS value of 800 psi per CFR Title 49 Part 192 for pressure calculations using equation 1)
0.80	Canada Only – Buried distribution, transmission or gathering systems for Canadian Federal and Provincial regulated fuel gases such as natural gas, LP gas, propane, butane, landfill gas
0.50	multi-phase fluids, wet natural gas, liquids or groundwater in or around the pipe having a 2% or greater concentration of permeating or solvating chemicals such as hydrocarbon liquids (gasoline, fuel oil, kerosene, crude oil, diesel fuel, jet fuel)

Surge Pressures

Pressure Surge

- Temporary fluctuation in operating pressure
- Caused by a rapid change in velocity
- Surge pressure capabilities of PE pipe are in reference to transient surges
  - Caused by flow velocity changes
  - Last a few seconds



Types of Surge Pressures

- Recurring
- Occasional

Design Conditions for Surge Pressures:

- Surge Pressure Magnitude
- Surge Pressure Allowance
- Fatigue Resistance

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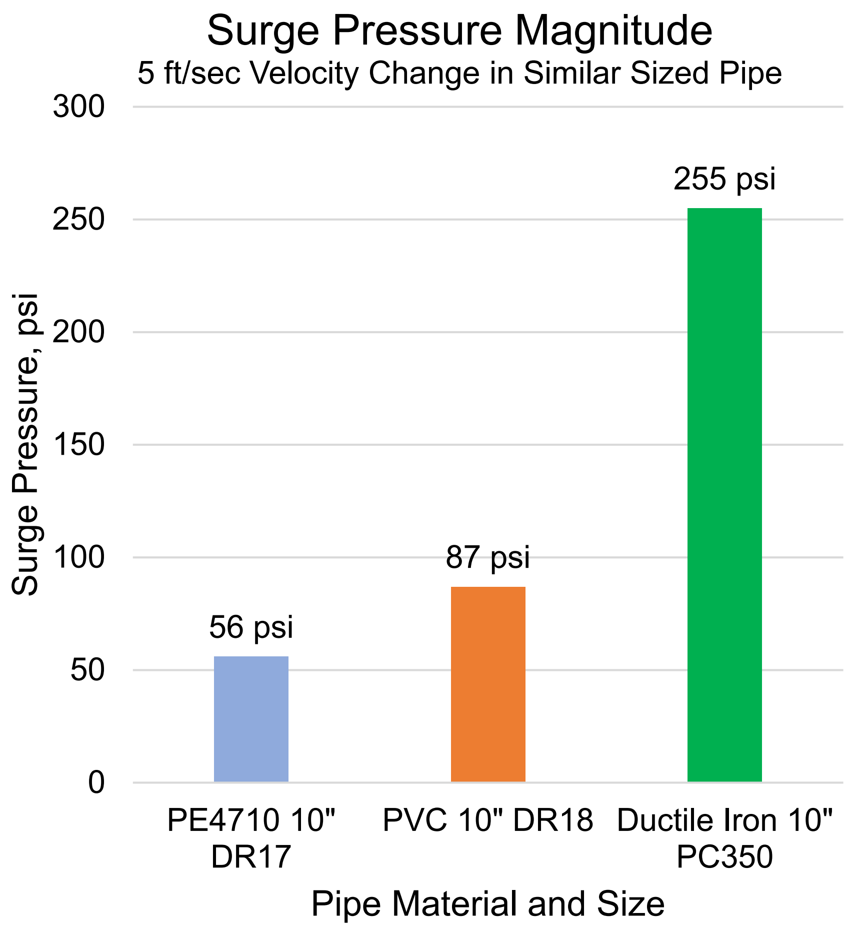
Surge Pressures

Surge Pressure Magnitude

- Two factors that affect surge pressure magnitude:
  - Velocity change
  - Material's modulus of elasticity
- Same velocity change ≠ same surge pressure
- Surge pressure magnitude depends on modulus of material type:
  - E_{PE} = 150,000 psi
  - E_{PVC} = 400,000 psi
  - E_{DI} = 24,000,000 psi



**Results developed utilizing PPI PACE*

Lower Modulus = Lower Surge Pressures

Surge Pressures

Surge Pressure Allowance

HDPE:

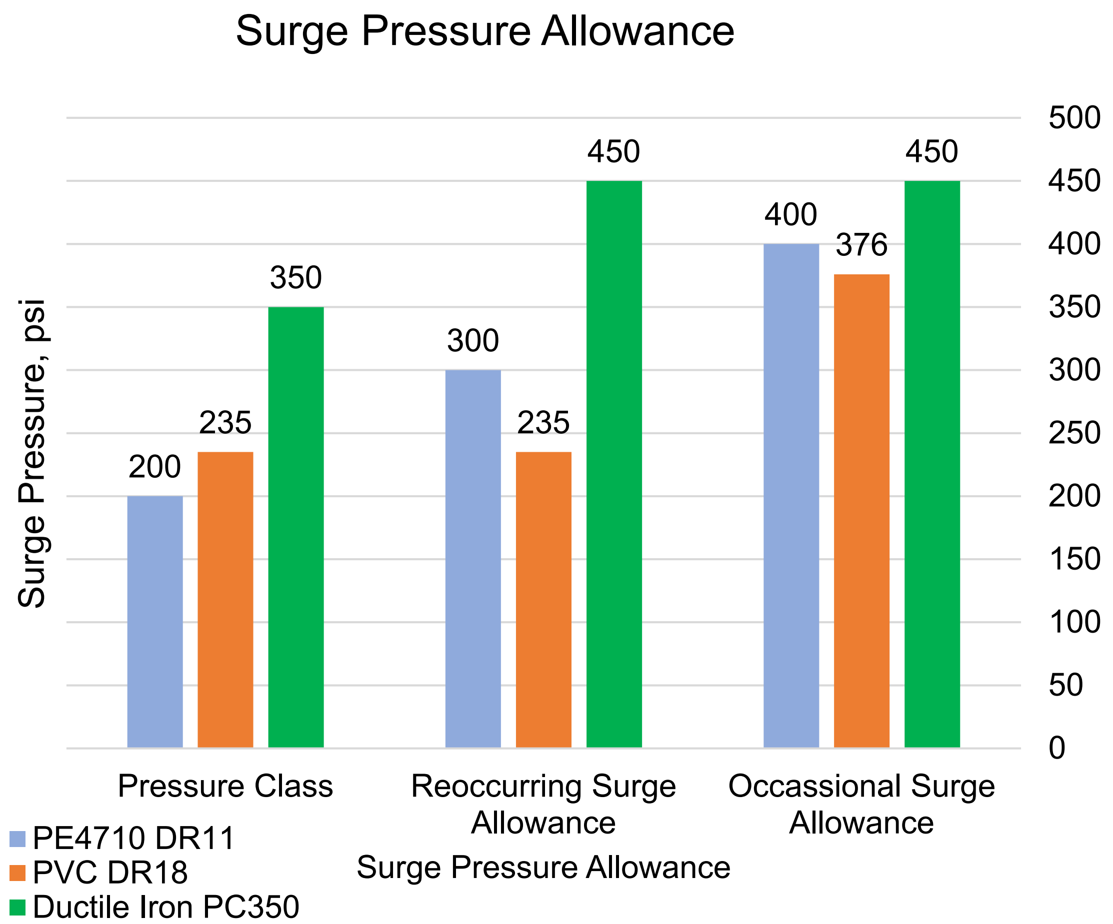
- Recurring = $1.5 * PC$
- Occasional = $2 * PC$

PVC:

- Recurring = $1.0 * PC$
- Occasional = $1.6 * PC$

Ductile Iron:

- Recurring = $PC + 100\ psi$
- Occasional = $PC + 100\ psi$

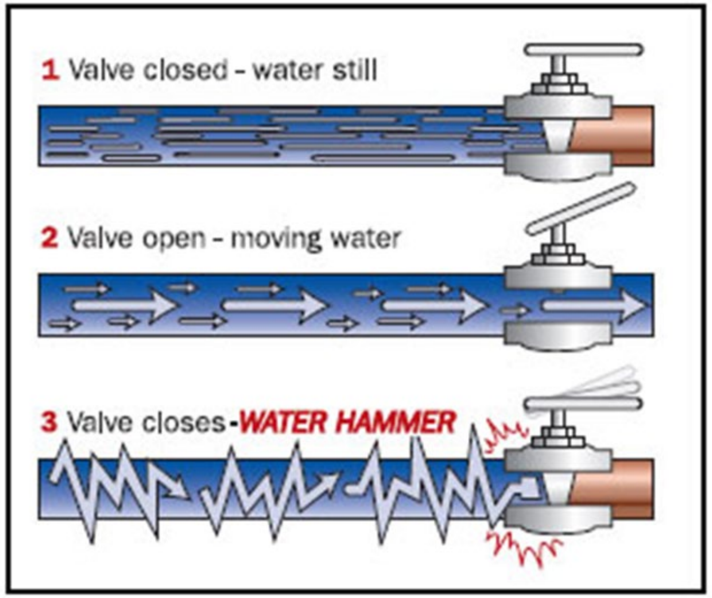


**Results developed utilizing PPI PACE*

Cyclic Fatigue

Fatigue Resistance

- Fatigue due to excessive surge pressure events can become a limiting factor for a pipe's allowable pressure rating and surge capabilities



HDPE

- Can handle 15,000,000+ cycles without fatigue failure

Ductile Iron

- Not factored into design

PVC

- Can limit allowable operating pressure and flow velocity

Calculator #2: PPI PACE

http://ppipace.com

Pipe Selection

HDPE (PE4710) Pipe

Sizing System	Nominal Size	Dimension Ratio
DIPS	12"	11 (PC200)

Ductile Iron Pipe

Sizing System	Nominal Size	Thickness
DIPS	10"	0.26 (PC350)

PVC (PVC12454-B) Pipe

Sizing System	Nominal Size	Dimension Ratio
CIOD	10"	18 (PC235)

Input Parameters

Pipeline Length [ft]	1000
Design Velocity for Recurring Surge [ft/s]	4
Design Velocity for Occasional Surge [ft/s]	8
Working Pressure [psi]	70
Anticipated Recurring Surges [per day]	55
Temperature [°F]	57
Minimum Design Life [years]	100

Step 1: Inputs

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Calculator #2: PPI PACE

http://ppipace.com

Result	PASS		FAIL		FAIL	
Material	**PE 4710**		**DI**		**PVC**	
Standard	AWWA-C906		AWWA-C151		AWWA-C900	
Pipe Rating at 57°F (PC x F_T)	125		350		235	
Working Pressure (no surge) Check	O.K.		O.K.		O.K.	
Nominal OD [in]	DIPS 10"		DIPS 10"		CIOD 10"	
Dimension Ratio (DR) or Thickness (TH)	DR = 17		TH = 0.26		DR = 18	
Average Inside Diameter (ID) [in]	9.72		10.46		9.79	
	Recur.	Occas.	Recur.	Occas.	Recur.	Occas.
Flow Rate (Q) [gpm]	924	1,849	1,070	2,140	939	1,878
Head Loss [psi]	2.0	7.4	2.1	7.7	2.0	7.3
Surge Pressure (P_S) [psi]	45	90	204	408	70	139
Total Pressure (P_T = WP + P_S) [psi]	115	160	274	478	140	209
Allowable Total Pressure During Surge (P_A) [psi]	1.5PC= 188	2.0PC= 250	PC+100= 450	PC+100= 450	1.0PC= 235	1.6PC= 376
Surge Pressure Check ($P_T \le P_A$)	O.K.	O.K.	O.K.	x	O.K.	O.K.
Number of Cycles To Failure	9.2×10^8	-	-	-	2.3×10^6	-
Design Fatigue Life [years; with SF = 2]	≥100	-	-	-	58	-
Design Fatigue Life Check	O.K.	-	-	-	x	-

Step 2: Design

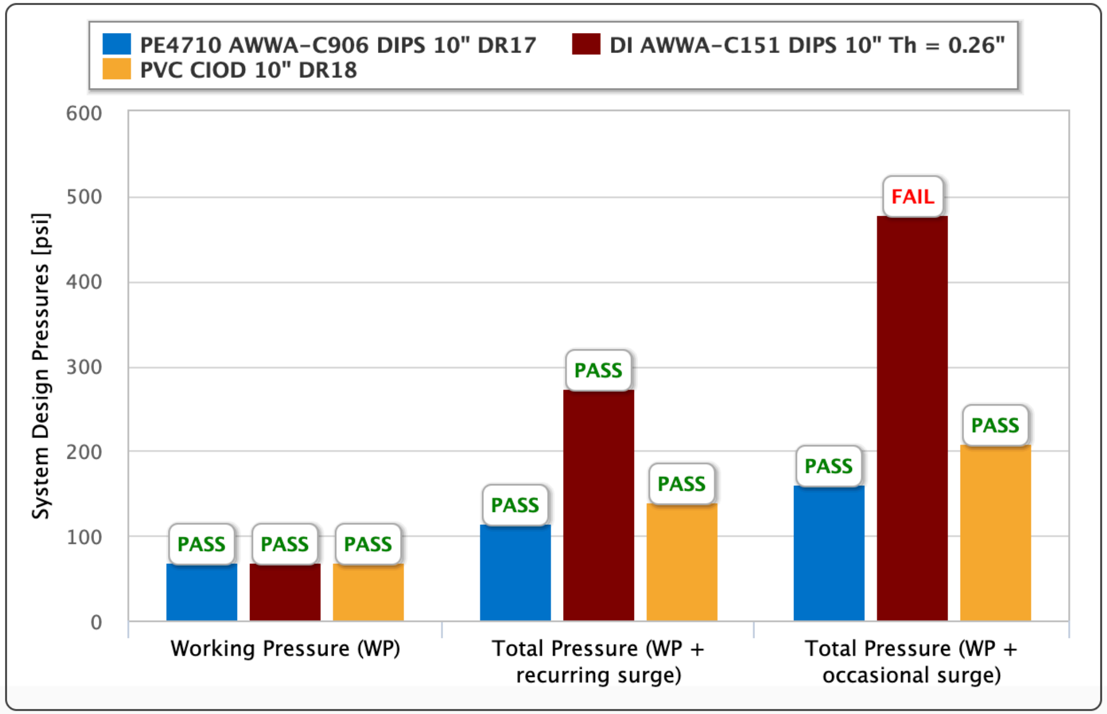
ALLIANCE FOR pepipe

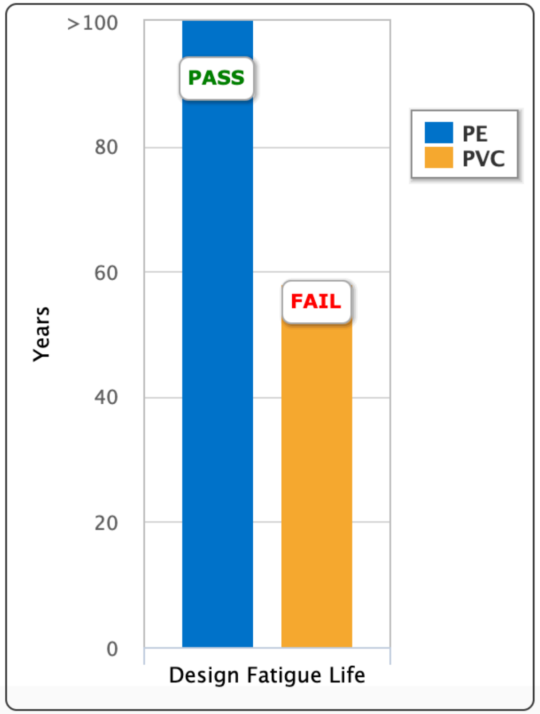
Calculator #2: PPI PACE

http://ppipace.com

PE4710 AWWA-C906 DIPS 10" DR17	Ductile Iron AWWA-C151 DIPS 10" Thickness = 0.26"	PVC AWWA-C900 CIOD 10" DR18
Pass	Fail	Fail

Input Summary: Pipe length = 1000 ft | Resin = PE 4710 | Working Pressure = 70 psi | Recurring Flow Velocity = 4 ft/s | Occasional Flow Velocity = 8 ft/s | Temperature = 57°F | Design Life = 100 years | Anticipated Recurring Surges Per Day = 55





Step 3: Results

ALLIANCE FOR pepipe

Installation Considerations

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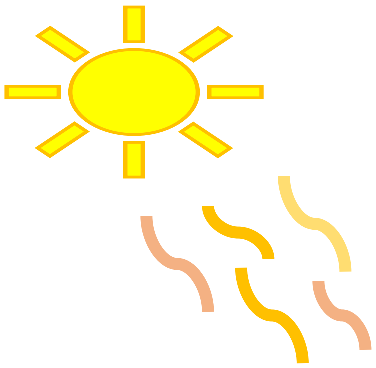
Expansion / Contraction: Thermal

Thermal Expansion and Contraction

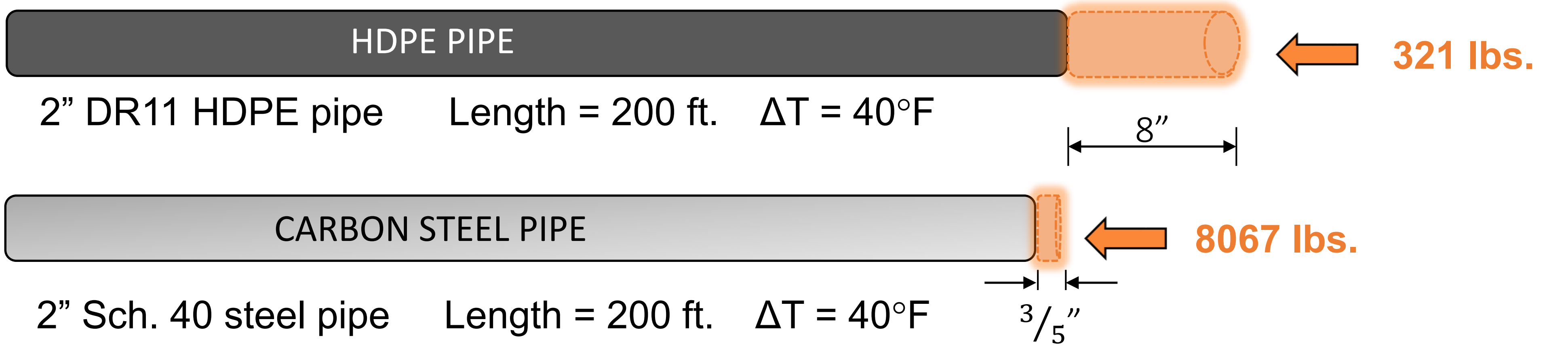
- PE expands and contracts at a rate of about 1 in/10°F/100 ft
- However, PE requires a much smaller force to restrain expansion and contraction compared to other materials



Piping Material	Coefficient of Thermal Expansion (α), in/in-°F	Elastic Modulus* (E), psi	Stress, psi ($\sigma = \alpha E \Delta T$)
^Carbon Steel	6.5×10^{-6}	29×10^{6}	188.5 x ΔT
^Stainless Steel	9.9×10^{-6}	28×10^{6}	277.2 x ΔT
Polyethylene	80×10^{-6}	0.065×10^{6}	5.2 x ΔT

*Polyethylene uses a time and temperature-dependent modulus of elasticity. Modulus shown in this table is for 10 hours at 73°F

^Values for carbon steel and stainless steel obtained from www.engineeringtoolbox.com



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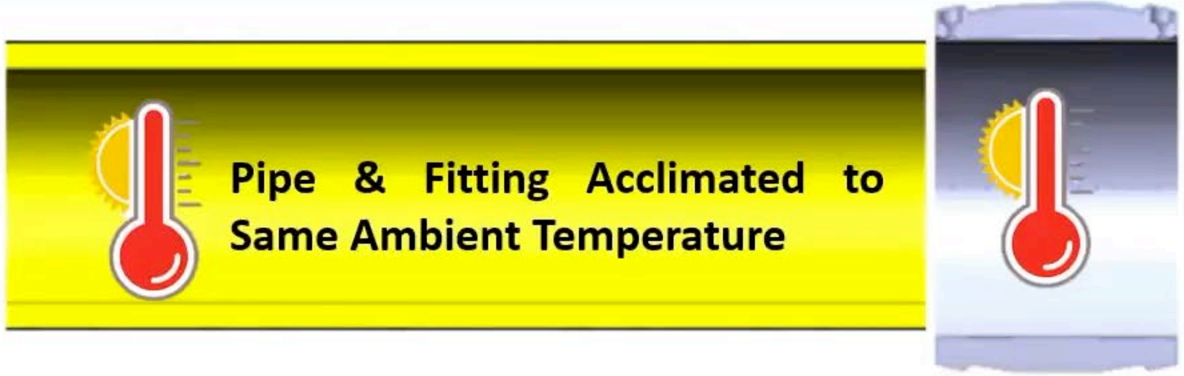
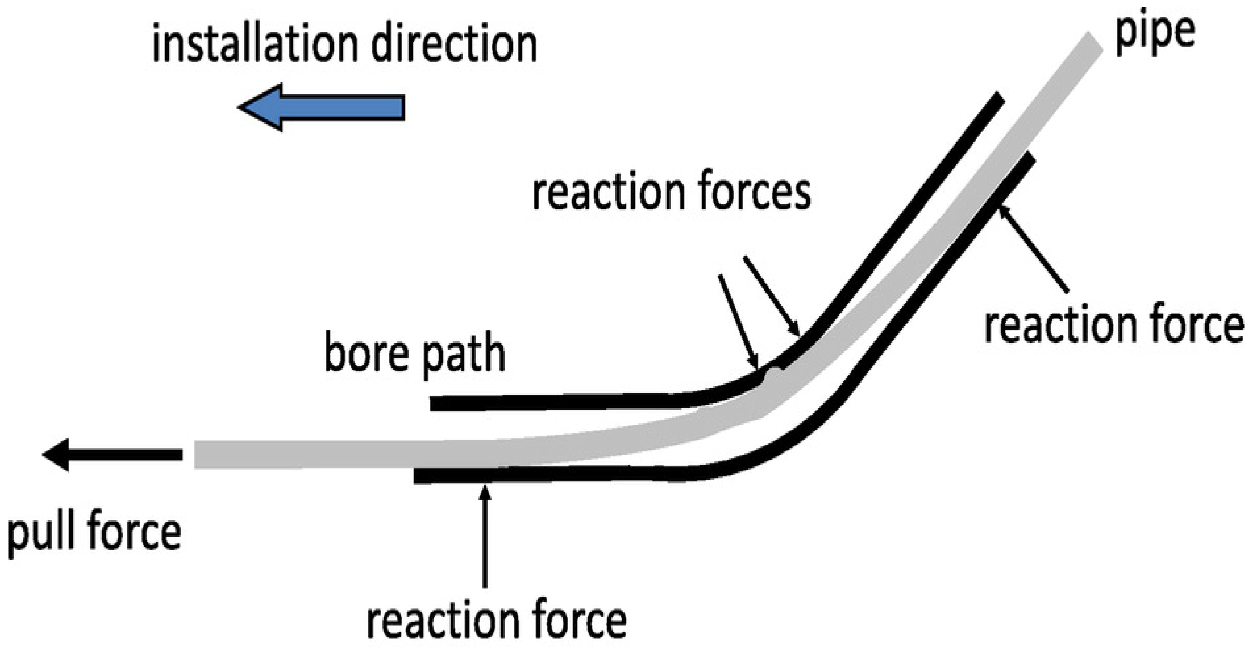
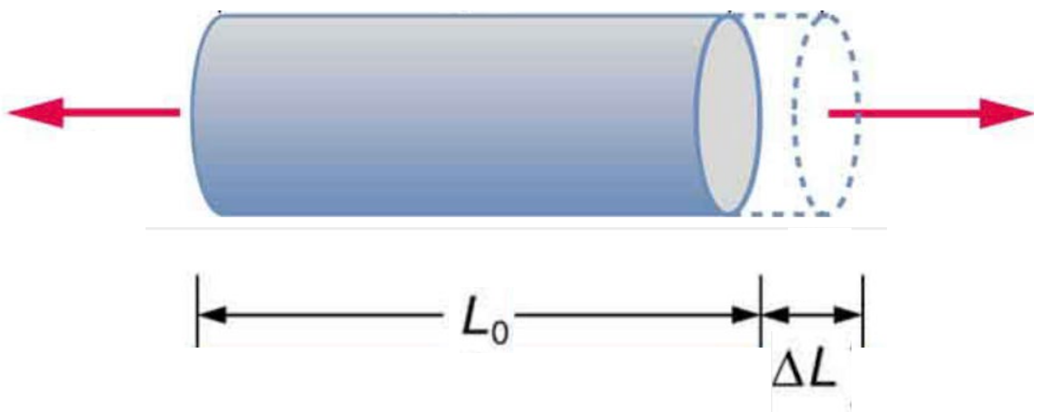
System Equilibrium



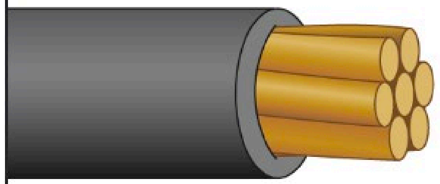
Expansion / Contraction: Mechanical





Expansion / Contraction: Mechanical

Tracer Wire

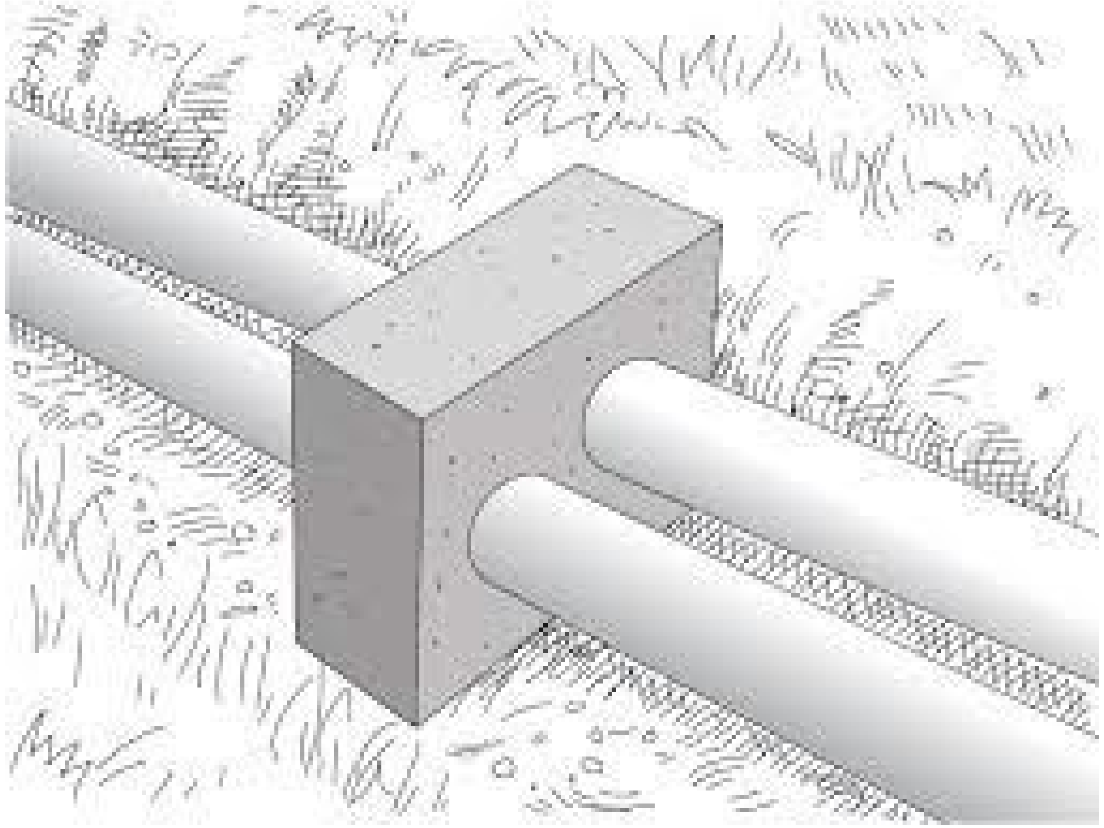


Horizontal Directional Drilling Wire (HDD)

Utility, Specialty

ALLIANCE FOR pepipe

Thrust Blocks



ALLIANCE FOR pepipe

Calculator #3: Thrust Blocks

PE4710	DIPS	12" - 13.200	11
COMPOUND	CLASSIFICATION	NOMINAL SIZE	C906 DIMENSION RATIO
PE4710	DIPS	12" - 13.200	11

ANCHOR/THRUST BLOCK REQUIREMENTS

OPEN IN PPI HANDBOOK PRINT

37.4
ANCHOR/THRUST BLOCK AREA (SQ.FT)

6' 3'' x 6' 3''
REQUIRED ANCHOR/THRUST BLOCK DIMENSIONS (FT X FT)

Input	
Working Pressure (psi)	200
Design Velocity for Surge (ft/s)	4
Soil Bearing Strength (psf)	1000

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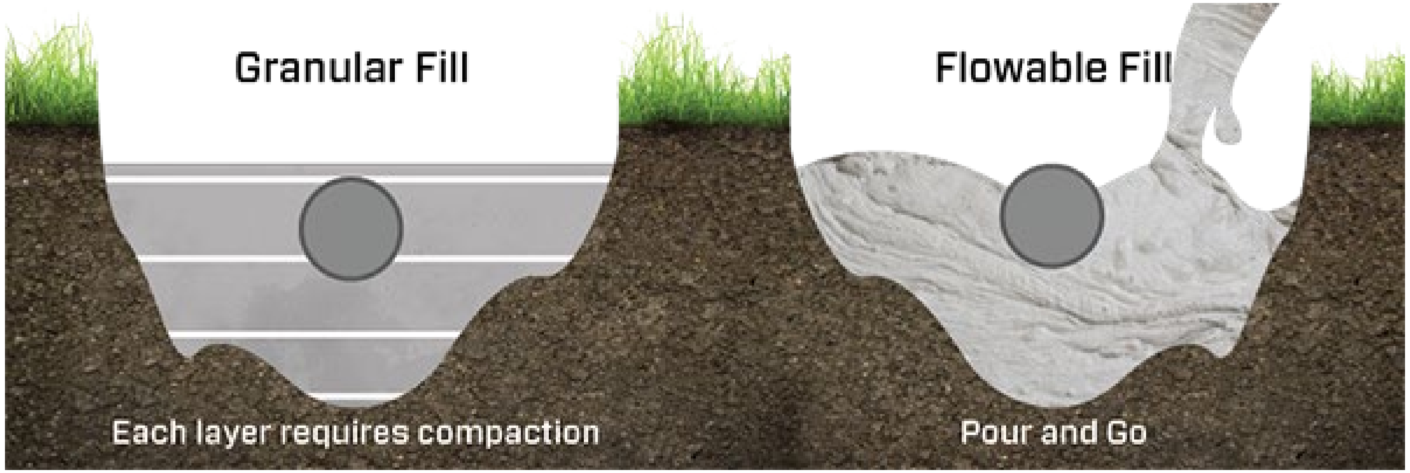
Flowable Fills



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Pressure Testing

PLASTICS·PIPE·INSTITUTE®

Guidance for Field Hydrostatic Testing Of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists
TN-46/2013a

ALLIANCE FOR pepipe

UV Radiation

Figure 1: Surface discoloration of PVC pressure

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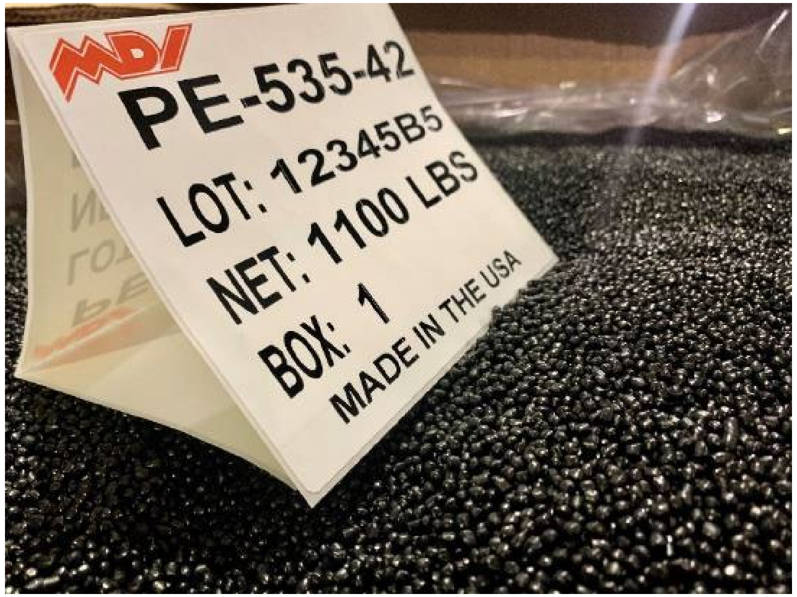
Carbon Black

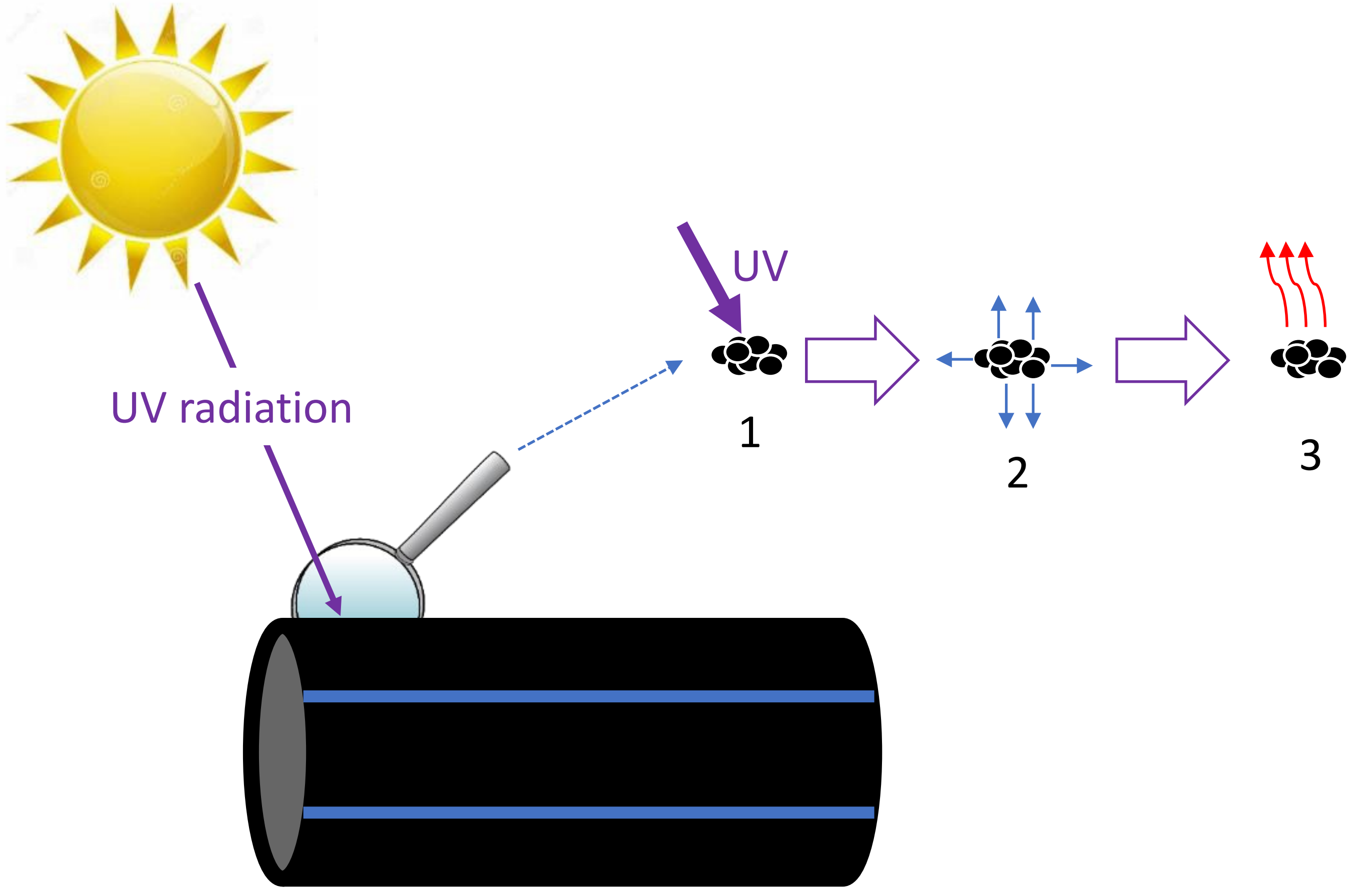
Goal: Protect polymer chains on a molecular level

Solution: 2% carbon black protects from UV radiation for an indefinite time



ALLIANCE FOR pepipe

UV Radiation



1. UV radiation strikes particles
2. Particles react to the UV energy by vibrating
3. Particles are constrained, and the vibrations are converted to heat

Eliminate Unnecessary Fittings

Bend Radius

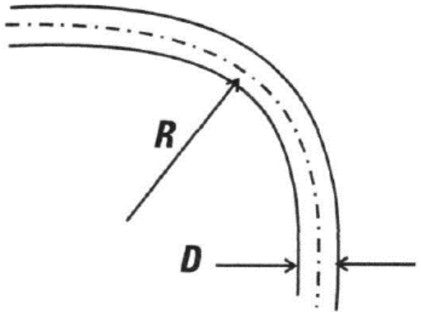
- Bend radius of PE pipe is limited by
  - Bending strain capacity
  - Resistance to kinking\

Longitudinal Wall Strain

  - Bend radius guidance limits longitudinal wall strain in the pipe to 2%
  - 2% longitudinal wall strain = bending ratio of 20

Kinking

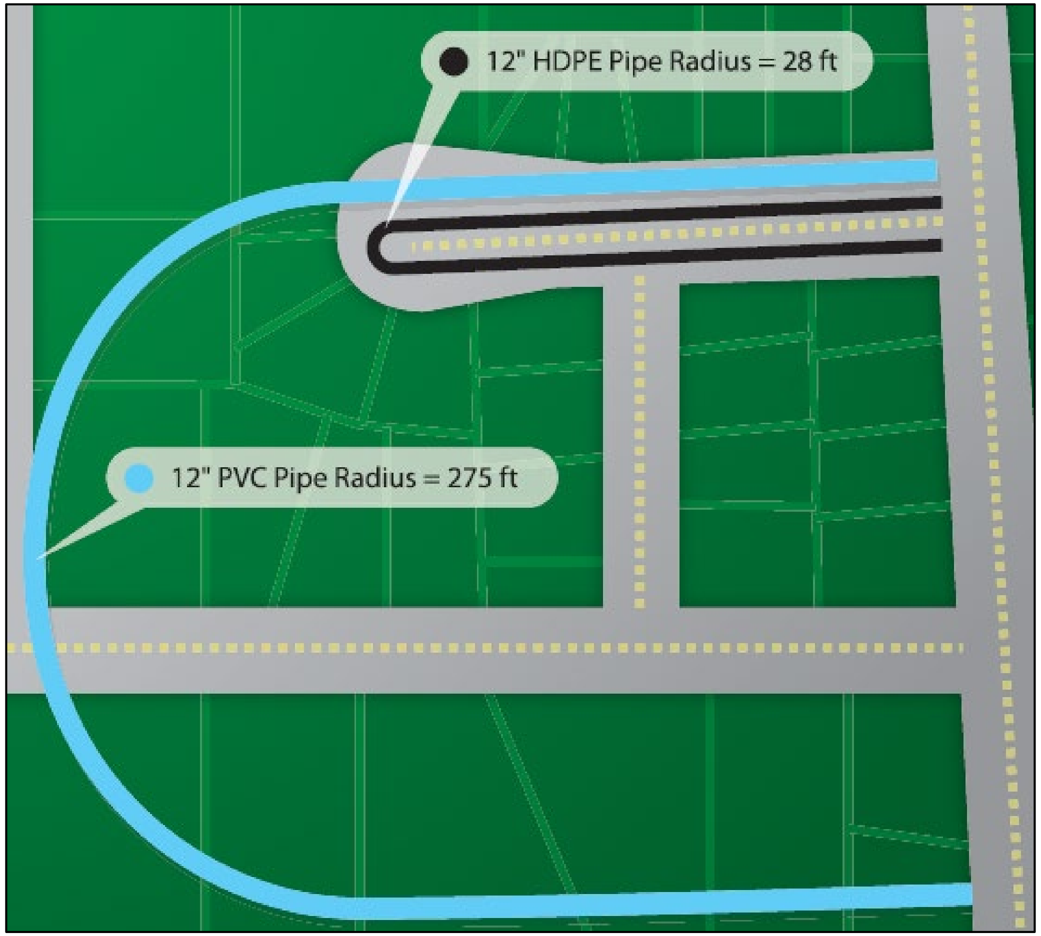
- Longitudinal bending induces ovality
- Thicker wall pipes have higher kink resistance
- Minimum bend radius decreases as pipe increases thickness (and DR)



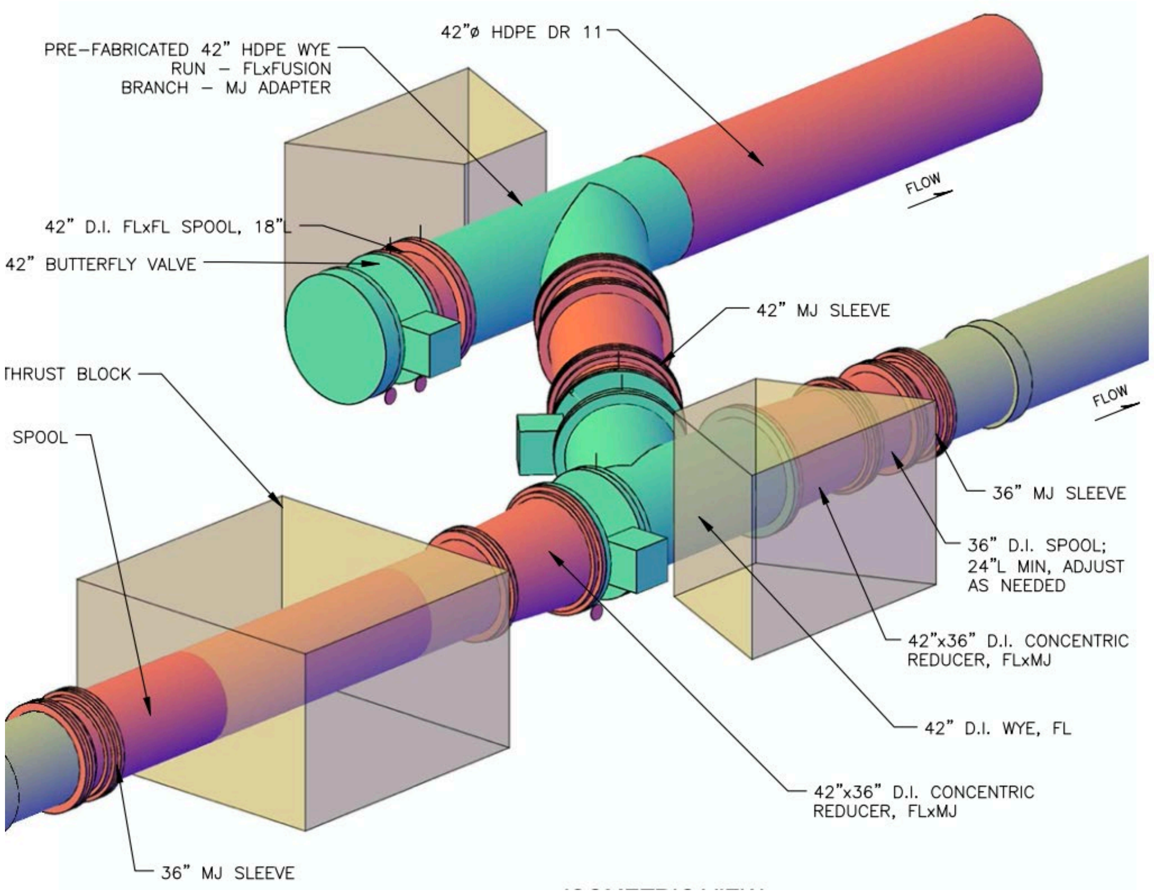
Pipe DR	Minimum Long-Term Bending Radius
≤ 9	20 x OD
11 – 13.5	25 x OD
17 - 21	27 x OD
26	34 x OD
32.5	42 x OD
Fitting or flange present in any bend	100 x OD

ALLIANCE FOR pepipe

Bend Radius



Installations & Design



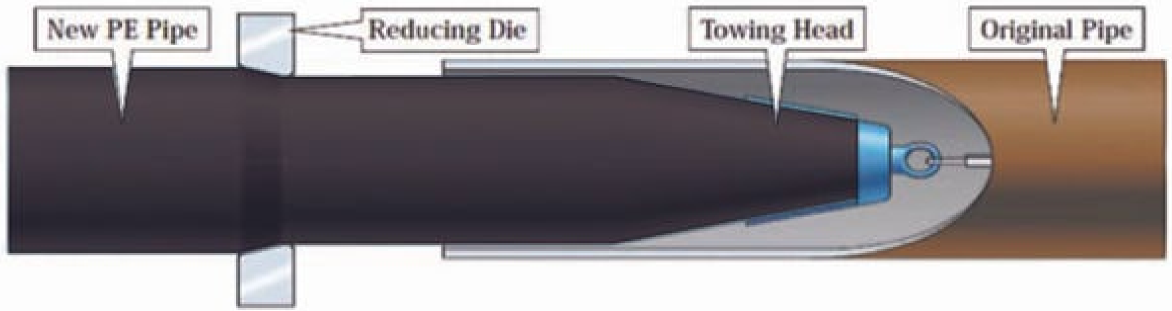
Minor Installation Methods

Above Ground / At Grade

Marine

Plowing

Compression Fit



Major Installation Methods

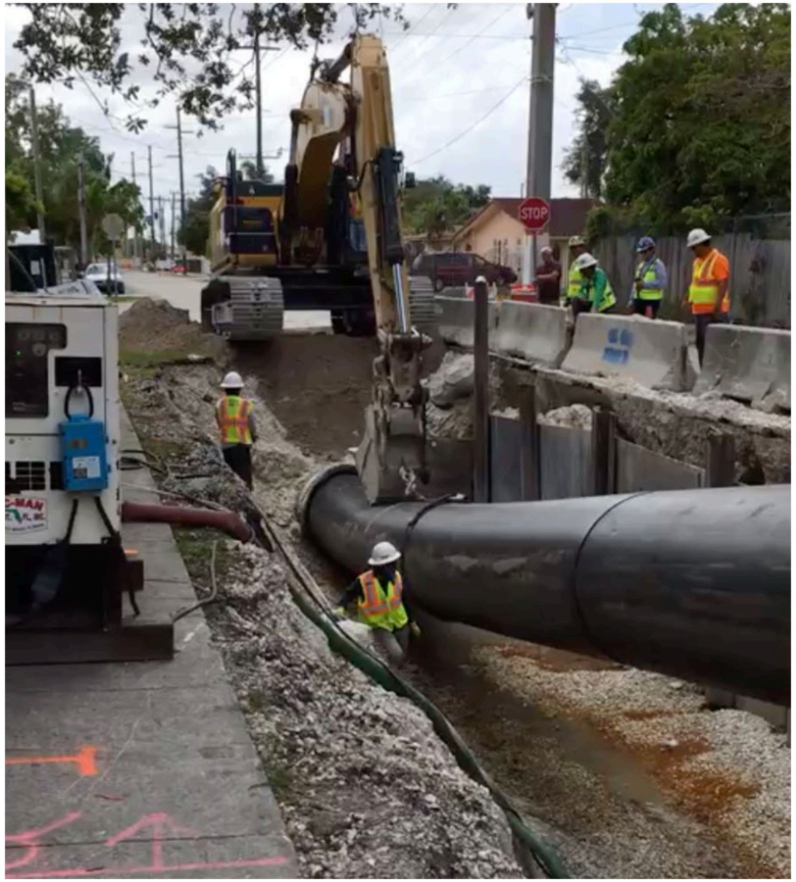
Open Cut

HDD

Major Installation Methods

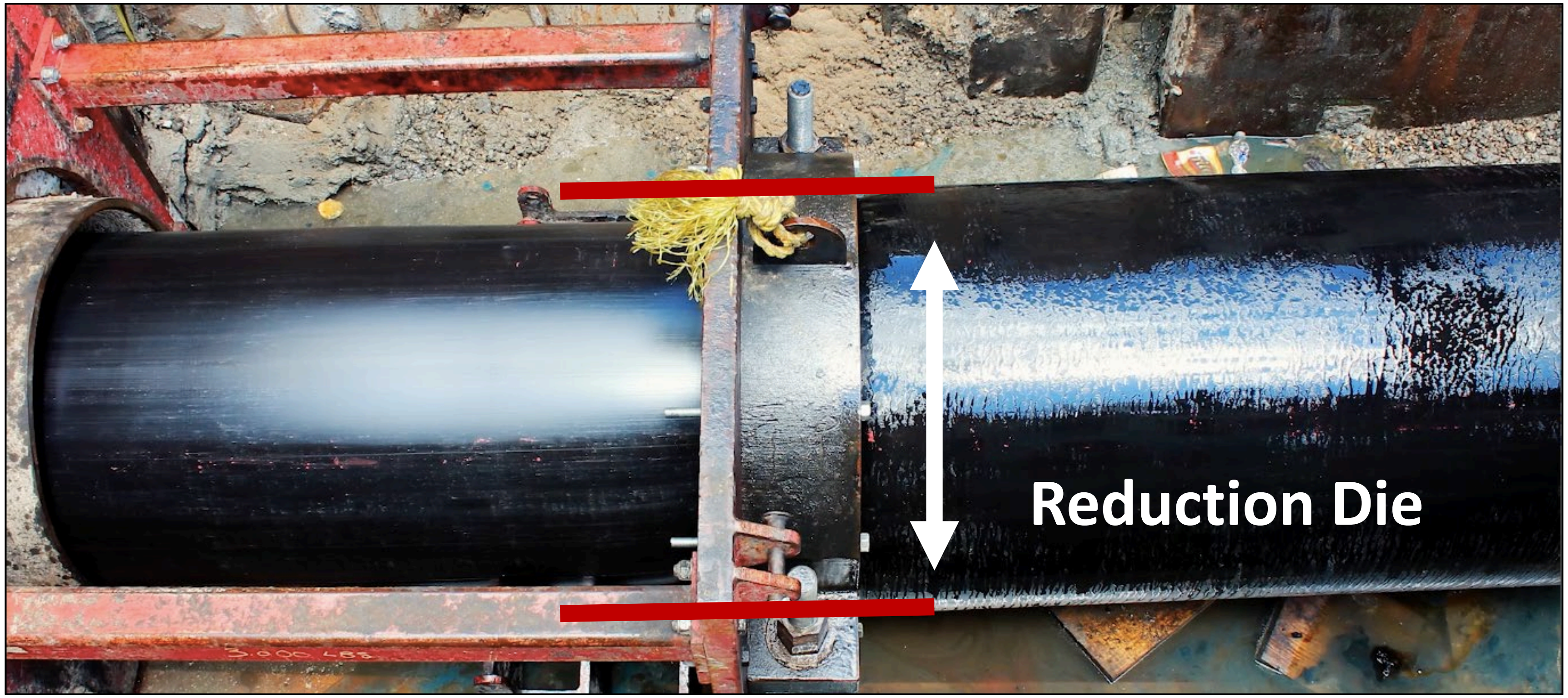
Pipe Bursting

Sliplining



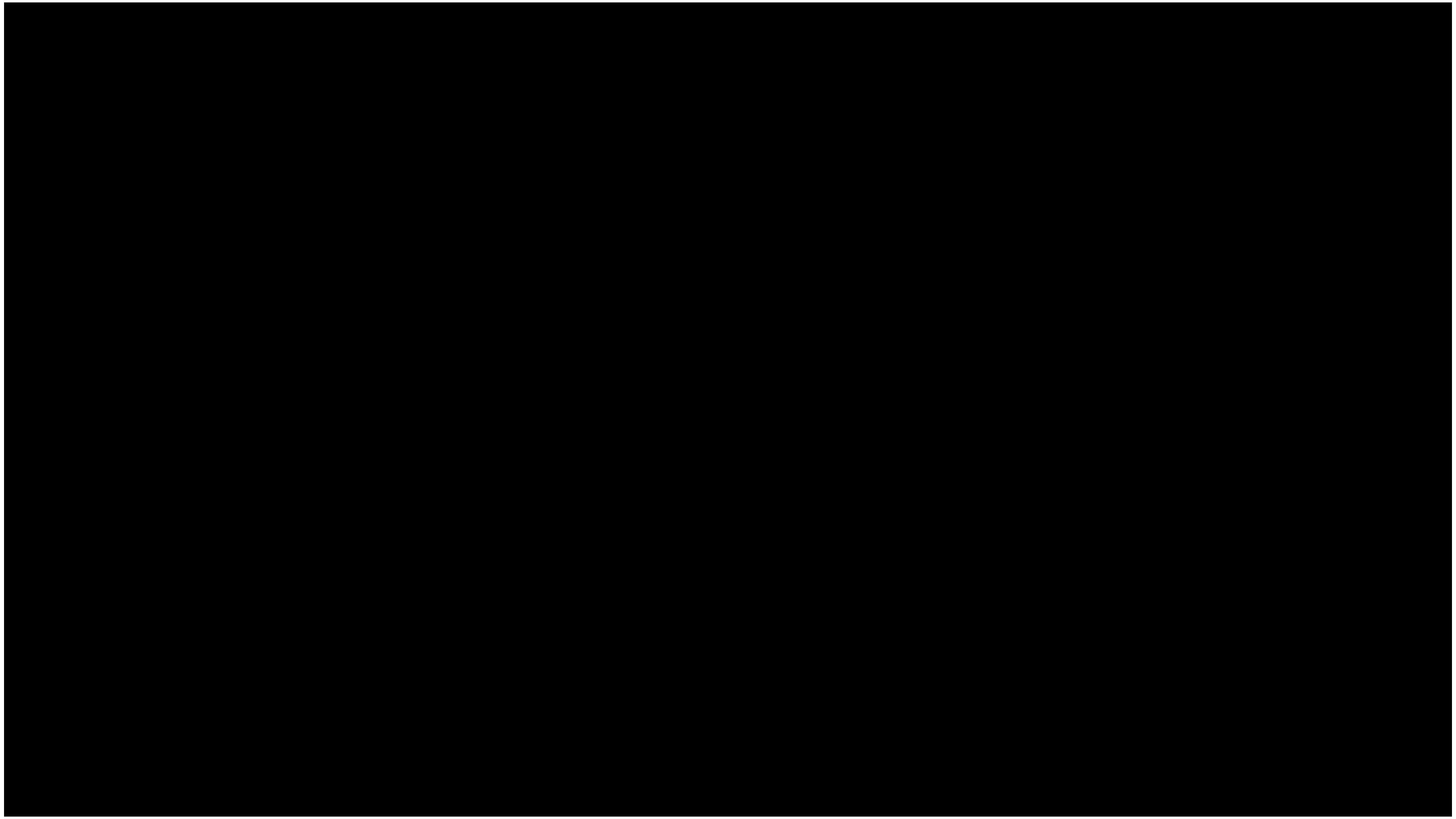
Minor Method #1 - Compression Fit

- No annulus
- Reduces pipe OD
- Host pipe Liner
- Structural (or not)
- 92% less Cut



ALLIANCE FOR pepipe

Compression Fit



Compression Fit

ASTM F3508

Minor Method #2 - Marine

Valuable when a project cannot utilize HDD.

1. Borepath has no structural integrity

- Marsh
- Swamp Land
- Bayou

2. Pipeline is too long for a drill

- Connecting islands
- Long outfalls

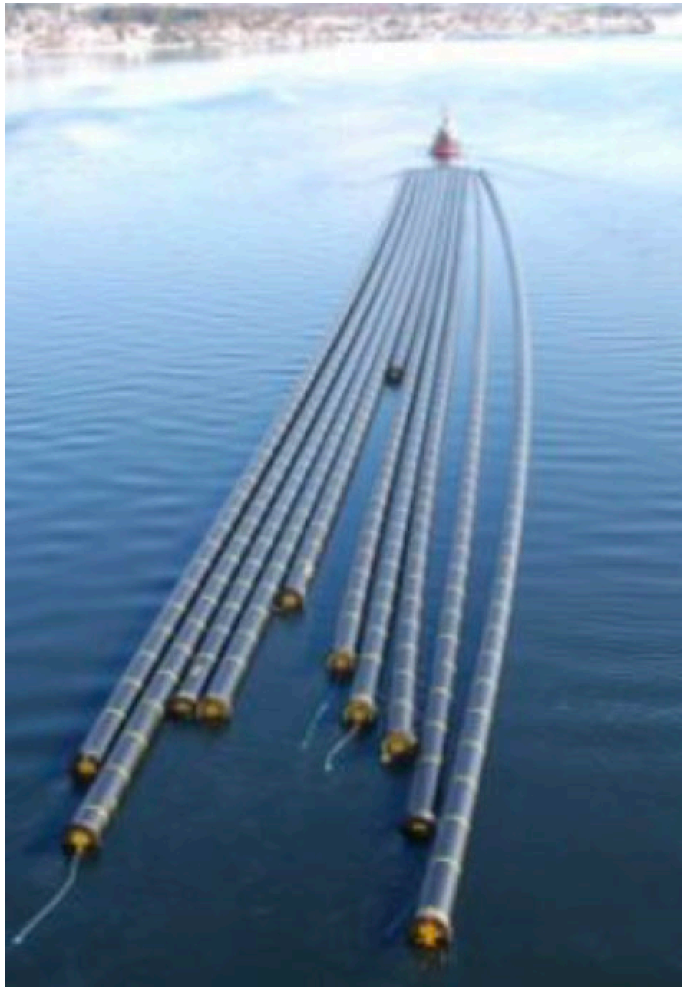
ALLIANCE FOR pepipe

Minor Method #2 - Marine

- Buoyant
- Almost unlimited lifetime underwater

Deliver to Land or Sink It

Minor Method #2 - Marine

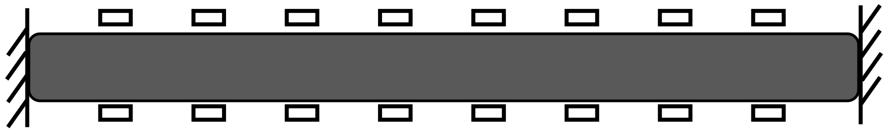


Minor Method #2 - Marine

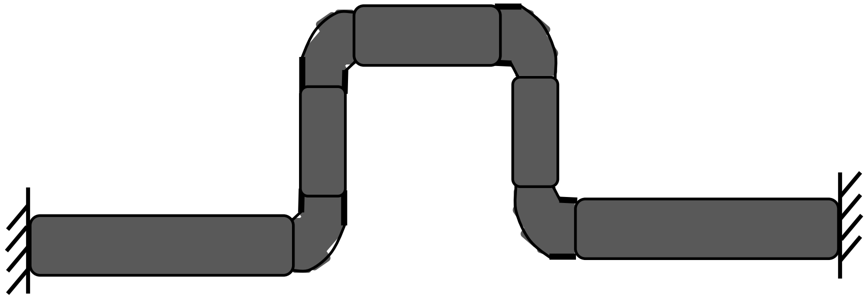
ALLIANCE FOR pepipe

Minor Method #3 - At Grade / Bypass

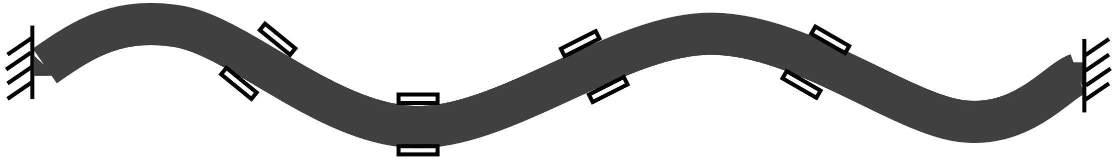
Key: Control Thermal Effects



1) Anchored and Guided System



2) Conventional Expansion Loop



3) Lateral Deflection Expansion Loop

ALLIANCE FOR pepipe

Minor Method #3 - At Grade / Bypass

Minor Method #4 – Plow In

Great For Rural Water

ALLIANCE FOR pepipe

Minor Method #4 – Plow In

ALLIANCE FOR pe pipe

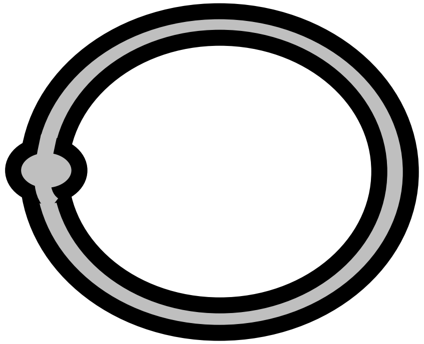
Minor Method #4 – Plow In

Open Cut Design

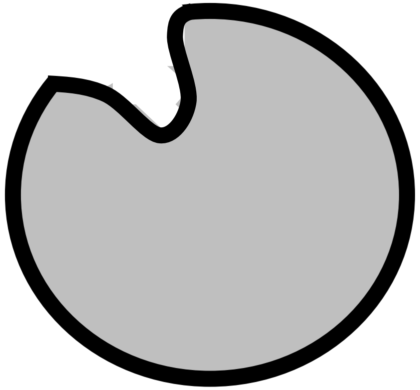
Terminology of Pipe Embedment Materials

The flexible pipe and pipe embedment materials must do the following:

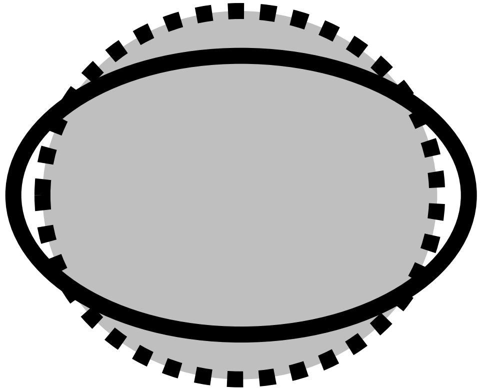
- Resist deflection of the pipe material
- Resist wall buckling for the constrained pipe
- Resist allowable external pressure for unconstrained pipe
- Meet allowable stress for wall buckling



Crush



Buckling



Deflection

ALLIANCE FOR pepipe

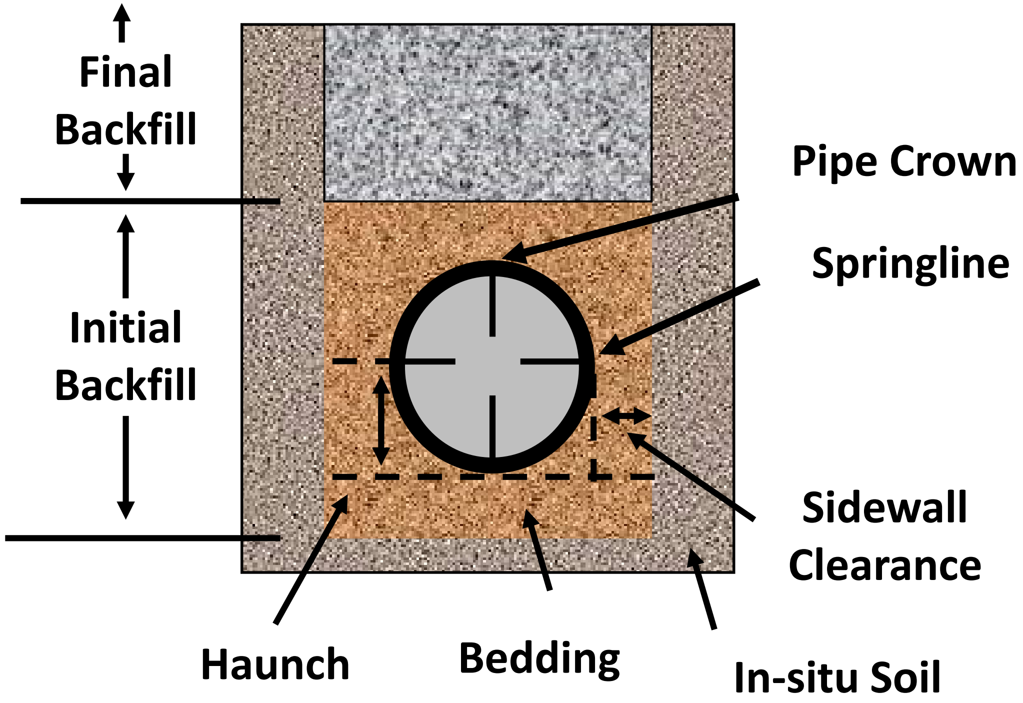
M55 Design Window

AWWA M55 Basic Window

- Require no design calculations for deflection, crush, or buckling

Design Window Requirements:

- Stress-rated PE pipe material
- No surcharge loads or ground water
- E’ of at least 1000 psi for both embedment material and native soil
- Unit weight of native soil less than 120 pounds per cubic foot
- DR and burial depth limitations (shown in table)



DR	Min. Depth of Cover with H20 Load	Min. Depth of Cover without H20 Load	Maximum Depth of Cover
7 - 21	3 ft.	2 ft.	25 ft.

Calculator #4: M55 Excel Macro

HDPE Pipe Deflection
AWWA M55 Manual, PE Pipe Design and Installation
Equation 5-2, page 48

$$\frac{\Delta y}{D_M} = \frac{k(T_L W_E + W_L + W_S)}{\frac{2E}{3(DR-1)^3} + 0.061E'}$$

$$W_E = \frac{wH}{144}$$

Table 5-3 Provides WL at various depths

4' Depth of Cover Live Load DR17

$\Delta y/DM$	0.41%		vertical deflection, %
D_M	6.494		mean diameter
D_0	6.900	inch	outside pipe diameter
t	17		pipe wall thickness
k	0.10		bedding constant
T_L	1.00		time-lag factor
W_E	3.33	psi	earth load pressure
W_L	4.20	psi	H20 live loads
W_S	0.00	psi	surcharge pressure
E	130000	psi	apparent modulus of elasticity of pipe material *See note
DR	17		dimension ratio
E'	1000	psi	modulus of soil reaction *Class 3 compacted
H	4	ft	depth of cover
w	120	lb/ft3	weight of soil

Pipe stiffness factor	21.16	$\frac{2E}{3(DR-1)^3}$
Soil stiffness factor	61.00	$0.061E'$

* For pressure applications, use the short term modulus of elasticity value of 130,000. For non-pressure applications, if the pipe stiffness factor is more than 25% of the soil stiffness factor, use a long term modulus elasticity value of 28,000

HDPE Wall Buckling for Constrained Pipe
AWWA M55 Manual, PE Pipe Design and Installation
Equation 5-6, page 55

$$P_{CA} = \frac{5.65}{N}\sqrt{R_b B' E' \frac{E}{12(DR-1)^3}}$$

$$P_{CA} > P_E + P_L + P_{ES} + P_V$$

$$R_b = 1 - 0.33 * \frac{H_w}{H}$$

$$B' = \frac{1}{1 + 4_{e^{-.065H}}}$$

4' Depth of Cover No Groundwater Wall Buckling

P_{CA}	30.20	psi	allowable external pressure for constrained pipe
N	2		safety factor
Rb	1		buoyancy reduction factor
B'	0.24		soil elastic support factor
E'	200	psi	modulus of soil reaction
E	28000	psi	apparent modulus of elasticity
DR	11		dimension ratio
Hw	0	ft	groundwater height above pipe
H	4	ft	depth of cover
e	2.71828		natural log based number

4' Depth of Cover 2' Groundwater Wall Buckling

P_{CA}	27.59	psi	allowable external pressure for constrained pipe
N	2		safety factor
Rb	0.835		buoyancy reduction factor
B'	0.24		soil elastic support factor
E'	200	psi	modulus of soil reaction
E	28000	psi	apparent modulus of elasticity
DR	11		dimension ratio
Hw	2	ft	groundwater height above pipe
H	4	ft	depth of cover
e	2.71828		natural log based number

ALLIANCE FOR pepipe

Embedment Requirements

Nominal Pipe Size	Max Particle Size
2 - 4"	1/2"
6 - 8"	3/4"
10 - 15"	1"
>= 16"	1.5"

ASTM D2321

ALLIANCE FOR pepipe

Trench Width

ASTM D2321

Nominal Pipe Size	Trench Width
<3"	12"
3 - 24"	OD + 12"
>24"	OD + 24"

ALLIANCE FOR pepipe

Open Cut – Lay In Method

Hydrocarbon Contamination

1. All Piping systems have potential contamination through joints, gaskets or wall
2. Hydrocarbons do not degrade polyethylene
3. Gross Contamination may require mechanical connections

Options in Addressing Gross Hydrocarbon Contamination?

- Surround pipe with clean soil of Class I or Class II type material
- Encase pipe in areas of active contamination
- Re-route pipe around contamination

Determination of Hydrocarbon Contamination Risk?

- BTEX Permeation Calculation

$$C_{pw\_Flow} = \frac{M}{V} = \frac{P_m \times \pi \times OD \times L_c \times t}{q \times t} = \frac{4 \times f(C_{bulk}) \times OD \times L_c}{ID^2 \times v} = C_{pw} \times FlowFactor$$

$$C_{pw\_Stagnation} = \frac{M}{V} = \frac{P_m \times \pi \times OD \times L_c \times t}{\frac{1}{4} \times \pi \times ID^2 \times L_T} = \frac{4 \times f(C_{bulk}) \times OD \times L_C \times t}{ID^2 \times L_T} = C_{pw} \times StagnationFactor$$

$$C_{pw\_Thickness} = \frac{M}{V} = \gamma \times \frac{4 \times f(C_{bulk}) \times OD}{ID^2}$$

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ALLIANCE FOR pepipe


KOMATSU

ALLIANCE FOR pe pipe

HDD

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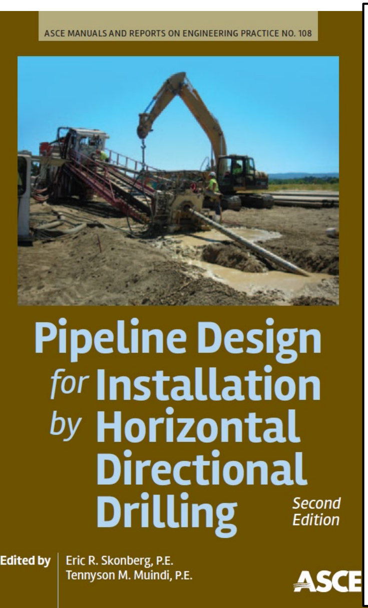
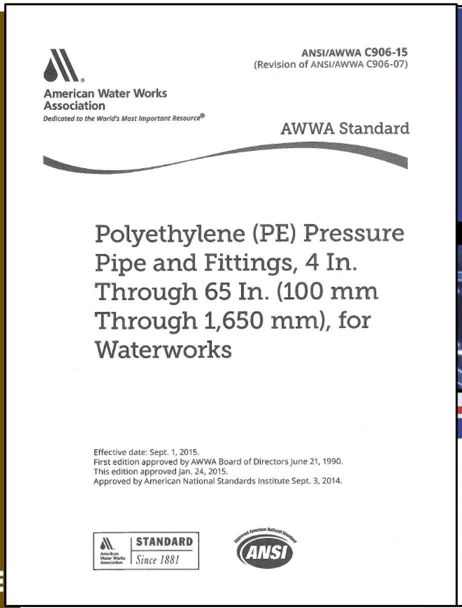
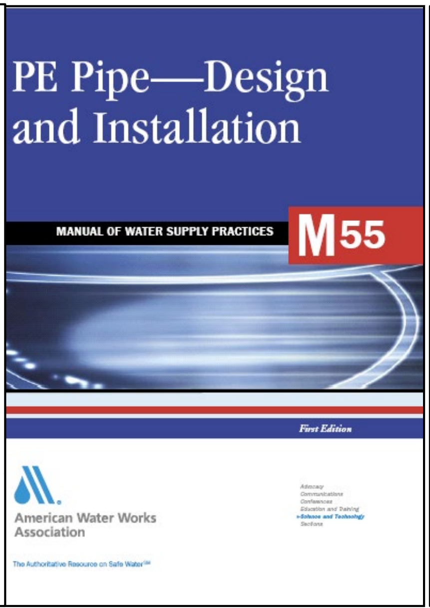
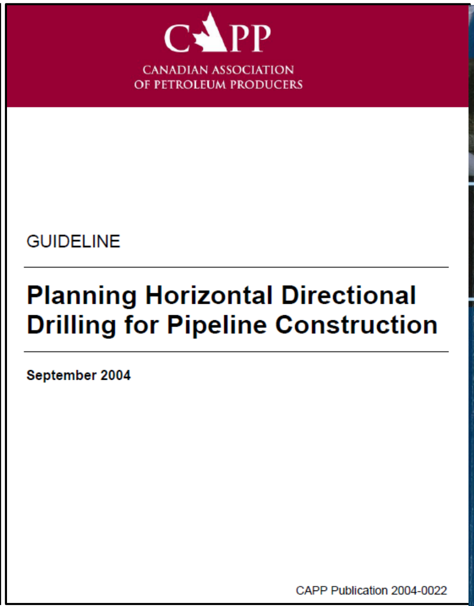
When To Drill?

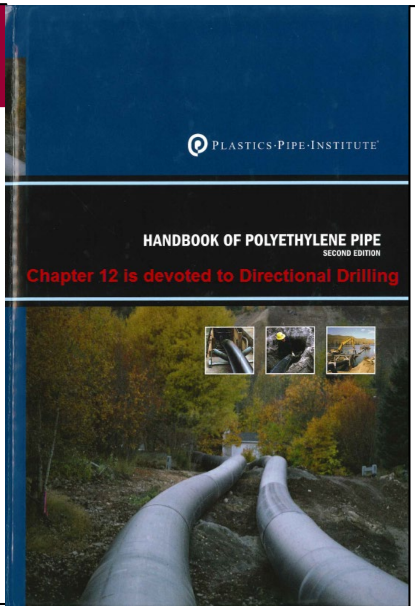
- Crossing rivers, lakes, roads, etc
- Where open cut is not feasible or cost effective
- Protecting environmentally sensitive areas

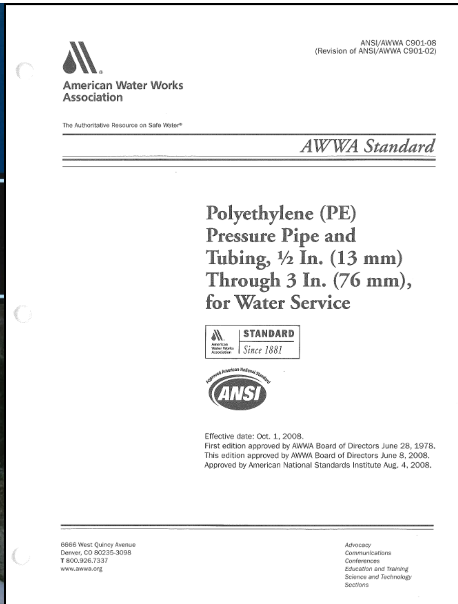




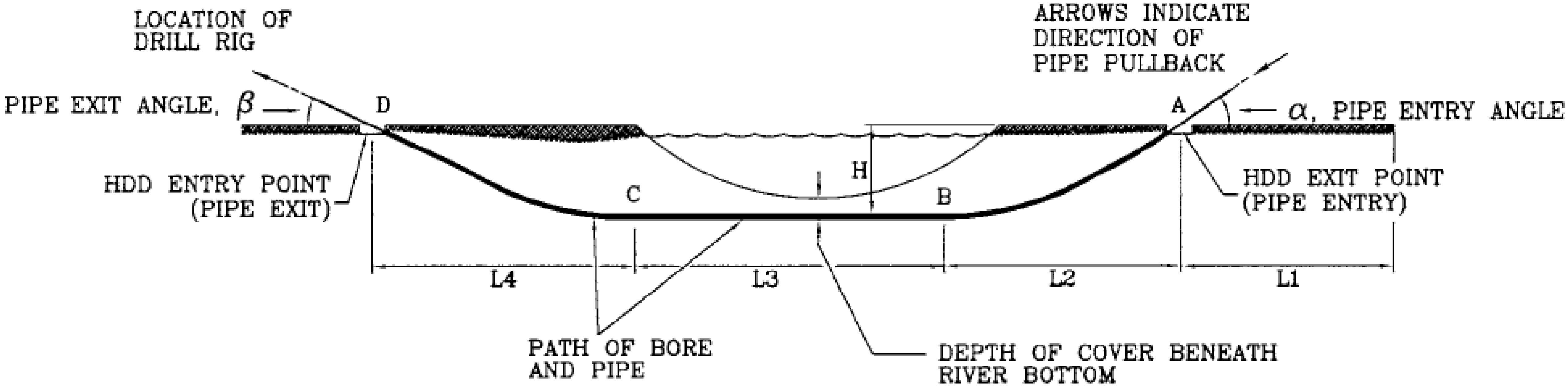






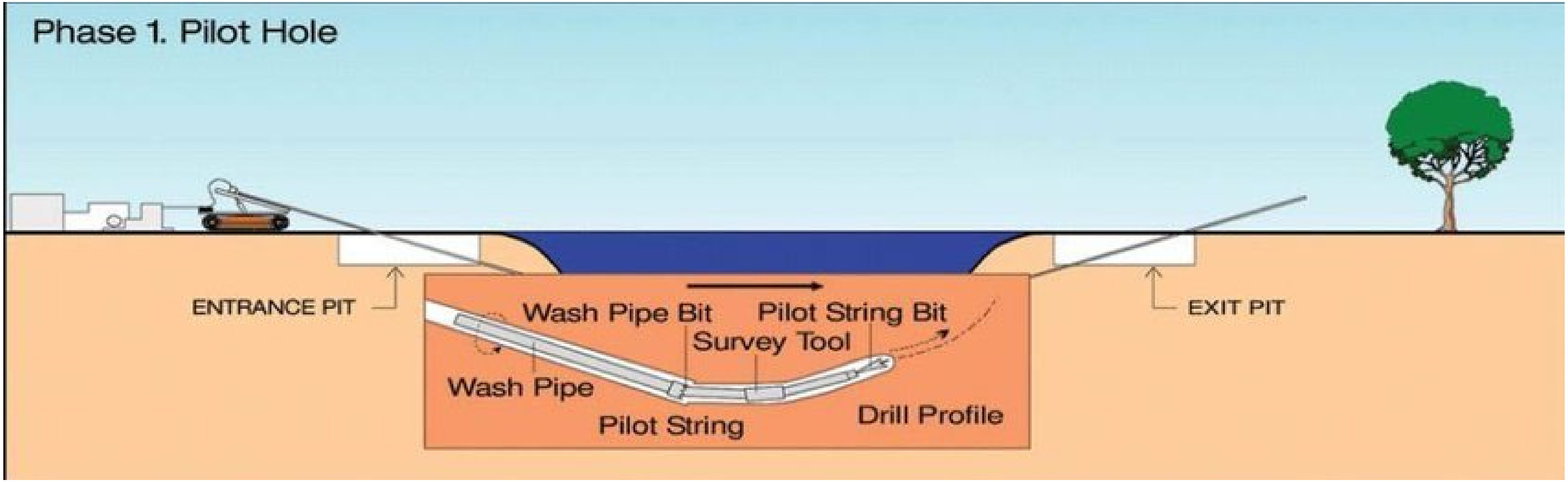


Installation Requirements

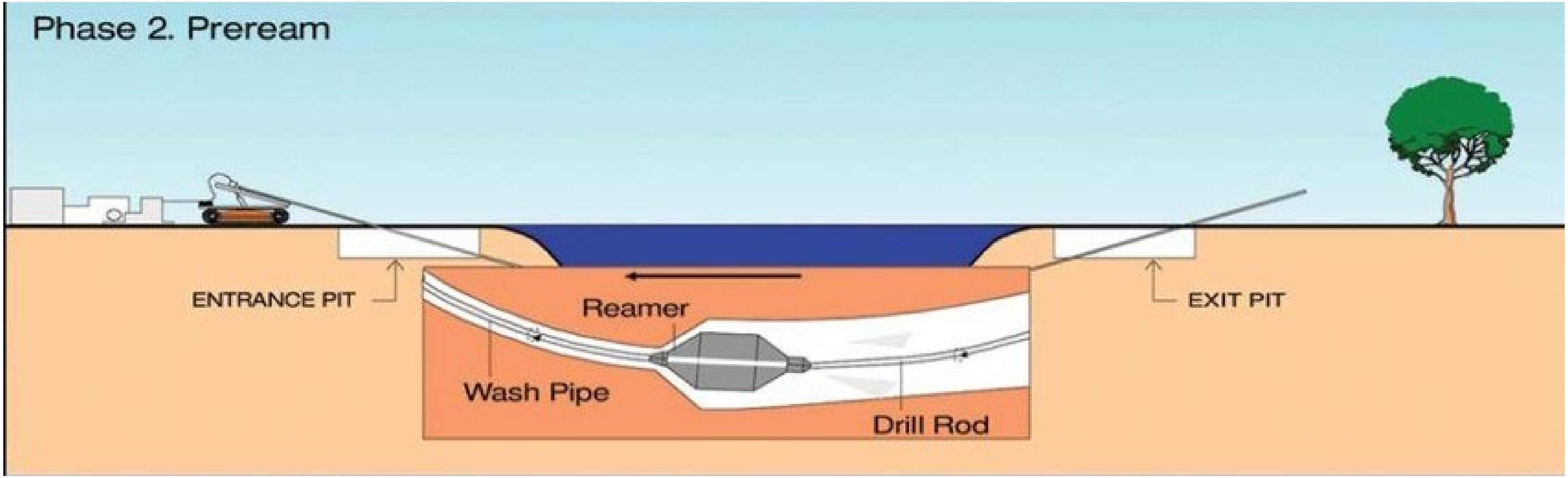


ALLIANCE FOR pepipe

Step 1 – Pilot Hole

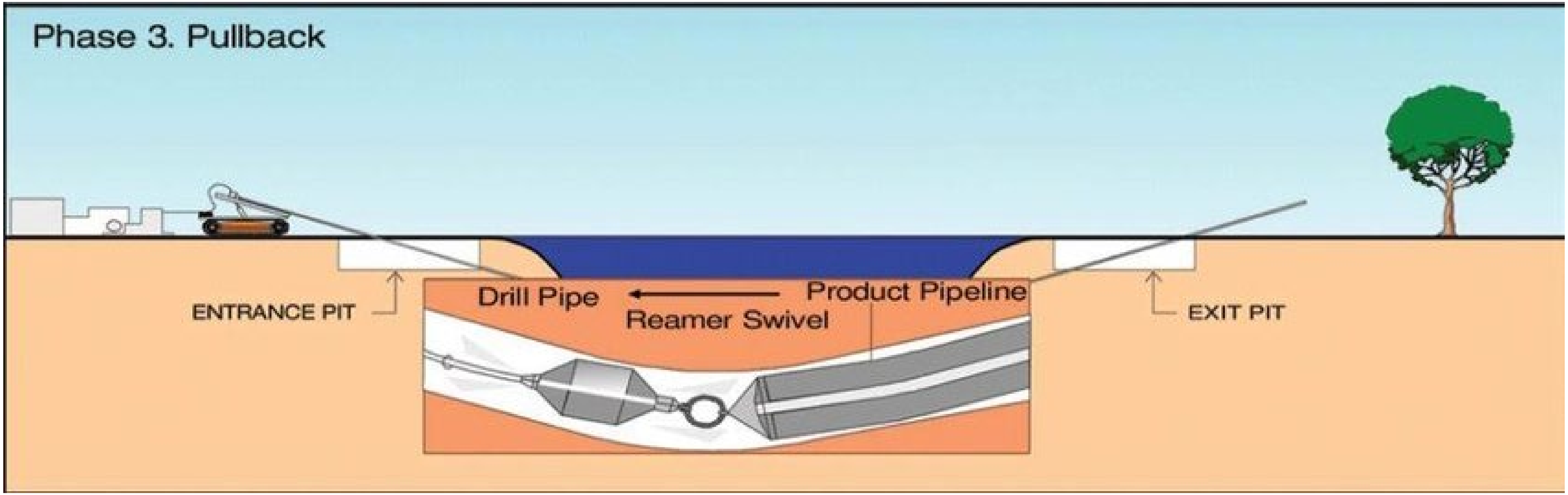


Step 2: Ream



Phase 2. Preream
ENTRANCE PIT
EXIT PIT
Reamer
Wash Pipe
Drill Rod

Step 3: Pullback



ALLIANCE FOR pepipe

Equipment

Drilling Rods

ALLIANCE FOR pepipe

Equipment

Reamer

ALLIANCE FOR pepipe

Equipment

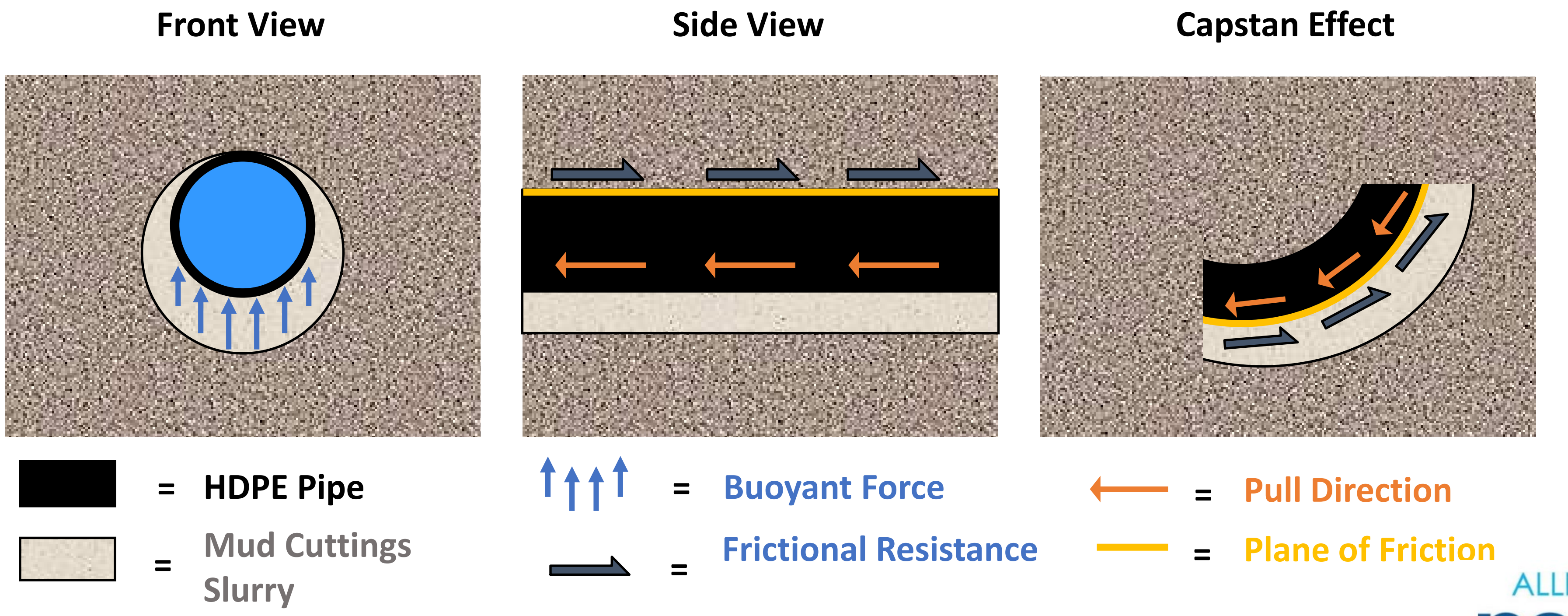
Bentonite


CAT

Borepath Frictional Forces

Borehole Friction

- HDPE pipe is less dense than mud-slurry
  - Pipe floats to the top of the bore hole
- Frictional resistance when being pulled across top of the bore hole
- Capstan effect occurs when HDPE pipe is pulled around bends
  - Larger frictional forces



ALLIANCE FOR pepipe

Safe Pull Force - HDD

Safe Pull Force

Safe pull force of HDPE pipe varies with:

- DR
- Time under tension
- Outside diameter

$$\text{Safe Pull Force} = \pi(OD)^2 f_Y f_T T_Y \left(\frac{1}{DR} - \frac{1}{DR^2}\right)$$

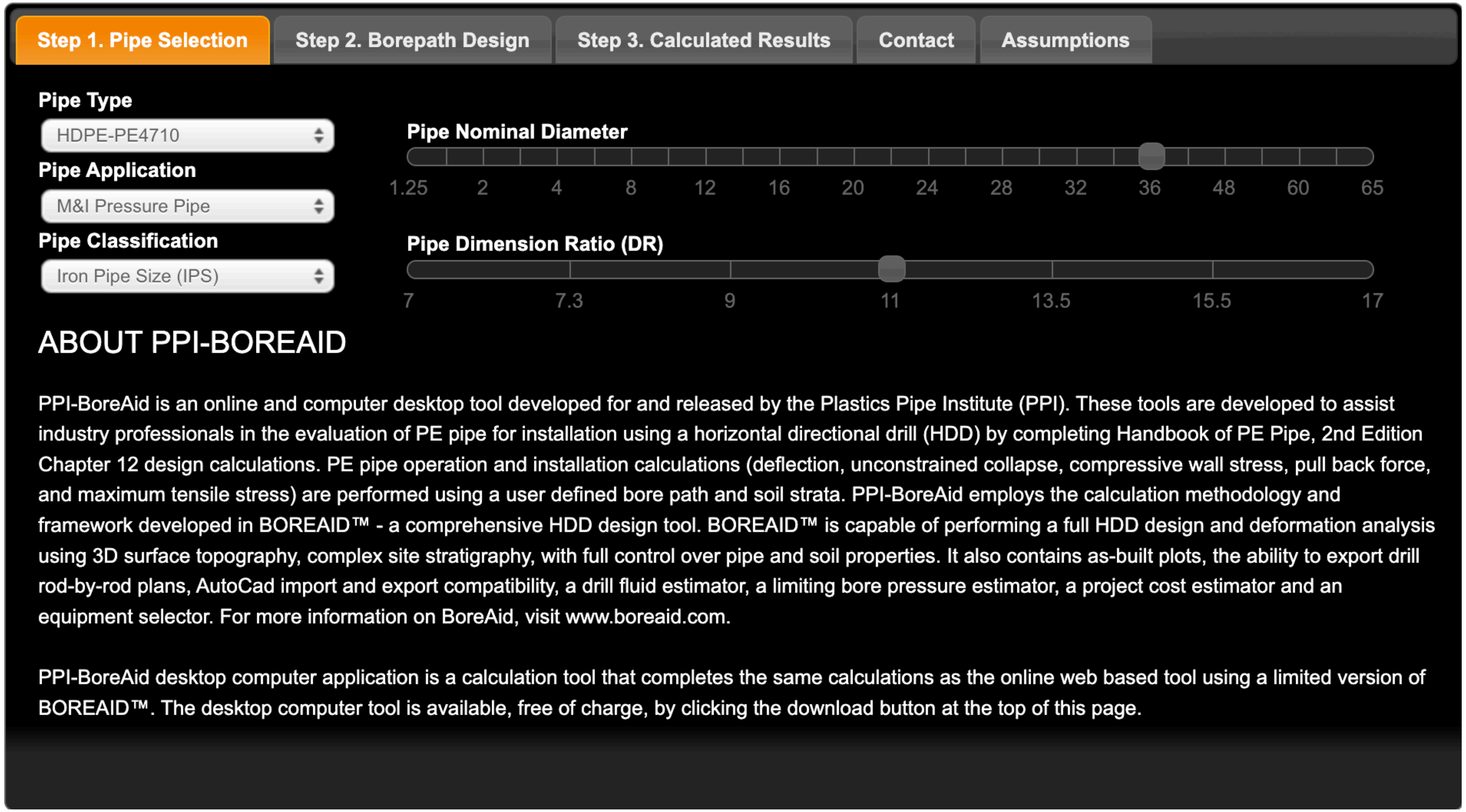
- Mechanical weak-link devices, such as breakaway swivels, are recommended
  - Assures the safe pull force of the PE pipe is never surpassed during installation
- Pipe rollers and ballasting reduces required pull force

Factor	Parameter	Recommended Value		
f_Y	Tensile Yield Design Factor	0.40		
f_T	Time Under Tension Design Factor	1.0 for up to 1 hour	0.95 for up to 12 hours	0.91 for up to 24 hours
T_Y	Tensile Yield Strength of Pipe	3500 psi for PE4710 at 73°F		

ALLIANCE FOR pepipe

Calculator #5 PPI BoreAid

http://ppiboreaid.com

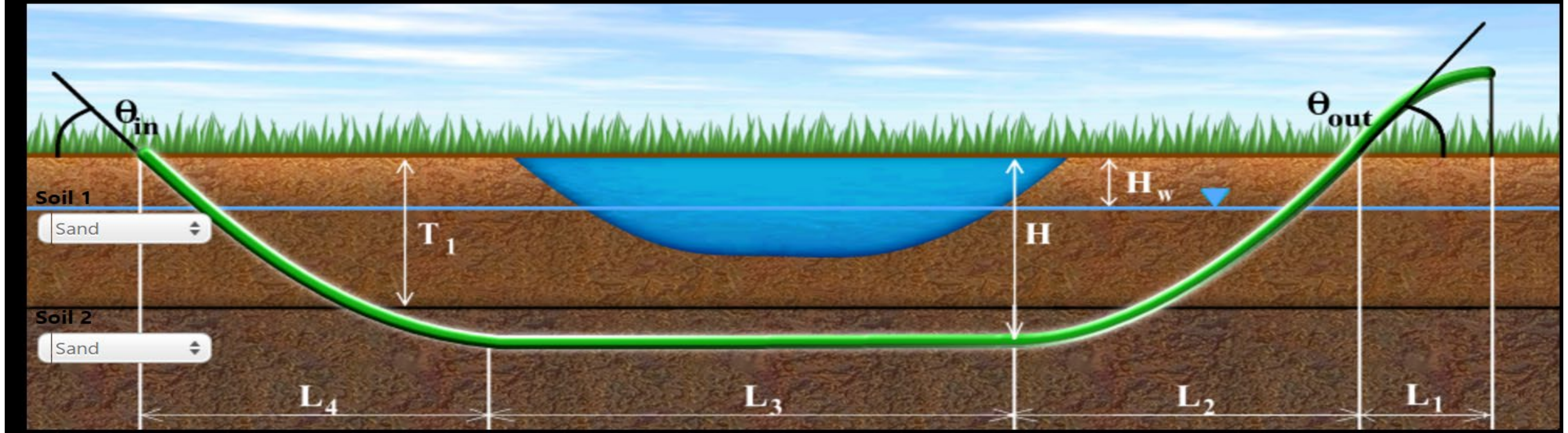


Step 1: Pipe Selection

Calculator #5 PPI BoreAid

http://ppiboreaid.com

Step 1. Pipe Selection | Step 2. Borepath Design | Step 3. Calculated Results | Contact | Assumptions



Input	
Project Length (L, ft)	2000
Pipe Entry Angle (θ_{out}, deg)	8.5
Pipe Exit Angle (θ_{in}, deg)	11
Depth of Cover (H, ft)	47
Depth to Water Table (H_w, ft)	0
Soil Thickness (T_1, ft)	50
Extra Length of Pipe (L_1, ft)	100

Calculated Values	
Length to Reach Depth of Cover (L_2, ft)	633.6
Length Traversed at Depth (L_3, ft)	876.8
Length to Rise From Depth of Cover (L_4, ft)	489.6
Bending Radius at Pipe Entry (R_{in}, ft)	4,271.1
Bending Radius at Pipe Exit (R_{out}, ft)	2,550.3

Step 2: Borepath Design

Calculator #5 PPI BoreAid

http://ppiboreaid.com

Step 1. Pipe Selection | Step 2. Borepath Design | Step 3. Calculated Results | Contact | Assumptions

- Show Calculated Values
- Show Factor of Safety

*** Many design and material parameters are assumed in these calculations based upon suggested values from ASTM F1962 - Click here for a complete list of assumed parameter values

	Applied Loading:		Earth pressure = 2.6 psi. Water pressure = 20.4 psi. Mud pressure = 30.5 psi.						
	HDPE-PE4710			OPERATIONAL	INSTALLATION				
	IPS Nom. OD	IPS DR	Deflection	Critical Collapse - Full - 50 yr (pressure pipe)	Critical Collapse - 1 hr	Critical Collapse - 10 hr	Pull Back Force	Allowable Pullback	Status
	inches		% OD	psi	psi	psi	lbs	lbs	
No Rollers & No Ballast	20	9	0.4	128	252	210	101,803	161,346	PASS
	20	11	0.8	66	123	102	106,745	135,011	PASS
	20	13.5	1.6	34	58	49	111,054	112,046	FAIL
With Rollers & No Ballast	20	9	0.4	128	253	211	99,308	161,346	PASS
	20	11	0.8	66	123	103	104,657	135,011	PASS
	20	13.5	1.6	34	59	49	109,322	112,046	FAIL
With Rollers & Ballast	20	9	0.4	128	276	230	46,042	161,346	PASS
	20	11	0.8	66	139	116	45,713	135,011	PASS
	20	13.5	1.6	34	70	58	45,426	112,046	PASS

Step 3: Calculated Results

ALLIANCE FOR

pe pipe

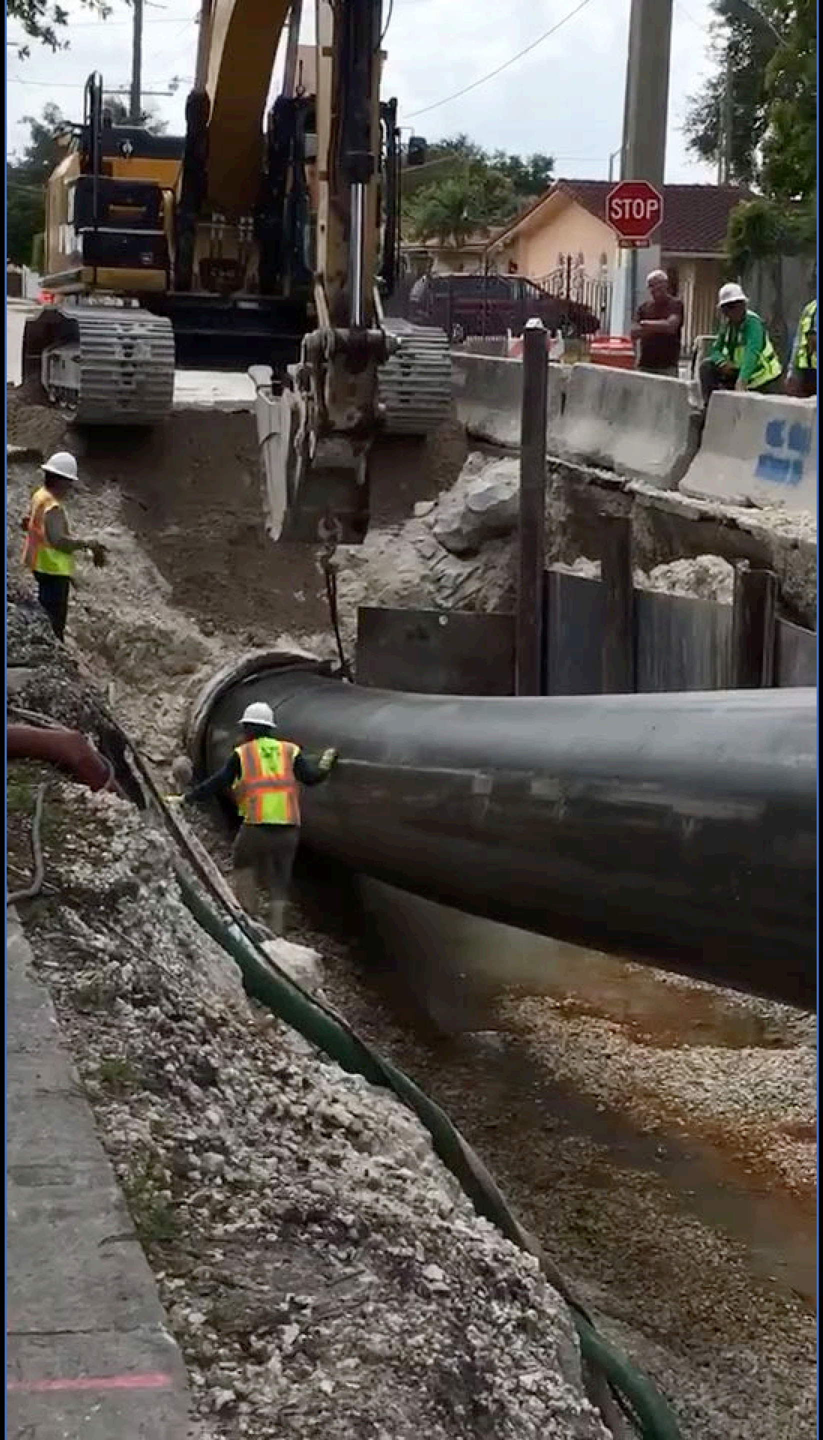
Sliplining

Key Points

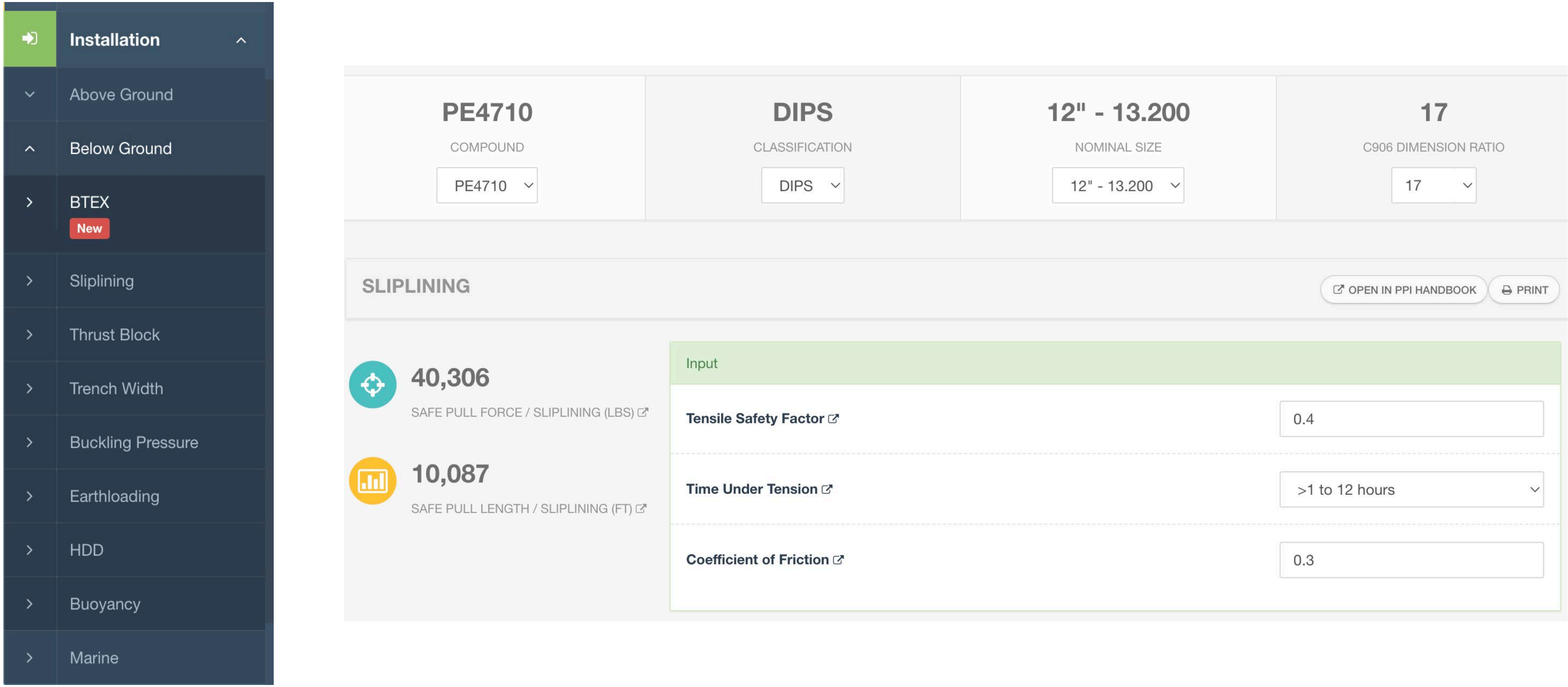
- Preparation is key to successful installation
  - *Evaluate integrity of host pipe*
- Limited by size of host pipe
  - *Often obtain same flow after lining*
- Limited ability to pull through bends
- Monitor pulling force
- Lubrication with bentonite or water reduces friction during pull-in
- ASTM F585

ALLIANCE FOR pepipe

Pull or Push


STOP

Calculator #6: Sliplining



ALLIANCE FOR pe pipe

Pipe Bursting

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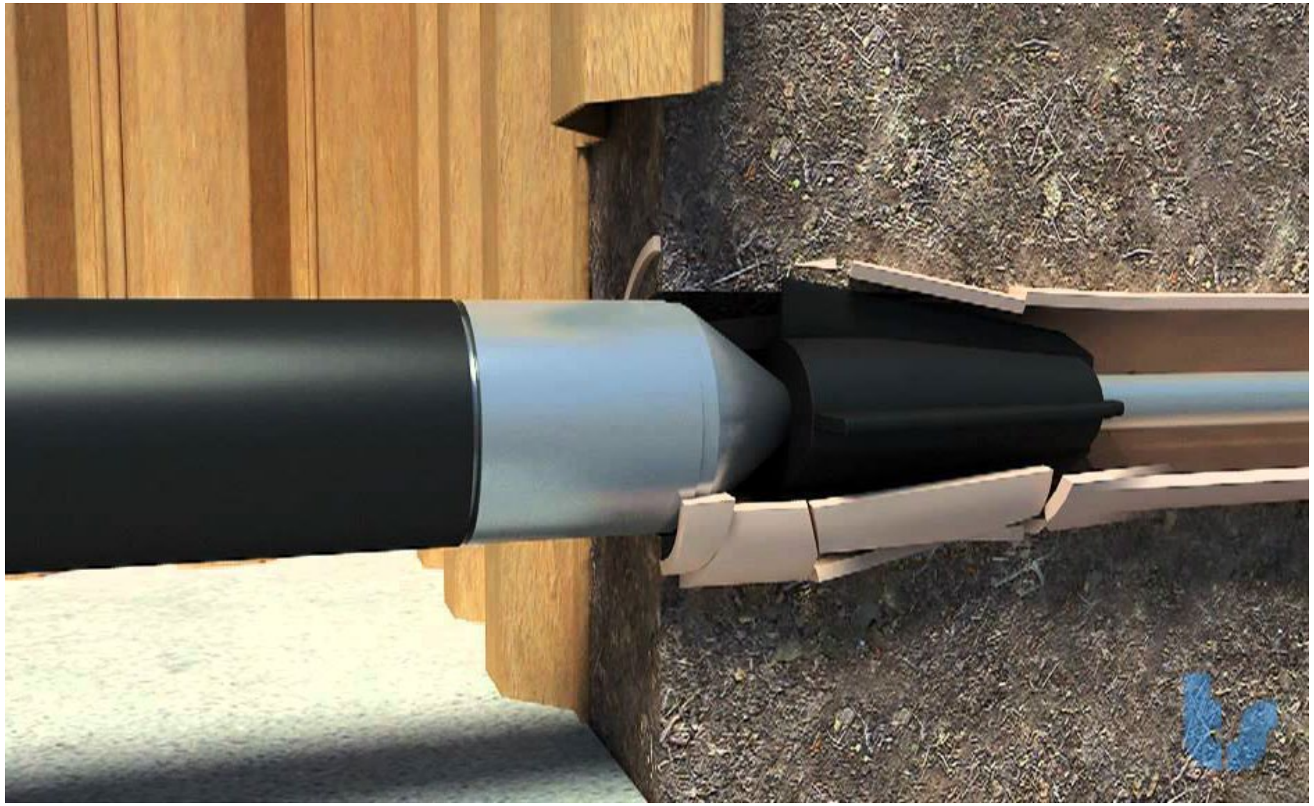
Pipe Bursting Definition



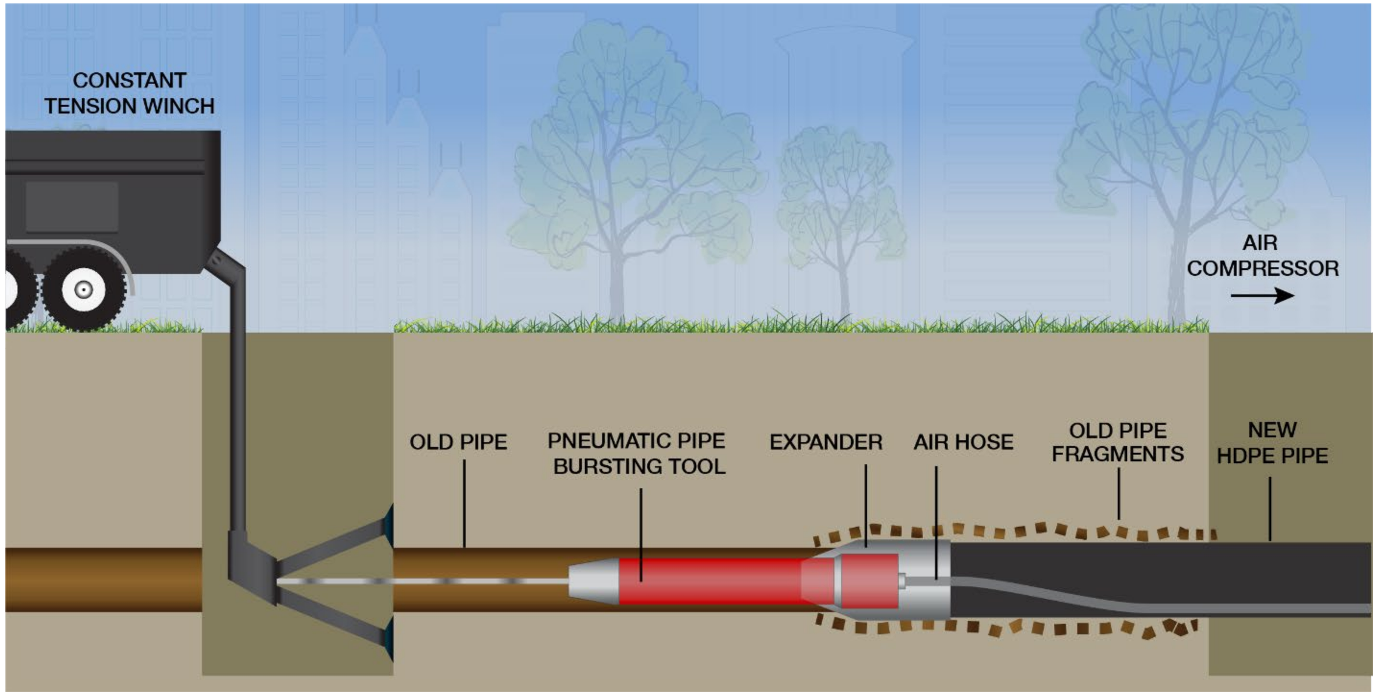
Three things are happening simultaneously

- (1) the existing pipe is being fractured or split
- (2) the soil is being expanded to receive the new pipe
- (3) the new pipe is being pulled into the place of the existing pipe.

ALLIANCE FOR pe pipe

Pneumatic Pipe Bursting

- *utilizes a soil displacement hammer inserted into the existing pipe & is powered by compressed air.*
- *An expander head is fitted to the front or rear of the pneumatic hammer.*
- *the unit is connected to a constant tension winch that keeps the hammer in contact with the existing pipe*

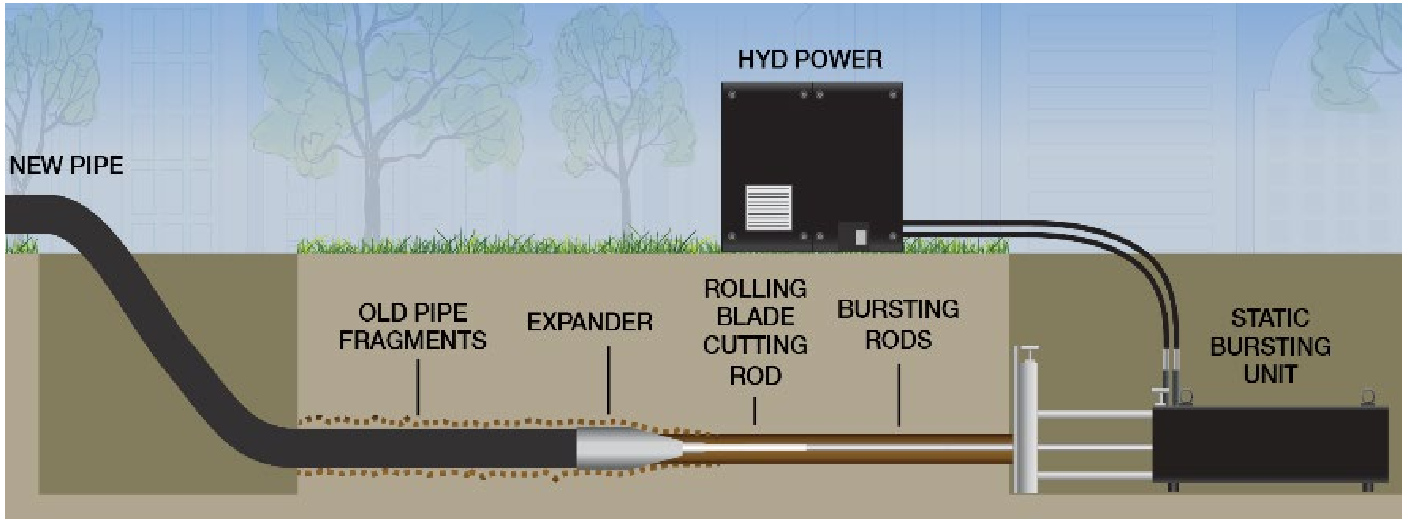


ALLIANCE FOR pepipe

Static Pipe Bursting

- *Static pipe bursting inserts a rod, cable or chain into the existing pipe and applies a large pull force to an expander head as it is pulled through the existing pipe.*

- *The expander head transfers the horizontal pulling force into a radial force that breaks the existing pipe and temporarily displaces the soil to provide space for the new pipe*



Pipe Bursting Benefits

Open Cut Replacement Costs

- Pavement saw-cutting
- Excavation
- Trucking spoil and dump fees
- Backfill and transport
- Compaction
- Concrete or asphalt repair
- Traffic control
- Bypass Pumping

ALLIANCE FOR pepipe

Pipe Bursting Benefits

- Installs a new seamless pipe
- Ability to upsize
- Eliminates up to 85% of excavation
- Follows the path of the existing utility
- Less disturbance to traffic patterns
- Often more cost effective than open trench replacement
- Proven technology with 70,000,000 feet installed worldwide

ALLIANCE FOR pepipe

Host Pipe

- Cast Iron
- Clay tile
- PVC
- Concrete
- Reinforced Concrete
- Asbestos Cement
- **Ductile Iron**
- **Steel**

ALLIANCE FOR pepipe

Jobsite Setup

Pre-Chlorinated Sequence

Previous Week

Pre-chlorinate

Send out samples

Pressure Test

Wed AM

Disconnect services

Excavate, expose

Burst

Wed PM

Services reconnected

Backfill, water back on

or do temporary water

ALLIANCE FOR pepipe


ARLINGTON
SILENCE
AND
RESPECT
NATIONAL CEMETERY

Resources

ALLIANCE FOR pepipe RESOURCES

PPI Plastics Pipe Institute

AWWA

Alliance Standard Details

Connections

- Service saddle connections
  - Sidewall fusion
  - Electrofusion
  - Mechanical service saddle
- Valve connections
- Connections to non-HDPE pipe materials

Fire hydrants

- Mechanical connections
- AVK fire hydrant

Manholes

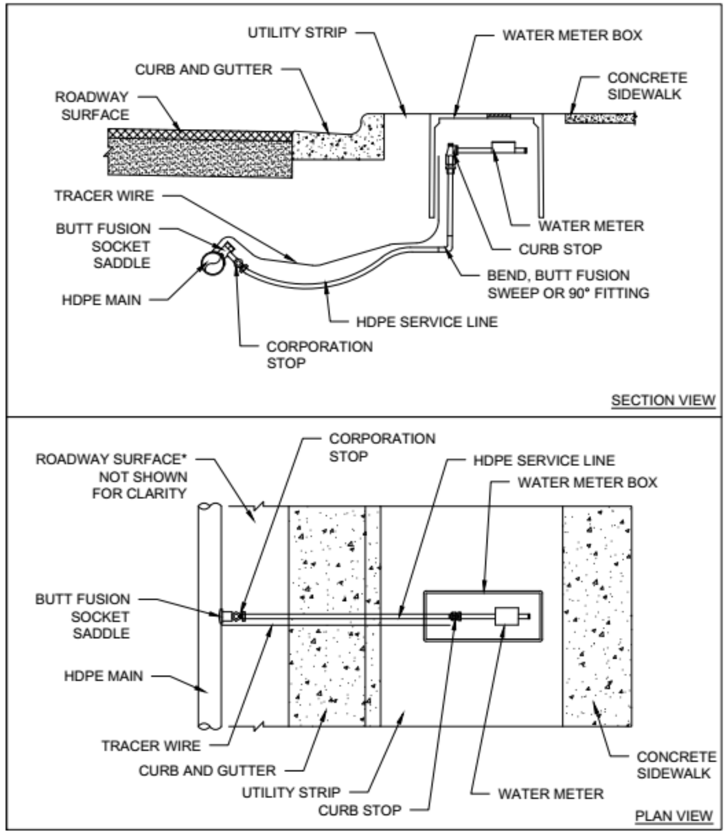
- HDPE manholes
- Pre-fabricated HDPE pipe stub
- Pre-fabricated HDPE pipe gusset
- Pre-fabricated HDPE sleeve for force mains
- Electrofusion connections
- Butt fusion connections
- HDPE anchor connecting ring
- Concrete anti-flotation anchor
- External HDPE drop pipe
- Internal HDPE drop pipe
- HDPE pipe connection to non-HDPE manholes

Installations

- Pipe bedding material
- Utility conflict adjustment
  - Electrofusion fittings
  - Adjustment through bend radius
- Electrofusion adjustable elbow

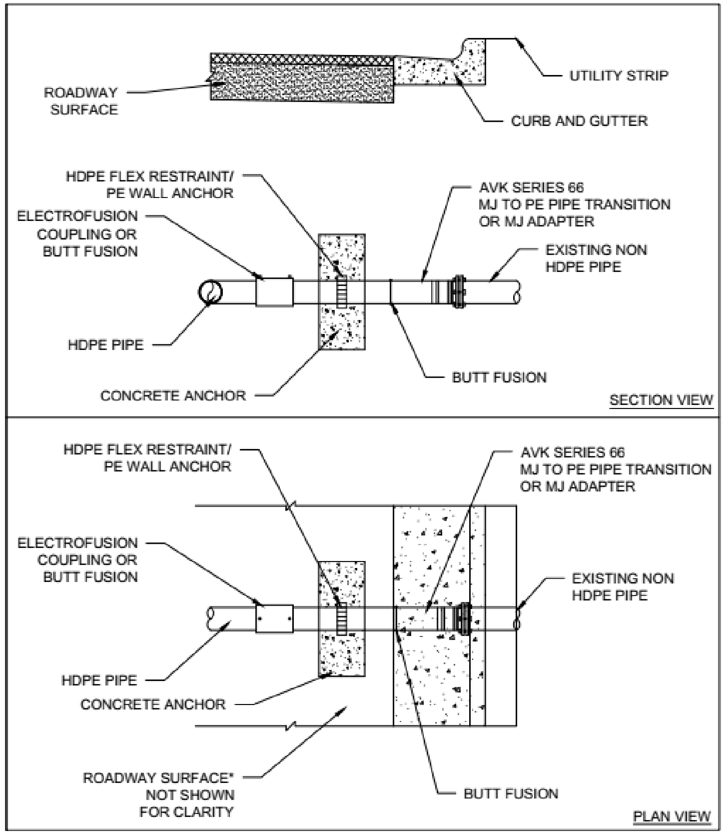
ALLIANCE FOR pepipe

Standard Details - Connections



WATER SERVICE WITH BUTT FUSION SOCKET SADDLE

HDPE Pipe
Responsible Infrastructure

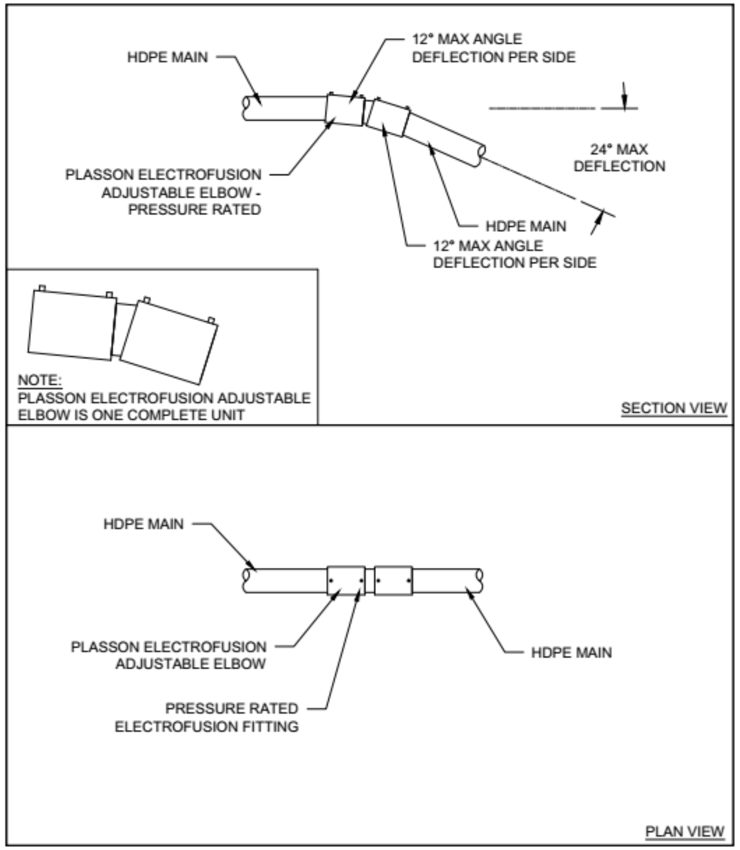


HDPE CONNECTION TO ALTERNATE PIPE MATERIAL

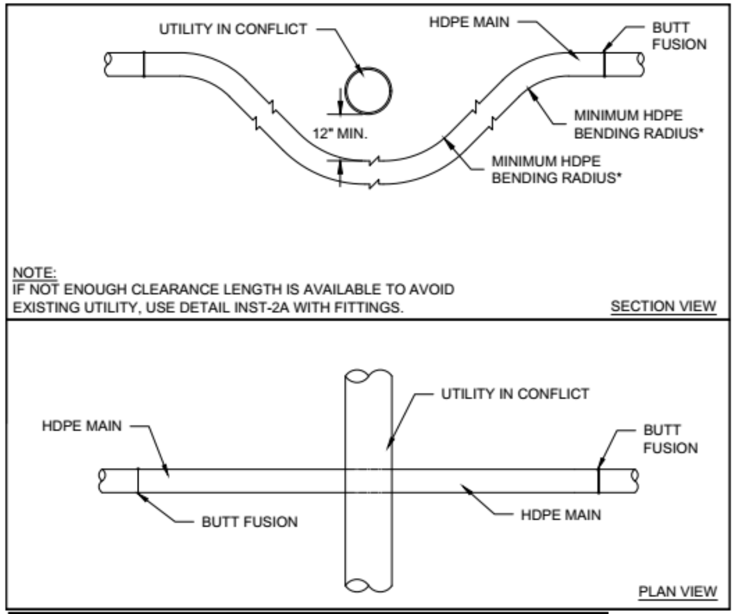
HDPE Pipe
Responsible Infrastructure

ALLIANCE FOR pepipe

Standard Details - Installation



PLASSON ELECTROFUSION ADJUSTABLE ELBOW	HDPE Pipe Responsible Infrastructure
ALLIANCE FOR PE PIPE	Standard Detail INST-2C Scale: NTS

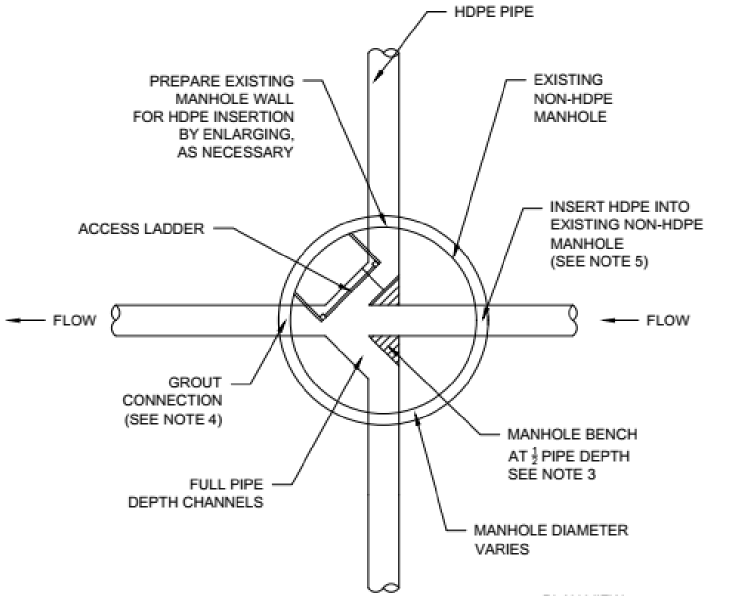


OD - DIPS (INCHES)	OD - NOMINAL (INCHES)	* MINIMUM BENDING RADIUS PER SDR (FEET)							
		7	9	11	13.5	17	21	26	32.5
		20* R	20 * R	25 * R	25 * R	27 * R	27 * R	34 * R	42 * R
4	4.8	8.0	8.0	10.0	10.0	10.8	10.8	13.6	16.8
6	6.9	11.5	11.5	14.4	14.4	15.5	15.5	19.6	24.2
8	9.1	15.1	15.1	18.9	18.9	20.4	20.4	25.6	31.7
10	11.1	18.5	18.5	23.1	23.1	25.0	25.0	31.5	38.9
12	13.2	22.0	22.0	27.5	27.5	29.7	29.7	37.4	46.2
14	15.3	25.5	25.5	31.9	31.9	34.4	34.4	43.4	53.6
16	17.4	29.0	29.0	36.3	36.3	39.2	39.2	49.3	60.9
18	19.5	32.5	32.5	40.6	40.6	43.9	43.9	55.3	68.3
20	21.6	36.0	36.0	45.0	45.0	48.6	48.6	61.2	75.6
24	25.8	43.0	43.0	53.8	53.8	58.1	58.1	73.1	90.3
30	32.0	53.3	53.3	66.7	66.7	72.0	72.0	90.7	112.0
36	38.3	63.8	63.8	79.8	79.8	86.2	86.2	108.5	134.1

UTILITY CONFLICT AND HDPE BEND RADIUS	HDPE Pipe Responsible Infrastructure
ALLIANCE FOR PE PIPE	Standard Detail INST-2B Scale: NTS

ALLIANCE FOR pepipe

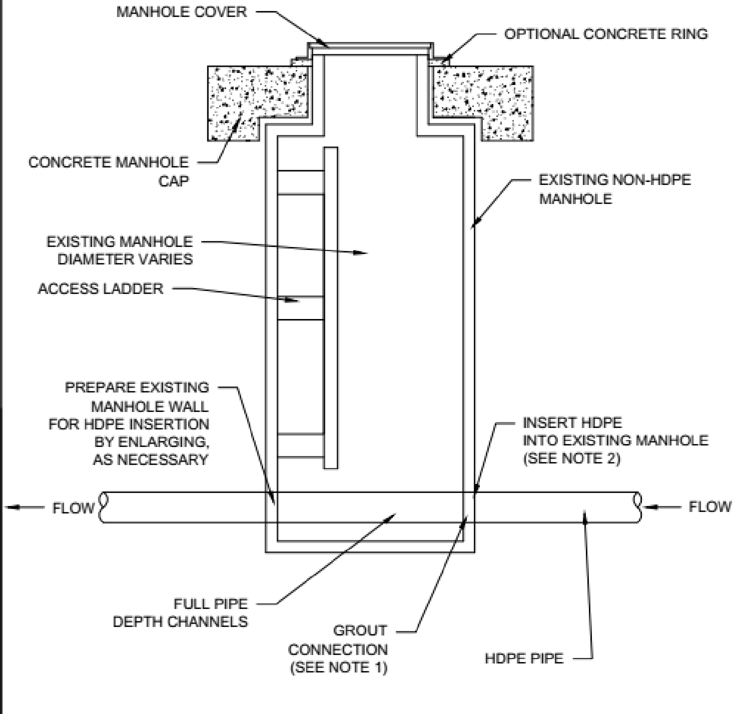
Standard Details - Manholes



PLAN VIEW
FOR PLAN VIEW SEE STANDARD DETAIL MH-3C

NOTES:
1. BACKFILL SHALL BE PLACED AROUND THE MANHOLE RISER FOR THE FULL HEIGHT OF THE MANHOLE.
2. BACKFILL SHALL EXTEND A MINIMUM OF 3.5' FROM THE RISER OR TO THE TRENCH WALL, WHICHEVER IS GREATER.
3. BENCH AND PIPE TO BE AT FULL PIPE DEPTH IN NON-HATCHED AREAS, HATCH LOCATIONS TO BE HALF PIPE DEPTH.
4. ALLOW HDPE TO RELAX PRIOR TO INSTALLING GROUT
5. INSERT LONGER LENGTH OF HDPE PIPE INTO MANHOLE AND ALLOW TO RELAX PRIOR TO INSTALLING GROUT

CONNECTING HDPE TO NON-HDPE MANHOLE	HDPE Pipe Responsible Infrastructure
ALLIANCE FOR PE PIPE	Standard Detail MH-3A Scale: NTS



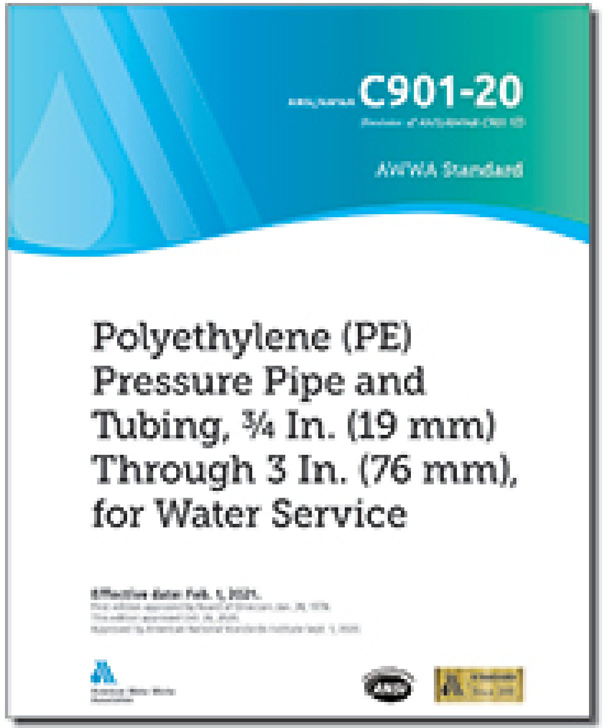
SECTION VIEW
FOR PLAN VIEW SEE STANDARD DETAIL MH-3A

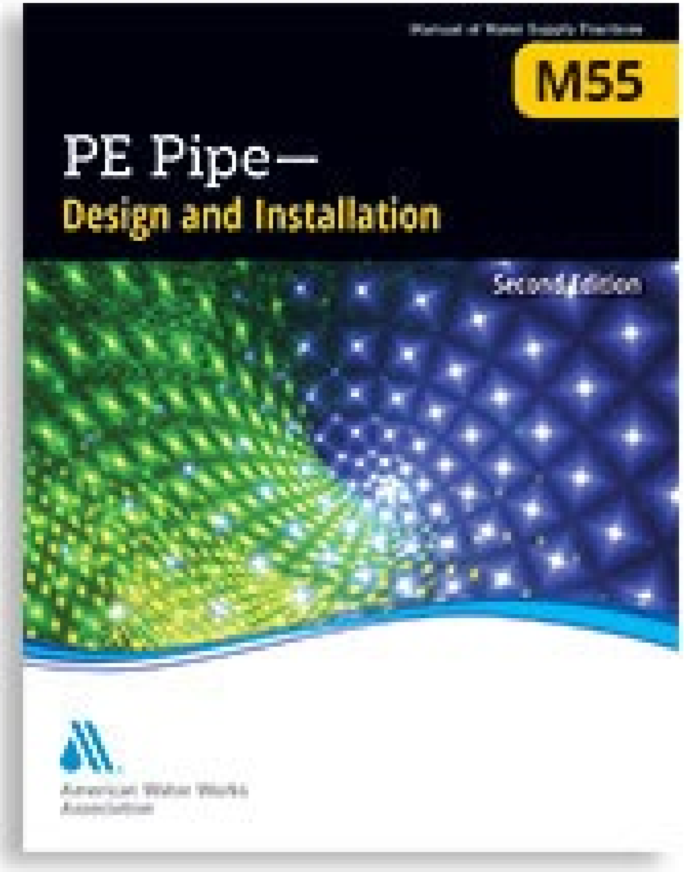
NOTES:
1. ALLOW HDPE TO RELAX PRIOR TO INSTALLING GROUT
2. INSERT LONGER LENGTH OF HDPE PIPE INTO MANHOLE AND ALLOW TO RELAX PRIOR TO INSTALLING GROUT

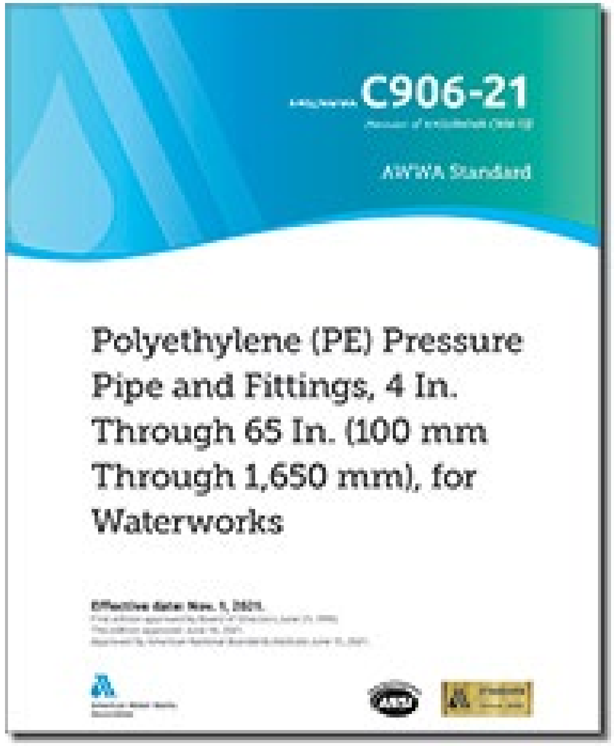
CONNECTING HDPE TO NON-HDPE MANHOLE	HDPE Pipe Responsible Infrastructure
ALLIANCE FOR PE PIPE	Standard Detail MH-3B Scale: NTS

ALLIANCE FOR pepipe

AWWA


C901-20
AWWA Standard
Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (19 mm) Through 3 In. (76 mm), for Water Service


M55
PE Pipe—
Design and Installation
Second Edition


C906-21
AWWA Standard
Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks

CONTACTS

- Questions
- PDH
- Project Assistance
- Specification Writing
- Engineers Package
- Case Studies

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ALLIANCE FOR pepipe

HDPE 301

www.pepipe.org