Why, Where, & Type of Joint Restraint

2018 Iowa AWWA Annual Course

John Gade, P.E.

FOX Engineering & Associates

FOX engineering

Topics Covered

Types of Thrust Restraint

Limitations

Engineering Resources

Stories

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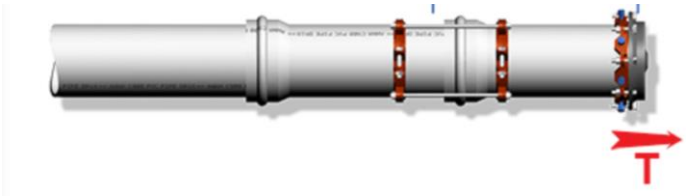
How much thrust force is generated by a Water Pipeline?

12-inch Water End Cap - 150 psi



17,000 Pounds of Force!!

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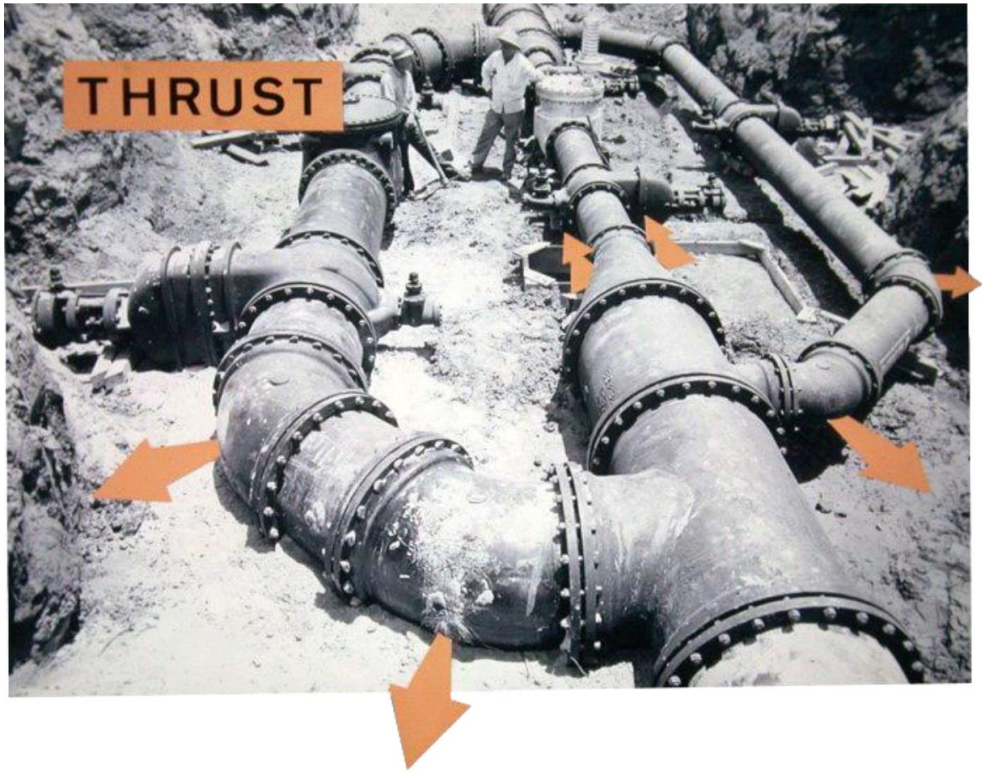
Types of Forces

Static Forces

- Internal Forces



Dynamic Forces

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Concrete Thrust Blocks

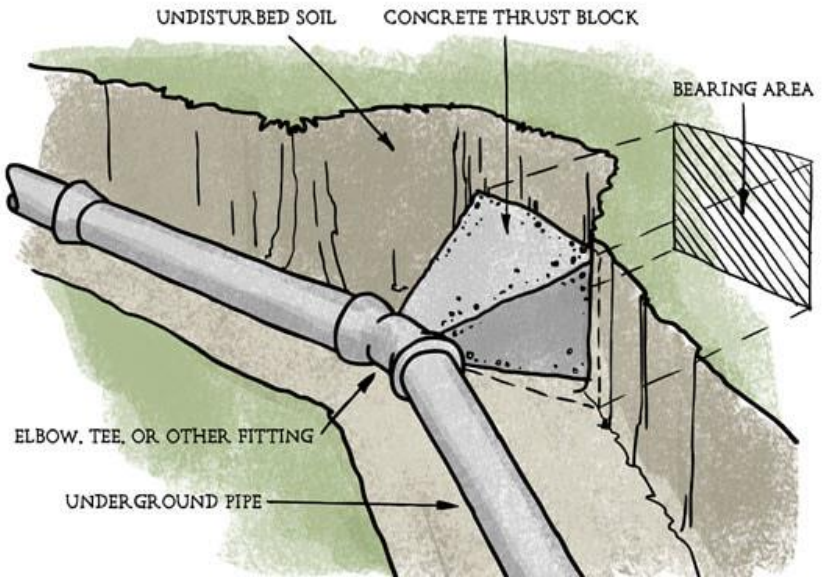
Widely Used & Accepted

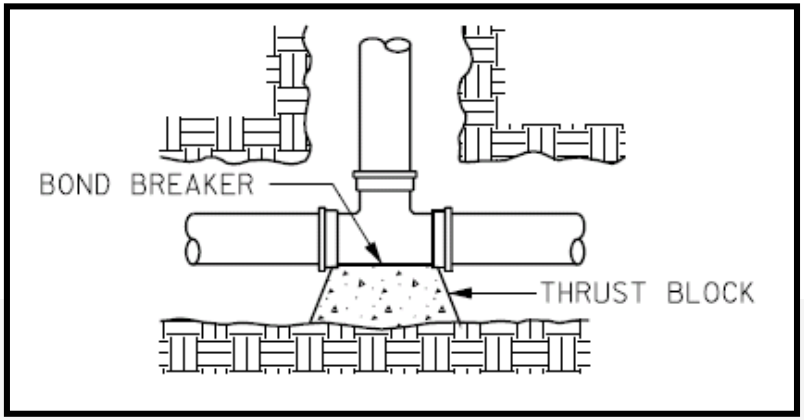
Poured in Place or Blocks

16” Pipe or Smaller

Special Care

- Bond Breaker
- Don’t Cover Joints
- Weep Holes (Hydrant)
- Valve Operating Mechanism





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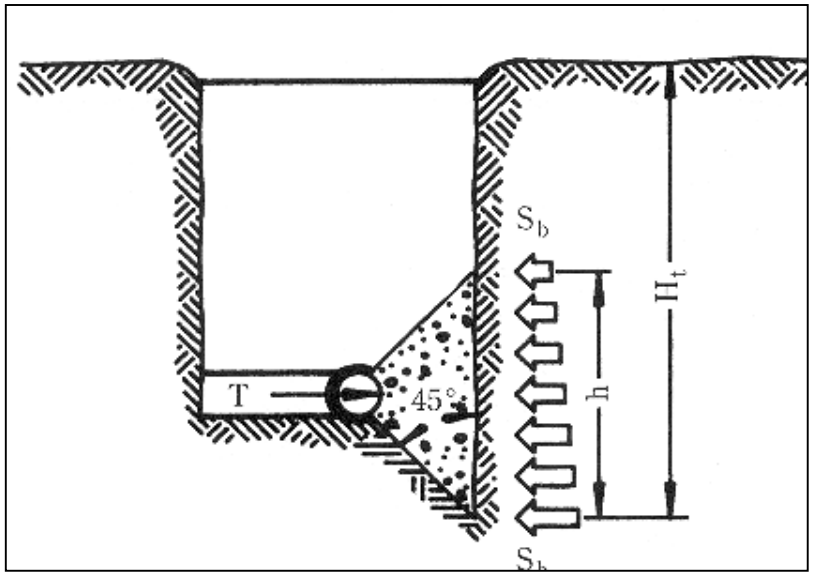
Concrete Thrust Blocks

Designed in Field

- Pipe Test Pressure
- Soil Type
- Undisturbed Soil
- Properly Formed
- Concrete Strength
- Cure Time



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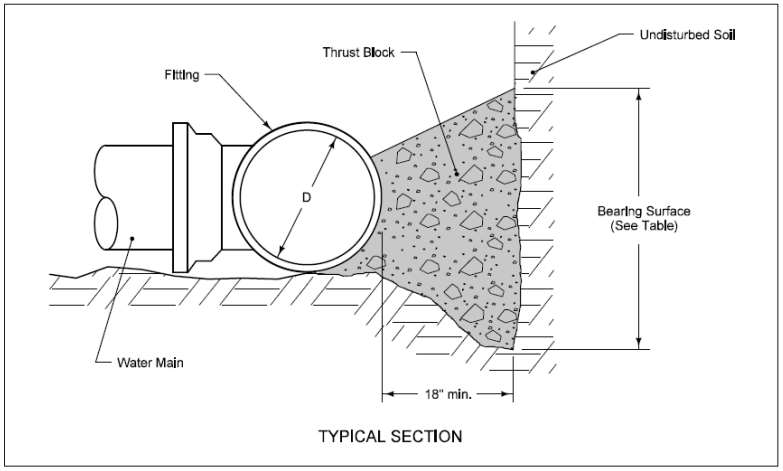
Concrete Thrust Blocks Design

Iowa Statewide Urban Design

& Specifications (SUDAS)

http://www.iowasudas.org/



TYPICAL SECTION

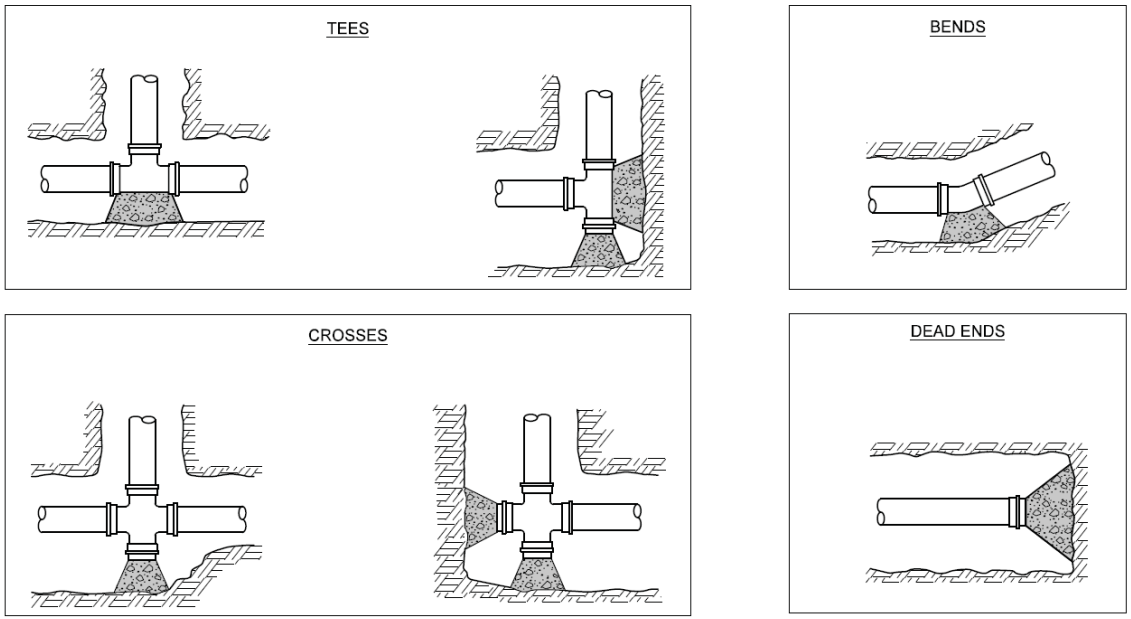
Extend thrust blocks to undisturbed soil. Excavation into trench wall may be necessary.

Form vertical surfaces of poured concrete thrust blocks except on bearing surface.

Encase all fittings in polyethylene wrap. Do not allow concrete to directly contact joints or fitting bolts.

Diameter of Pipe, D (Inches)	MINIMUM BEARING SURFACE (sf)				
	Bends				Tees and Dead Ends
	$11\frac{1}{4}^{\circ}$	$22\frac{1}{2}^{\circ}$	45°	90°	
4	1	1	2	4	3
6	1	2	4	8	6
8	2	4	7	14	10
10	3	6	11	21	15
12	4	8	16	29	21
14	5	11	21	39	28
16	7	14	27	50	36
18	9	17	34	63	45
20	11	21	42	78	55
24	15	31	60	111	78
30	24	47	92	171	120
36	34	67	132	244	173

Minimum surface area based on water pressure of 150 psi and allowable soil pressure of 1,000 psf.



TYPICAL PLAN

FIGURE 5010.101 SHEET 1 OF 2

SUDAS | IOWA DOT

REVISION
1 10-18-16

FIGURE 5010.101 | STANDARD ROAD PLAN

WM-101

SHEET 1 of 2

REVISIONS: Replaced Iowa DOT and SUDAS logos with new logos.

Paul D. Wigand
SUDAS DIRECTOR

Brian Smith
DESIGN METHODS ENGINEER

THRUST BLOCKS

Concrete Thrust Block - Bearing

Diameter of Pipe, D (Inches)	MINIMUM BEARING SURFACE (sf)				
	Bends				Tees and Dead Ends
	$11\frac{1}{4}^{\circ}$	$22\frac{1}{2}^{\circ}$	45°	90°	
4	1	1	2	4	3
6	1	2	4	8	6
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24	15	31	60	111	78
30	24	47	92	171	120
36	34	67	132	244	173

Minimum surface area based on water pressure of 150 psi and allowable soil pressure of 1,000 psf.

Soil	Bearing Strength S_b (lb./ft^2)
Muck	0
Soft Clay	1,000
Silt	1,500
Sandy Silt	3,000
Sandy Silt	4,000
Sandy Clay	6,000
Hard Clay	9,000

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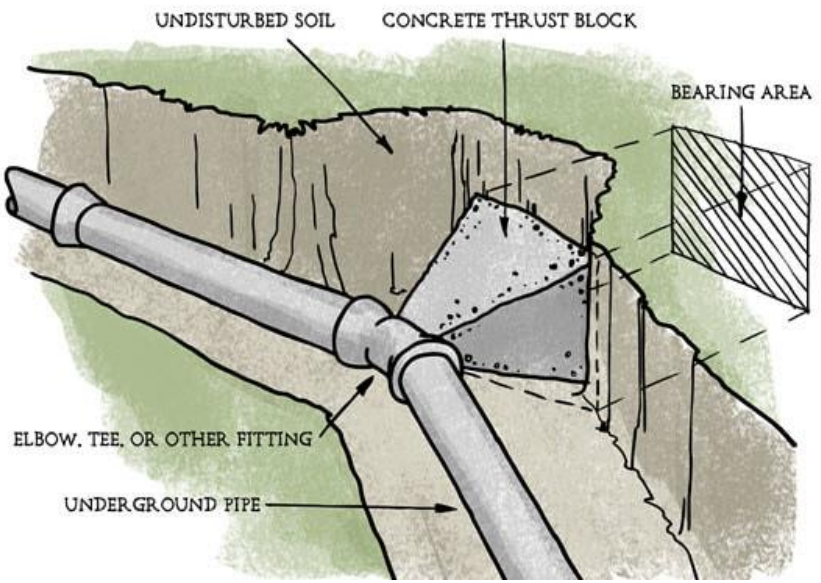
Thrust Blocks Limitations

- Undisturbed Soil?
- Contractor Skill?
- Confined Space?
- Future Connections?
- Other Utilities?
- Vertical Bends?
- Site Access?



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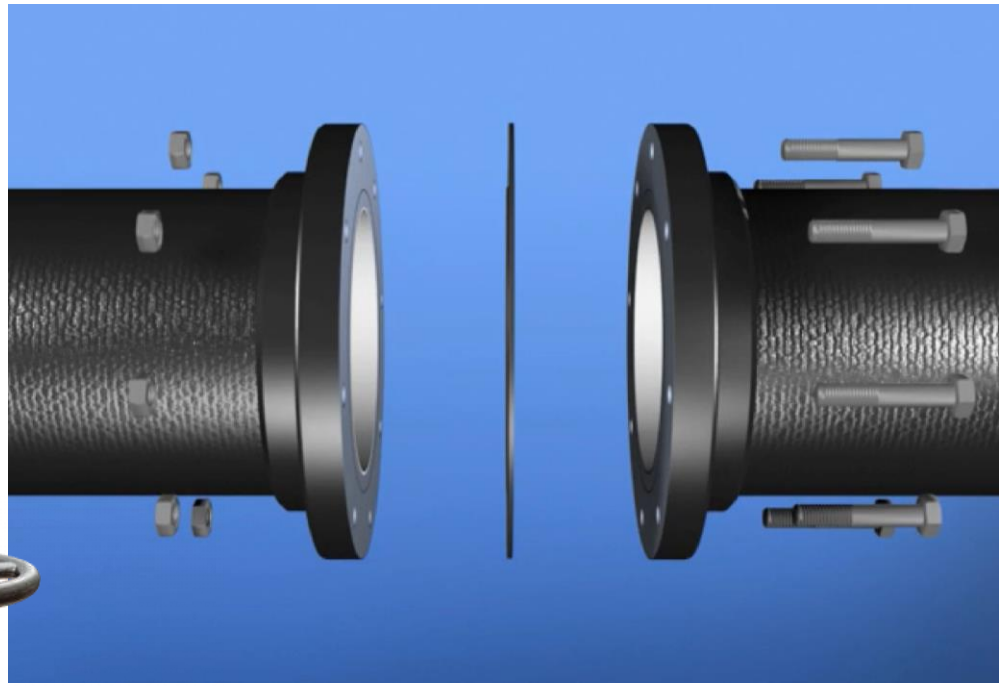
Flanged Joints

Transfer thrust to pipe

Rigid

Valves & Fittings

Above Ground



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Tie Rods or Restrain Harness

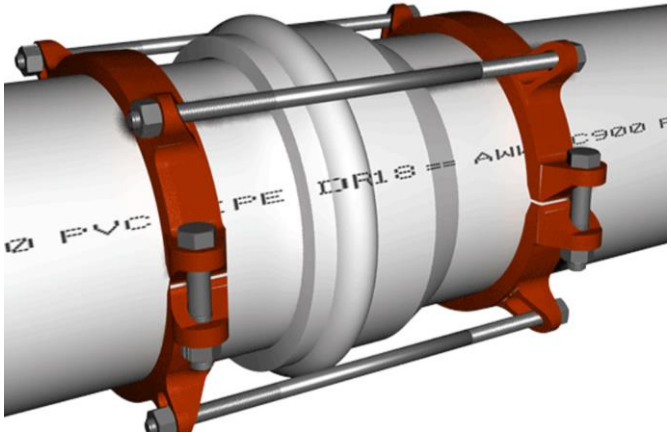
Transfers thrust through rods to point of connection (Effective)

Labor Intensive

Expensive

Good for Retrofit

Corrosion Concerns



FOX engineering

Retainer Glands

Transfers thrust from fitting to pipe

“MegaLugs” (set screw or wedge)

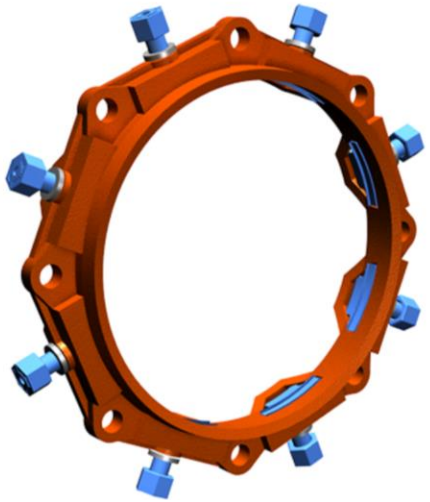
Widely Used & Effective

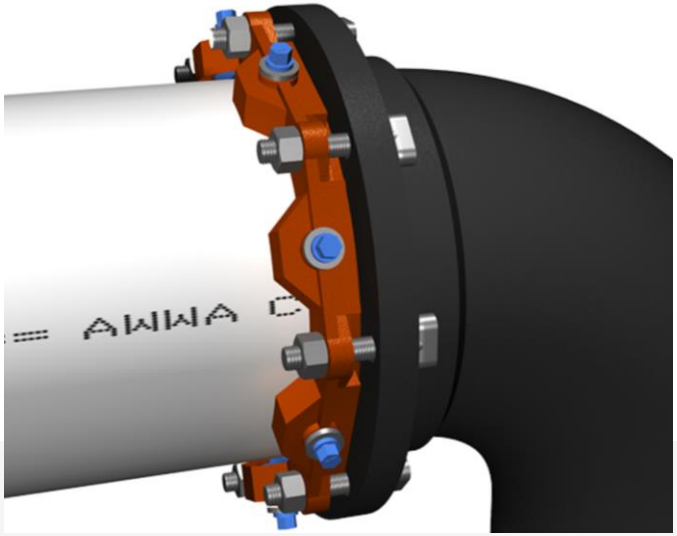
Cost Effective

Lots of Screws (trench issues)

DIP & PVC & HPDE

- ❑ Use Right Product!





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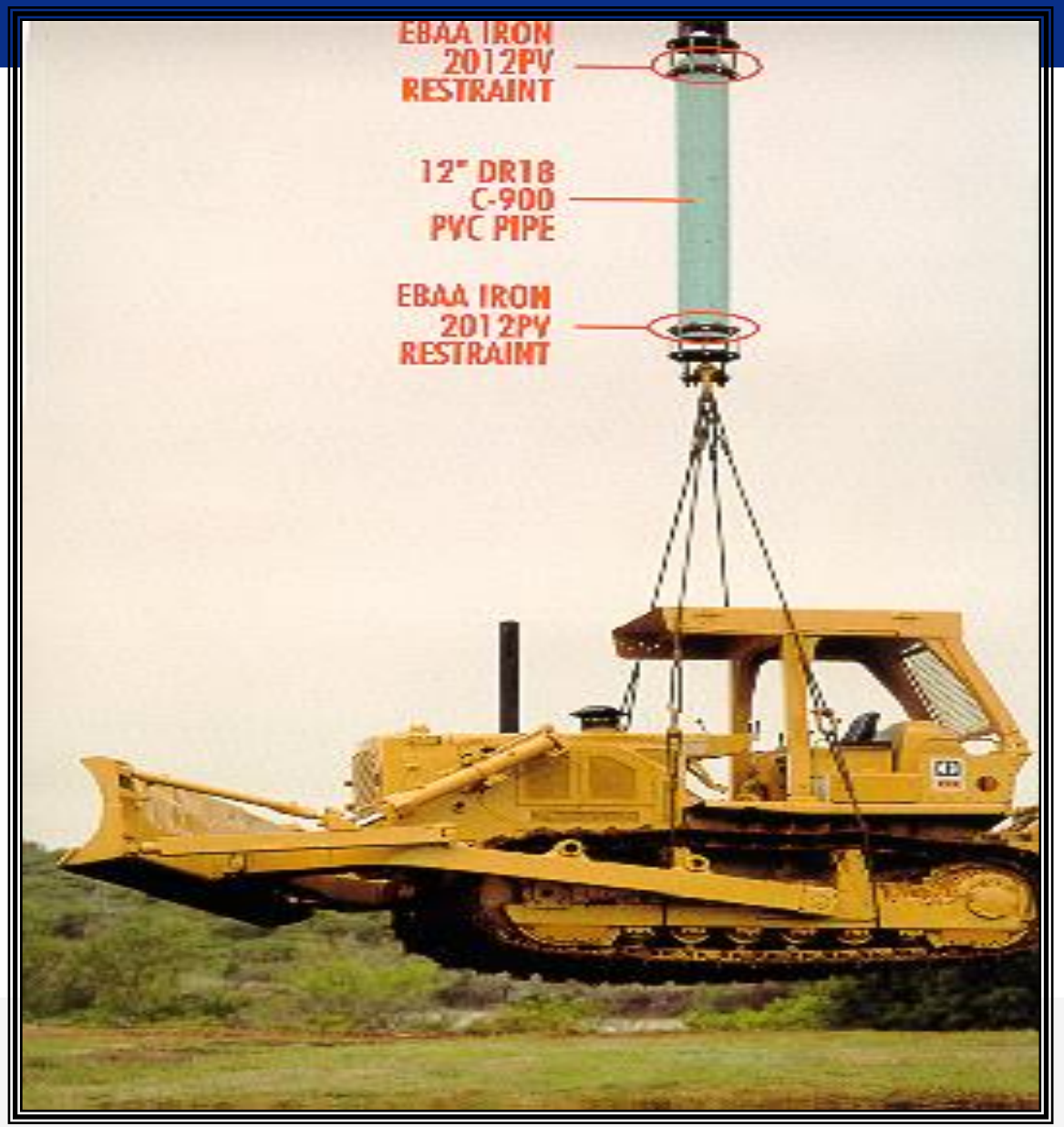
Retainer Glands

50 Tons!



Restrained Joint Pipe

Transfer thrust to pipe

Push on joint (no bolts)

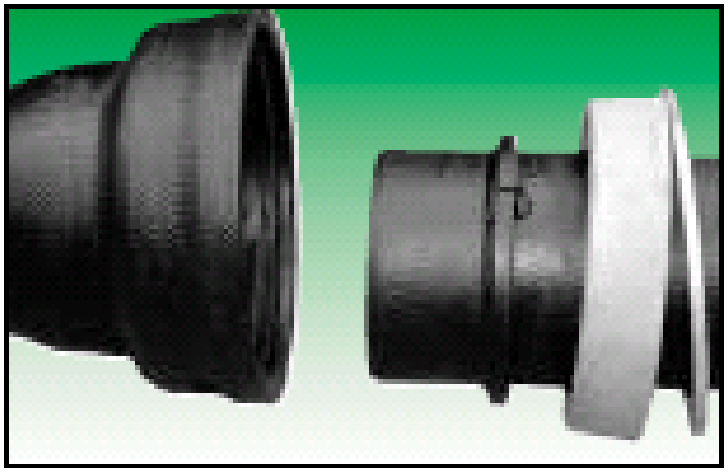
Welded bead on male end w/ restraining gland

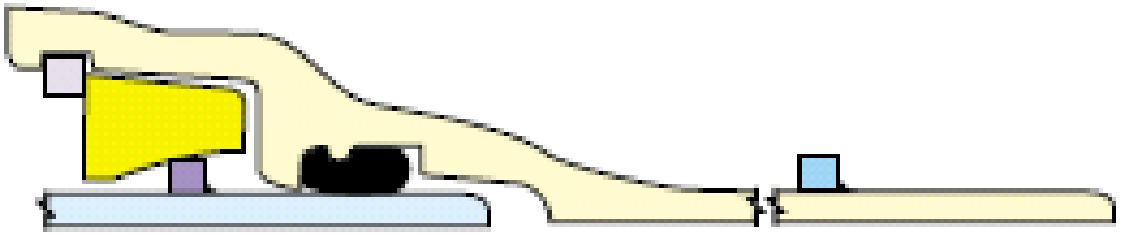
Specific design lengths

Fast & Easy Install

Can be Dissembled

No field “Fit”





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Restrained Gaskets

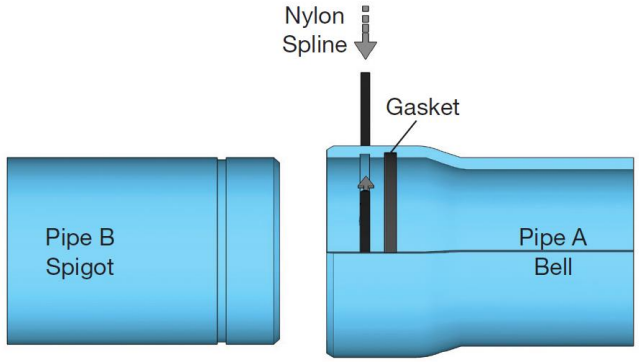
Transfer thrust to pipe

Push-on & Mechanical

Locking teeth gaskets

Field Installed

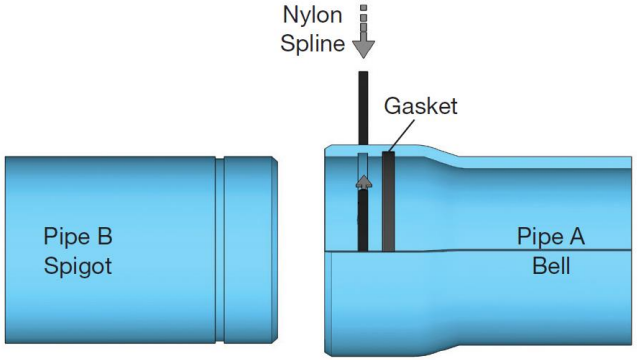
Can be difficult to remove



FOX engineering

Restrained Joint - Coupled

Transfer thrust to coupled joint



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Restrained Joint Pipe
(Trademark Names)

US Pipe

- ✓TR Flex
- ✓Field Lok
- ✓Field Lok 350
- ✓HD Lok

Griffin

- ✓Snap Lok
- ✓Mech Lok
- ✓Bolt Lok

PVC Pipe

- ✓Certa Lock
- ✓Bulldog

American

- ✓Fastite
- ✓Flex Ring
- ✓Lock Ring
- ✓Fast Grip
- ✓ Field Flex Ring
- ✓MJ Coupled Joint

Pac States - Thrust Lock

Clow - Super Lock

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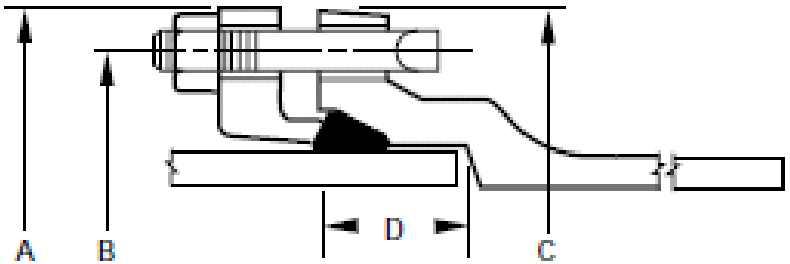
Mechanical Joint

NOT Restrained

Uses Bolts & Wedge



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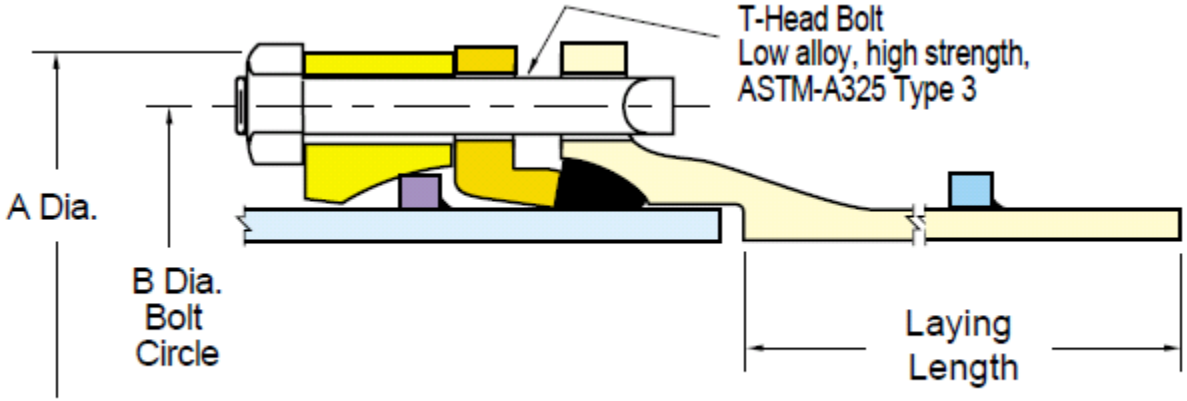
Mechanical “Restrained” Joint

Restrained

Uses Bolts & Wedge

Works Nice with Fittings



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Determine Length of Restraint

Restraint Length Calculator

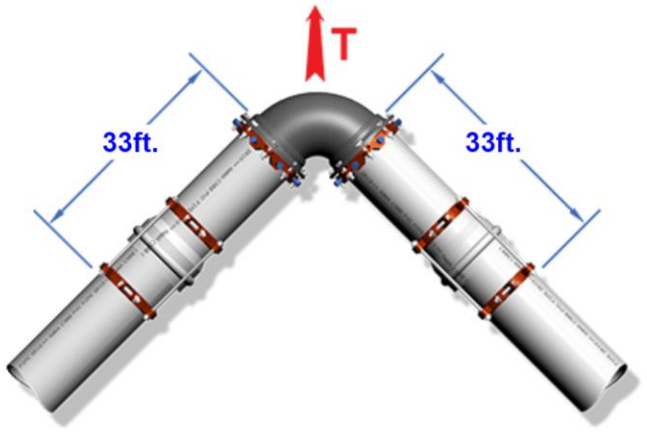
Project Name Notes

Site Name Notes

Item 1 of 1

Pipe Material	PVC
Soil Type	CL
Safety Factor	1.5 to 1
Trench Type	3
Depth of Bury (ft.)	5
Test Pressure	150
Fitting Type	Horizontal Bend
Nominal Size	12
Bend Angle	90

EBAA IRON
EBAA IRON SALES, INC.



33 ft. = Length to be restrained on each side of the bend

29,031 lbs. = Thrust

CALCULATED RESTRAINT LENGTH

- ALL JOINTS WITHIN THE CALCULATED LENGTH MUST BE RESTRAINED
- IF YOUR DISTANCE BETWEEN FITTINGS IS LESS THAN OR EQUAL TO THE CALCULATED RESTRAINT LENGTH, RESTRAIN ALL JOINTS BETWEEN THOSE FITTINGS.

contact@ebaa.com 1.800.433.1716

MEGALUG®

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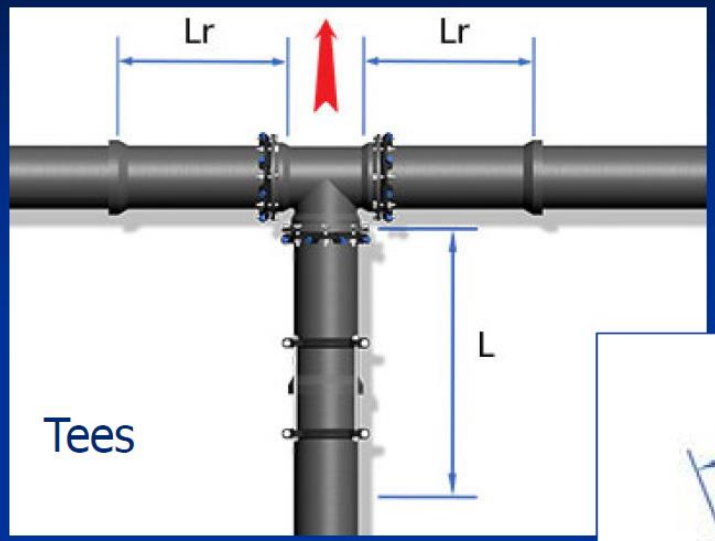
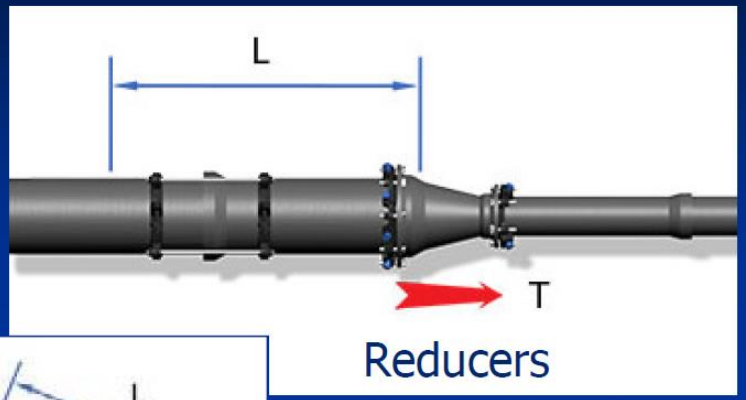
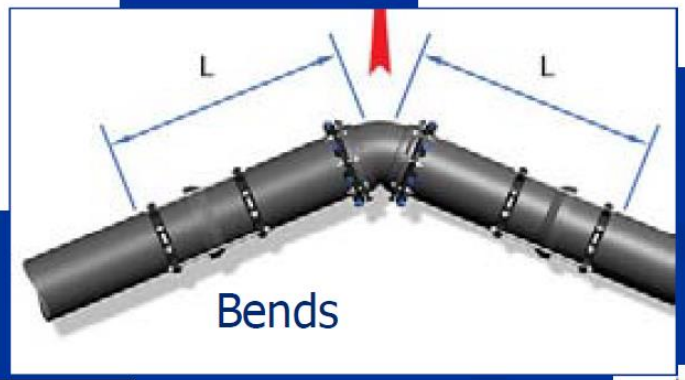
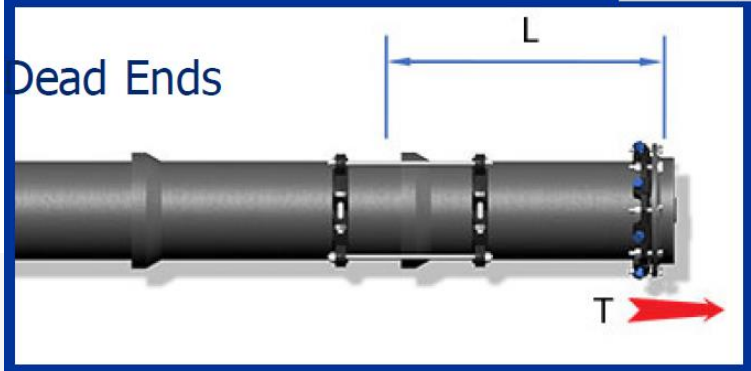
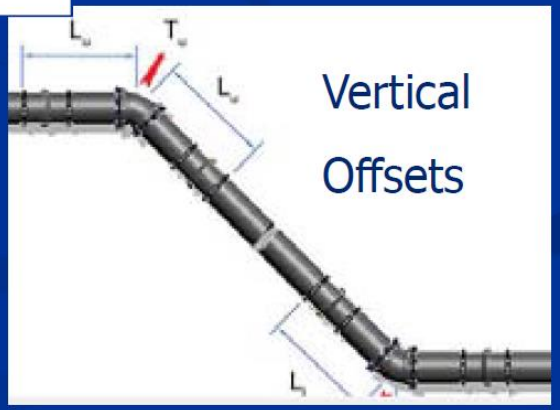
Fitting Types Supported by EBAA Software



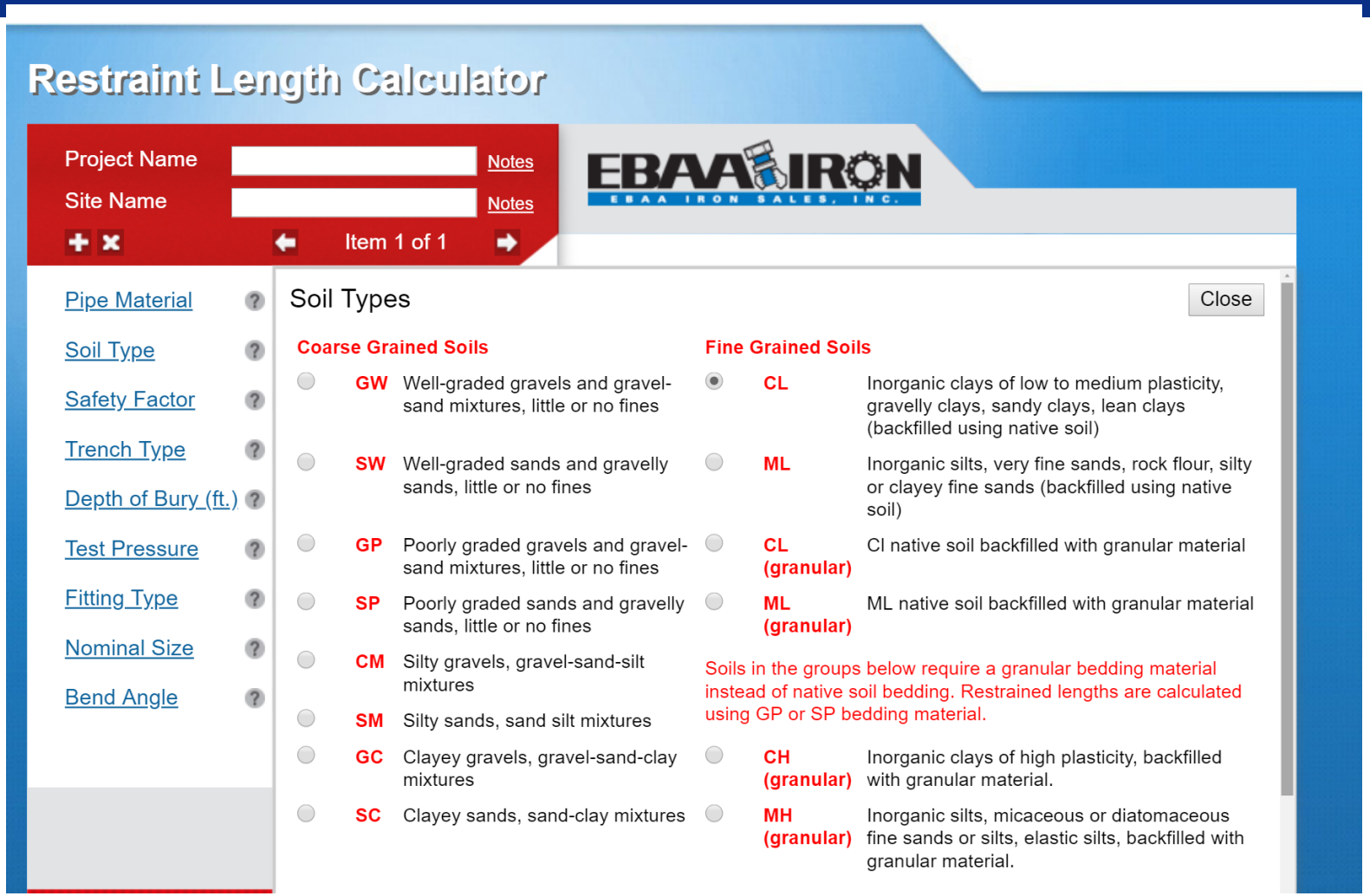








Soil Types



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Trench Type

Type 3

Pipe bedded in 4 inches minimum loose soil. Backfill lightly consolidated to top of the pipe.

Type 4

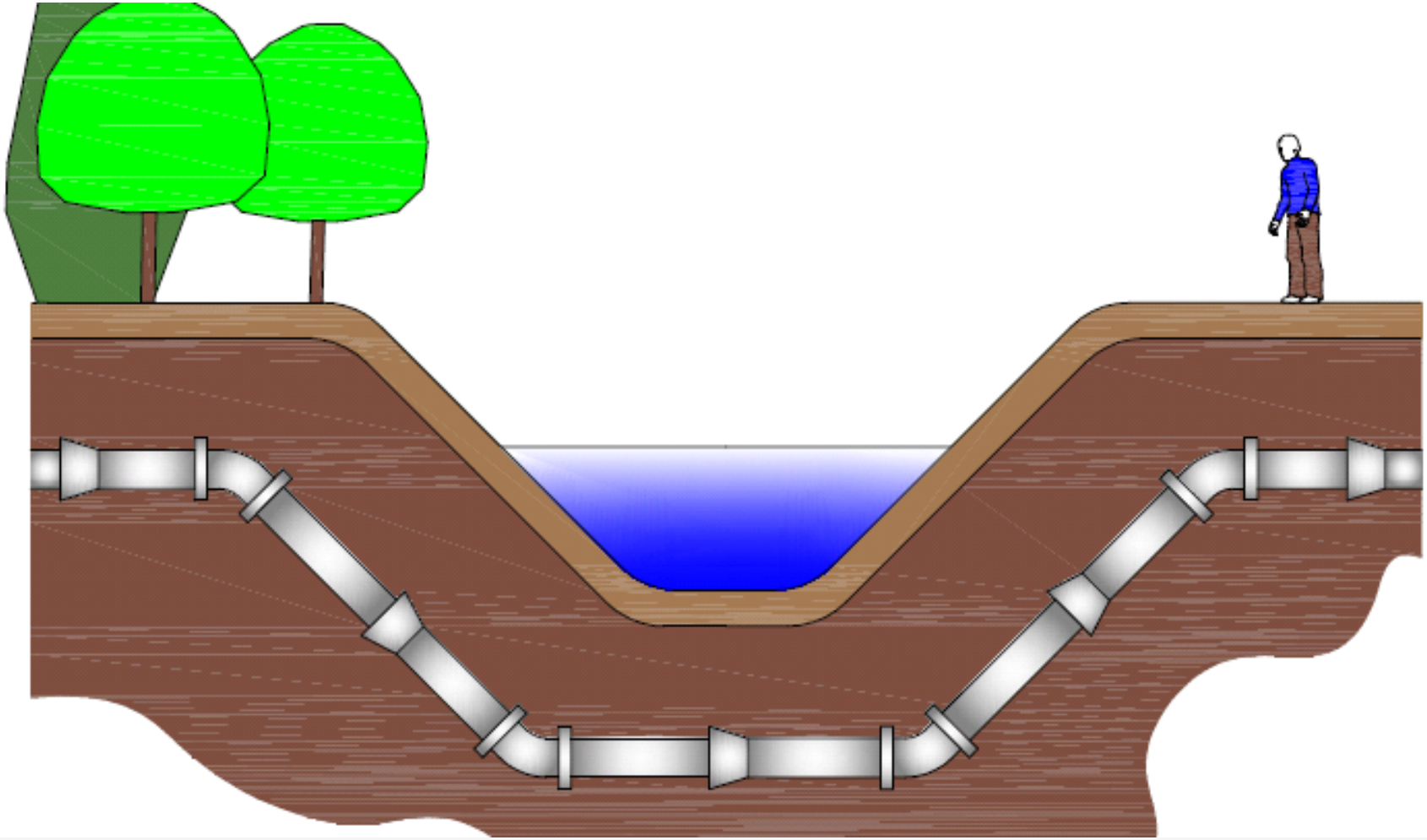
Pipe bedded in sand, gravel, or crushed stone to a depth of 1/8 pipe diameter, 4 inch minimum. Backfill compacted to top of pipe. (Approximately 80 percent Standard Proctor, AASHTO T-99)

Type 5

Pipe bedded in compacted granular material to the centerline of the pipe, 4 inches minimum under the pipe. Compacted granular or select material to top of pipe. (Approximately 90 percent Standard Proctor, AASHTO T-99)

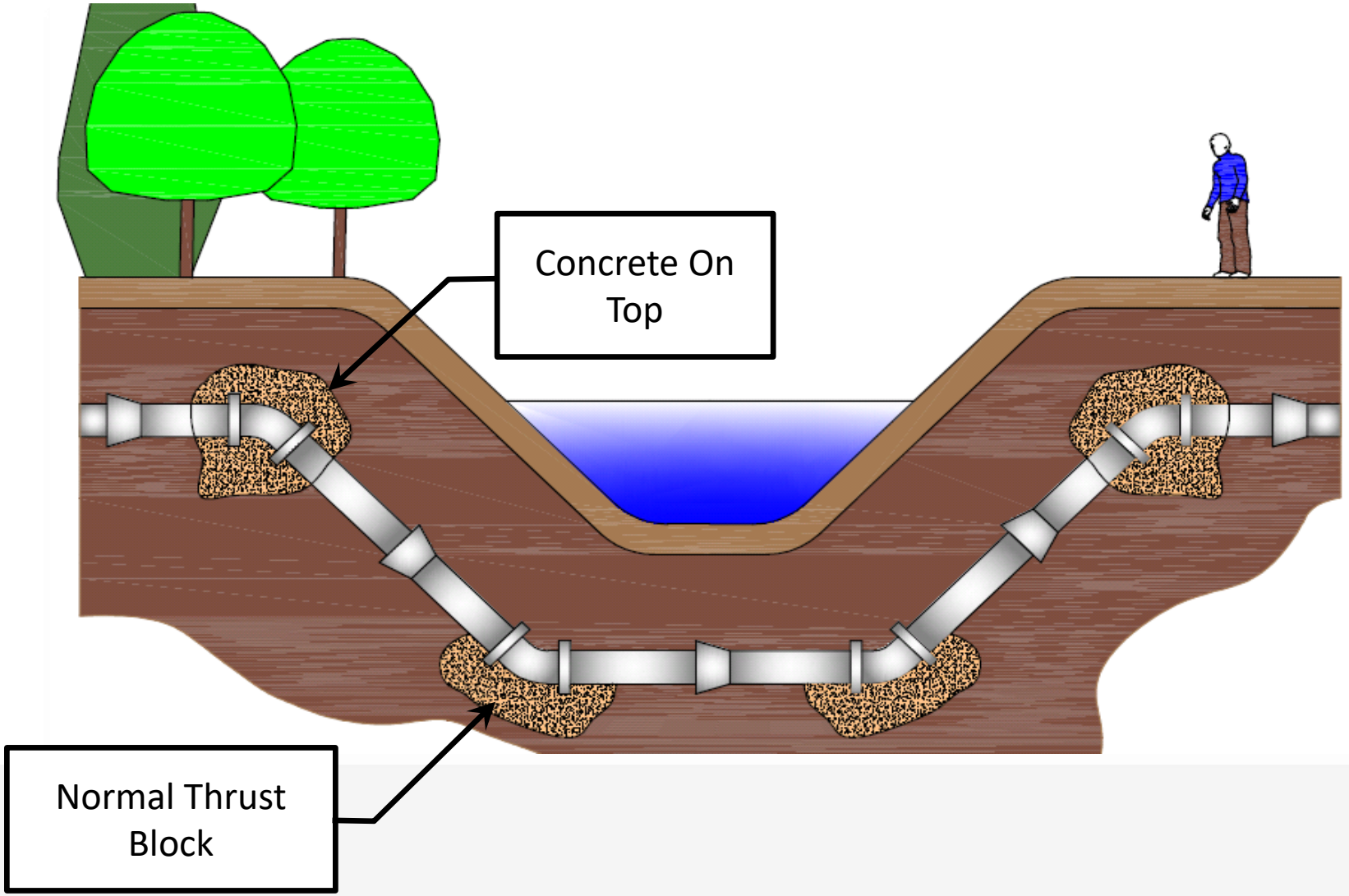
FOX engineering

Creek Crossing

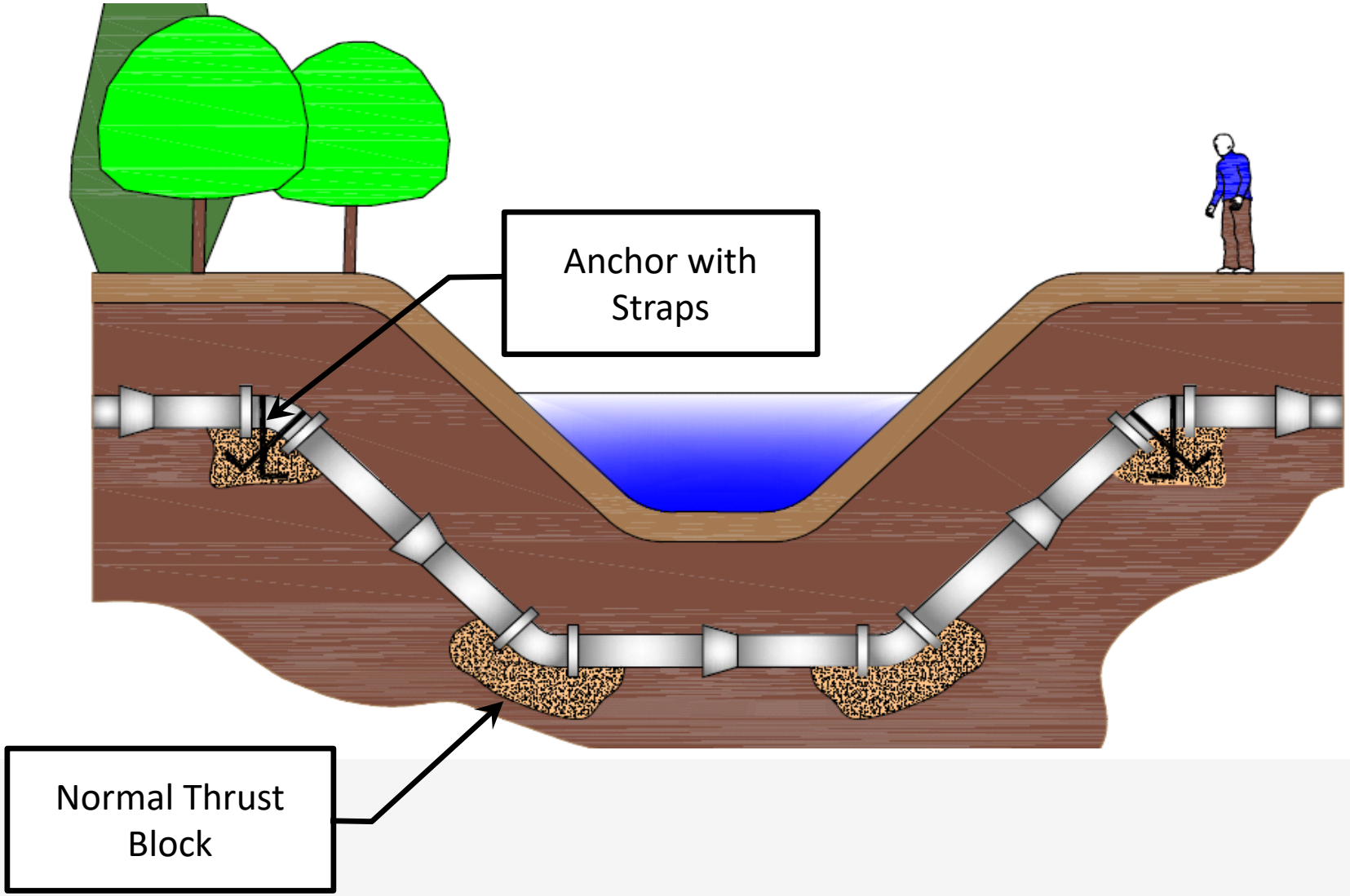


FOX engineering

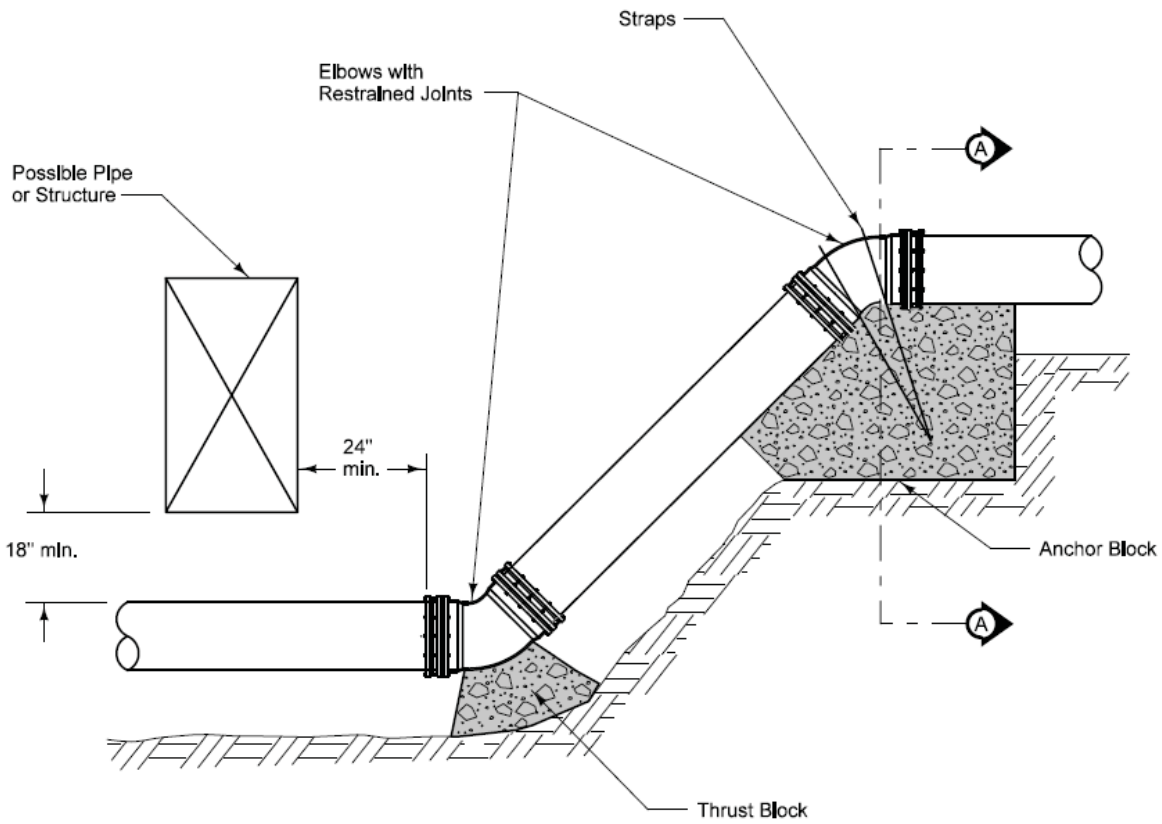
Concrete Thrust Blocks - Bad

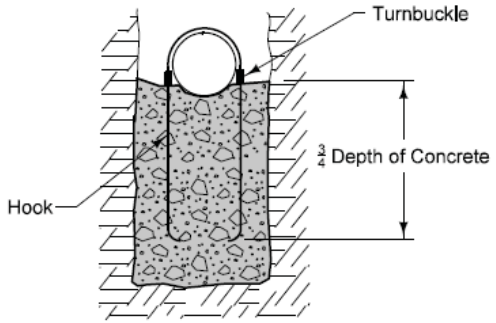


Concrete Thrust Blocks - Better



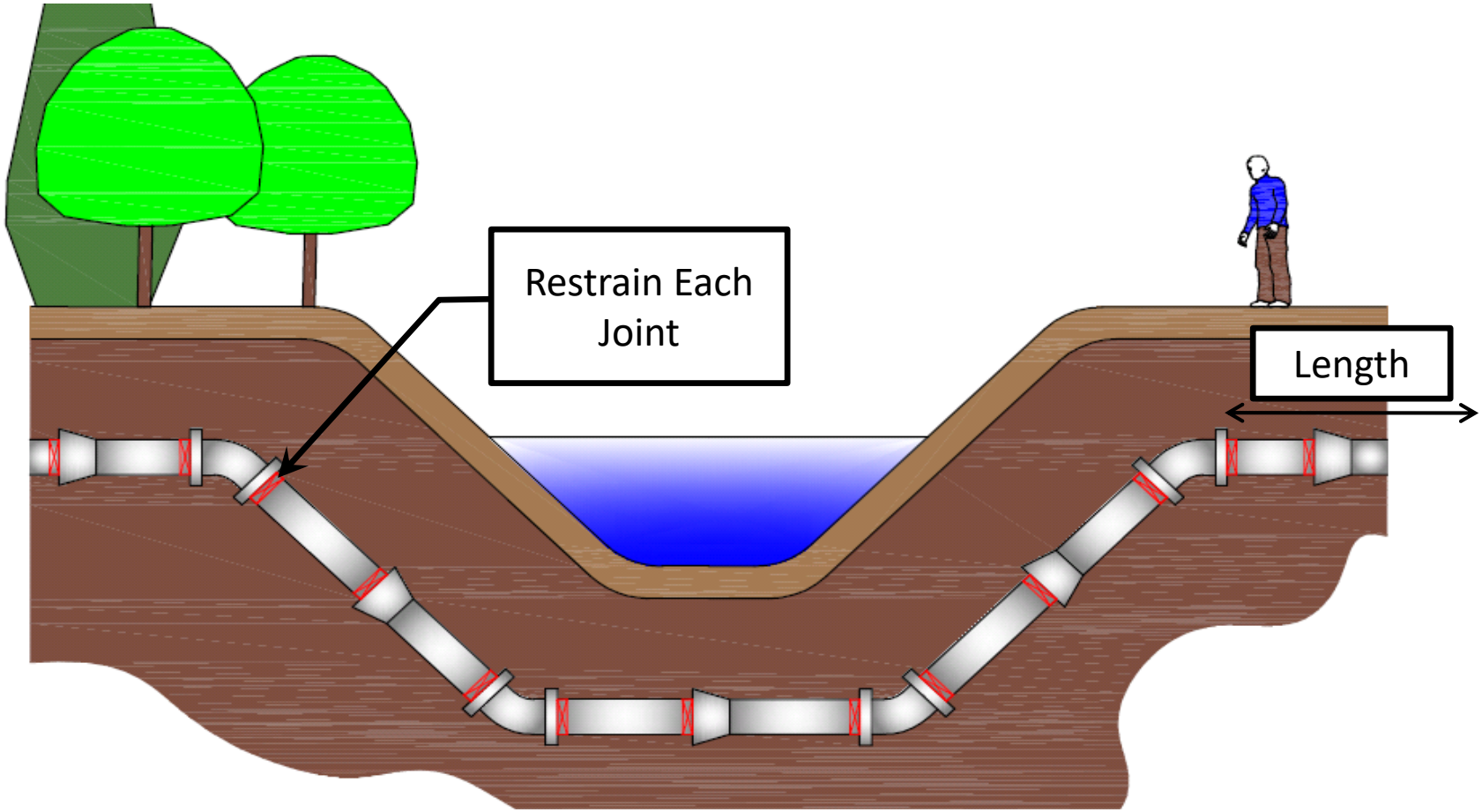
SUDAS Details





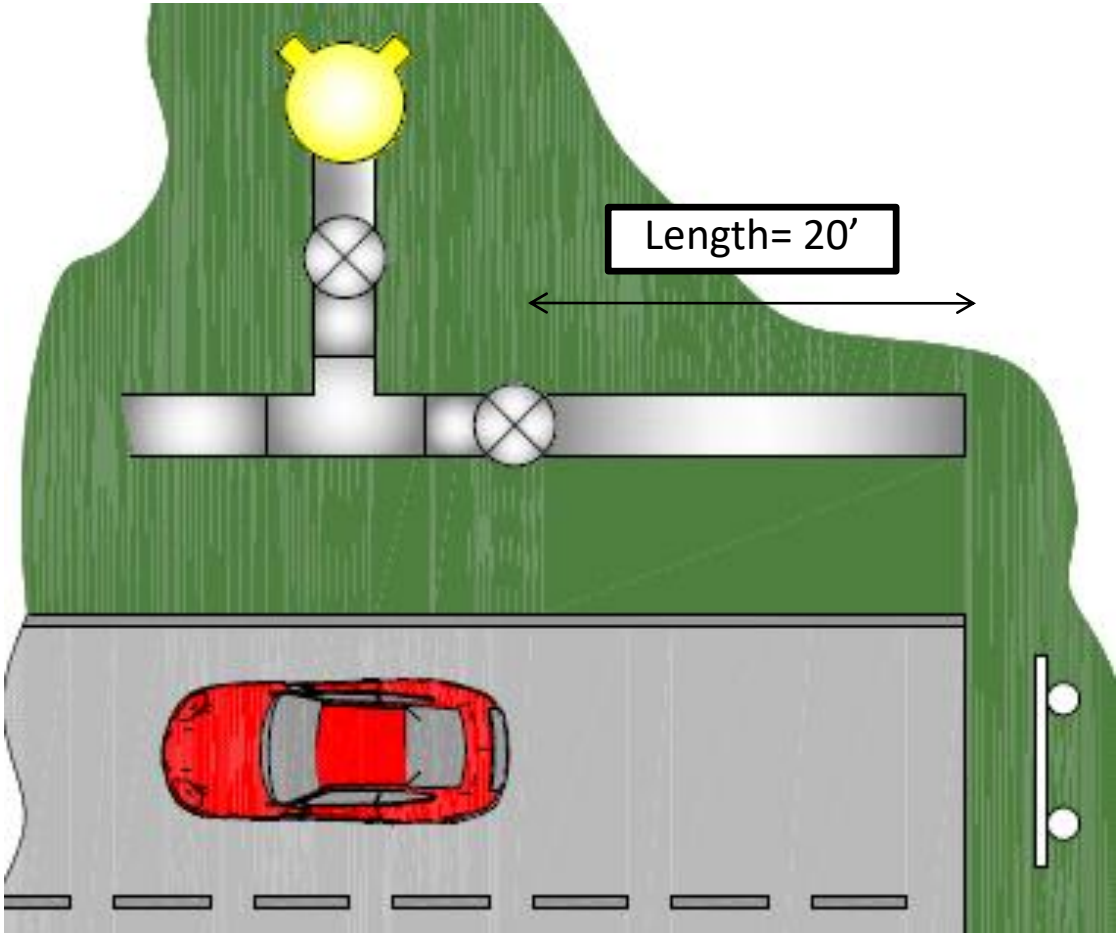
SECTION A-A

Best Solution



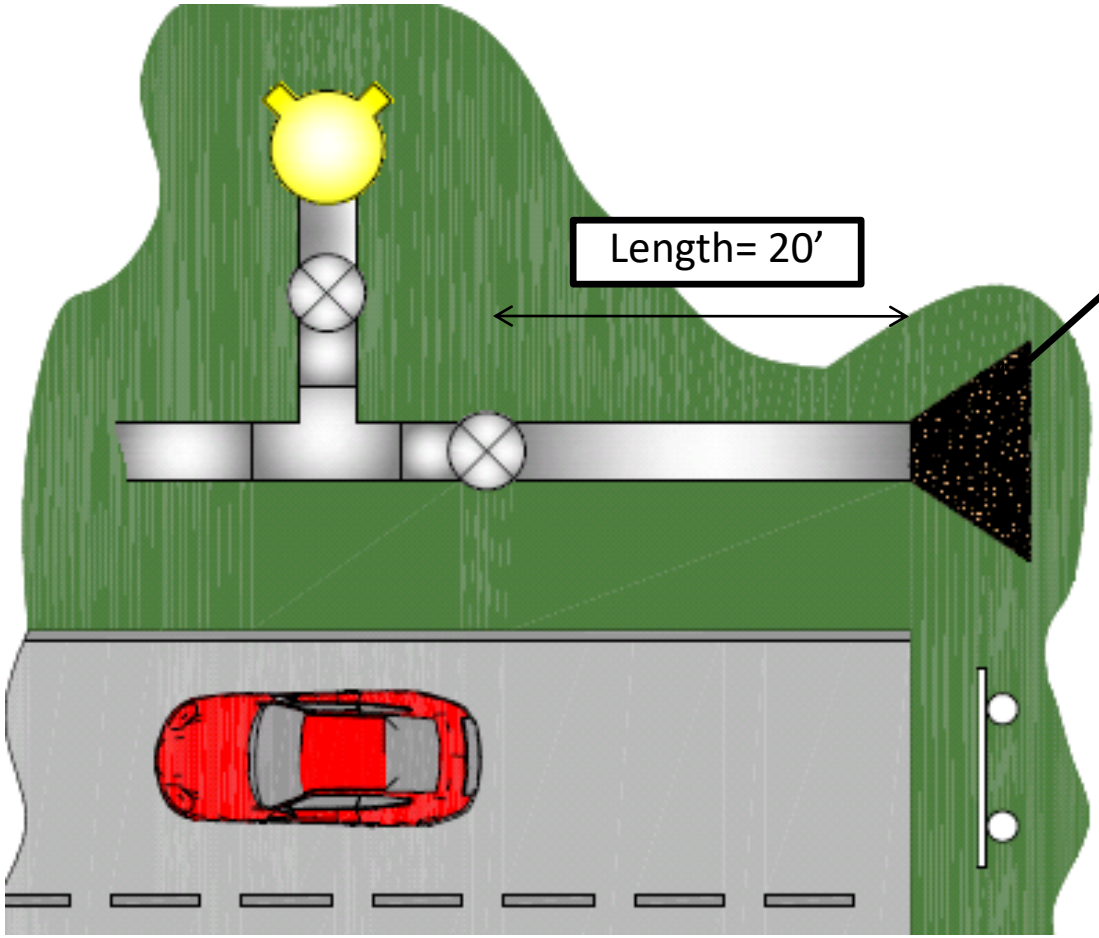
FOX engineering

Dead End Water Main



FOX engineering

Dead End Water Main - Thrust Block

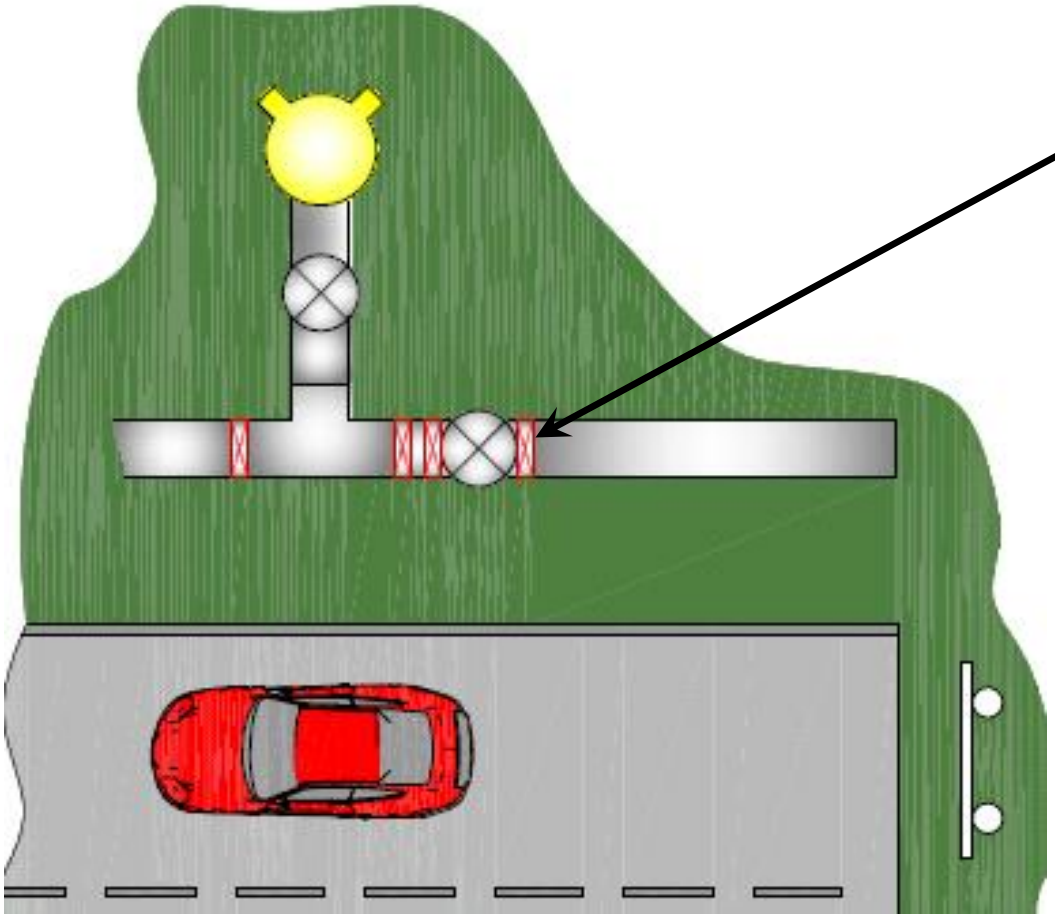


Easy Install

Extension Issues

FOX engineering

Dead End Water Main – Retrain Joints



Effective

Most Expensive

Time Consuming

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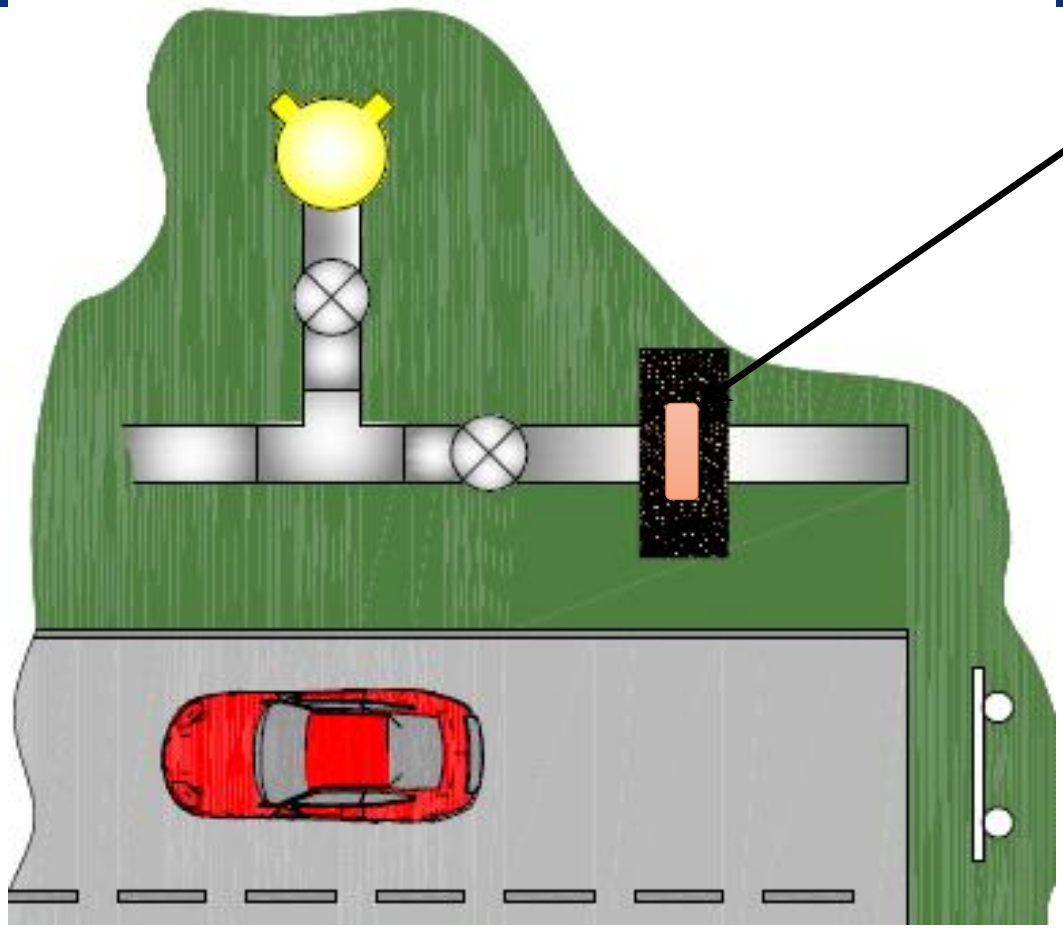
Dead End Water Main – Thrust Block & Gland



Effective

Little Expensive

No Future Removal

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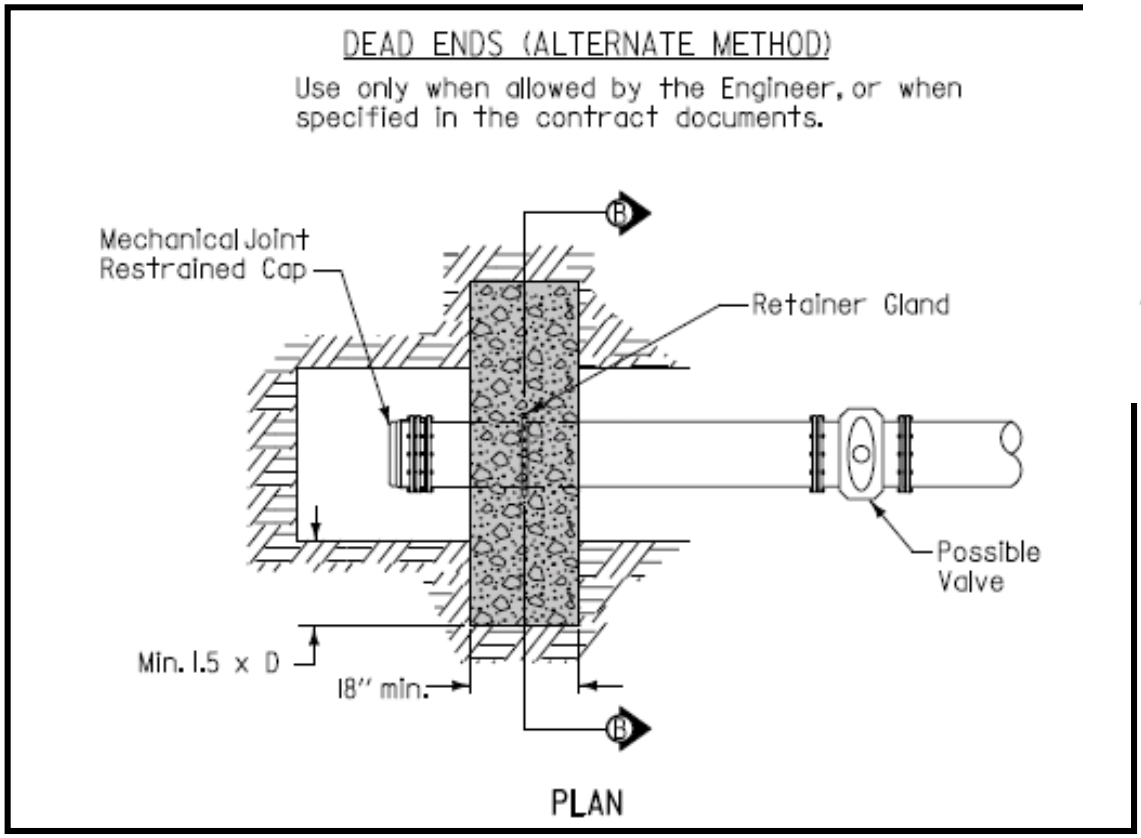
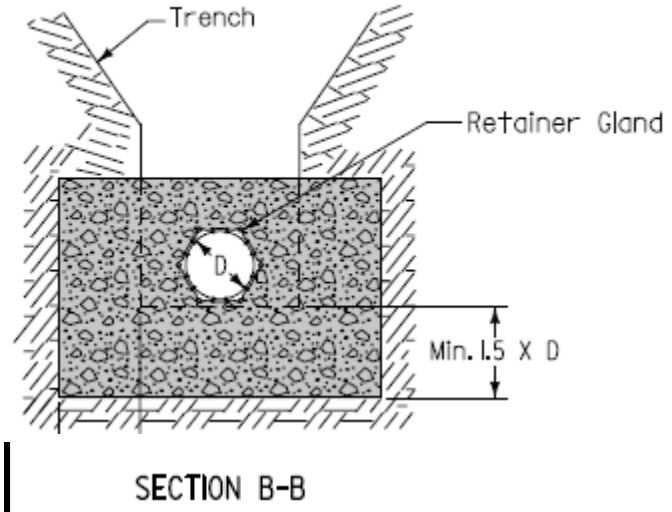
SUDAS Detail





Hydrant Thrust Restraint

Relocate Hydrant

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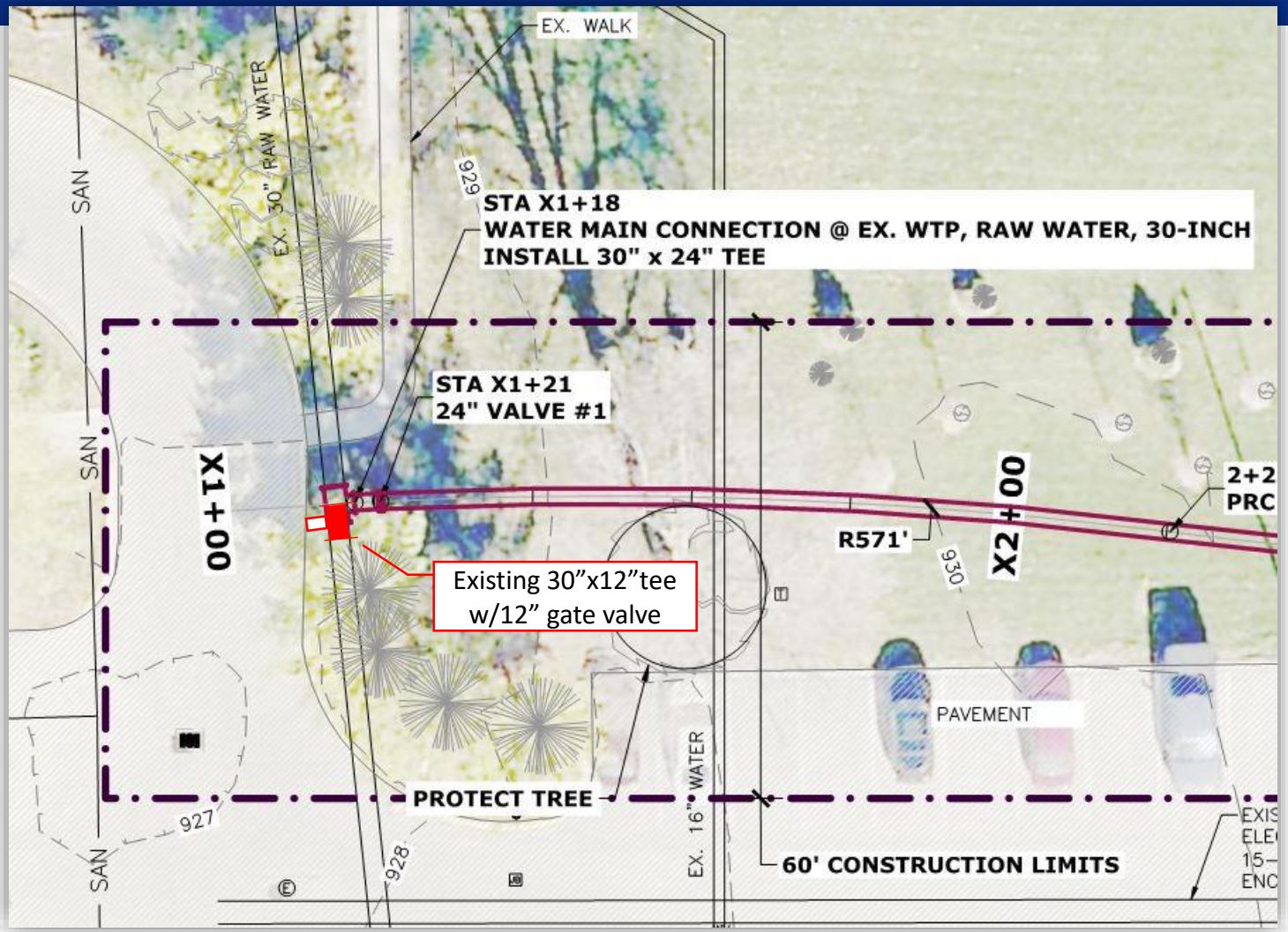
Existing Utilities, Thrust Blocks



Existing Utilities, Thrust Blocks

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Existing Utilities, Thrust Blocks

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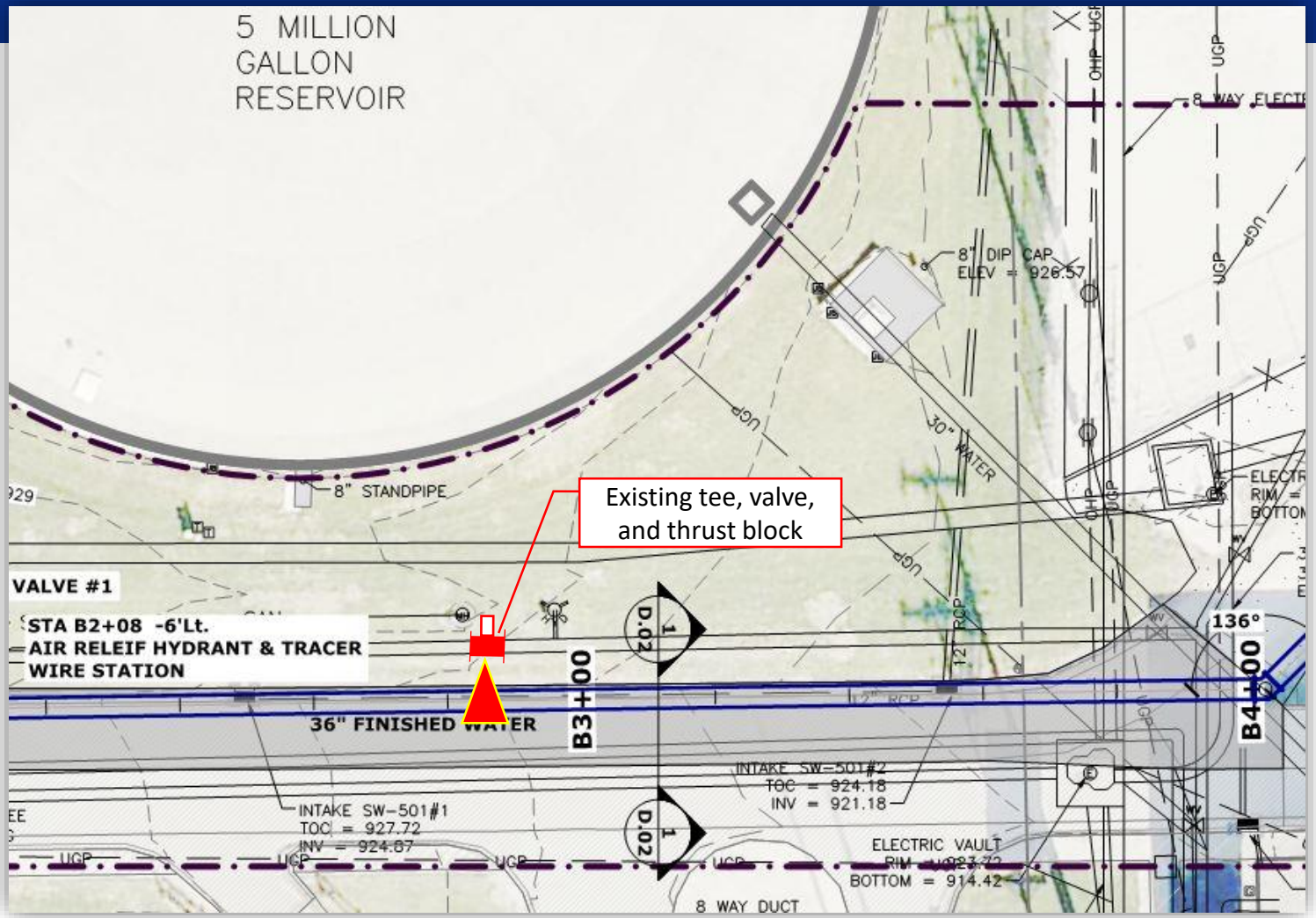
Existing Utilities, Thrust Blocks



Existing Utilities, Thrust Blocks

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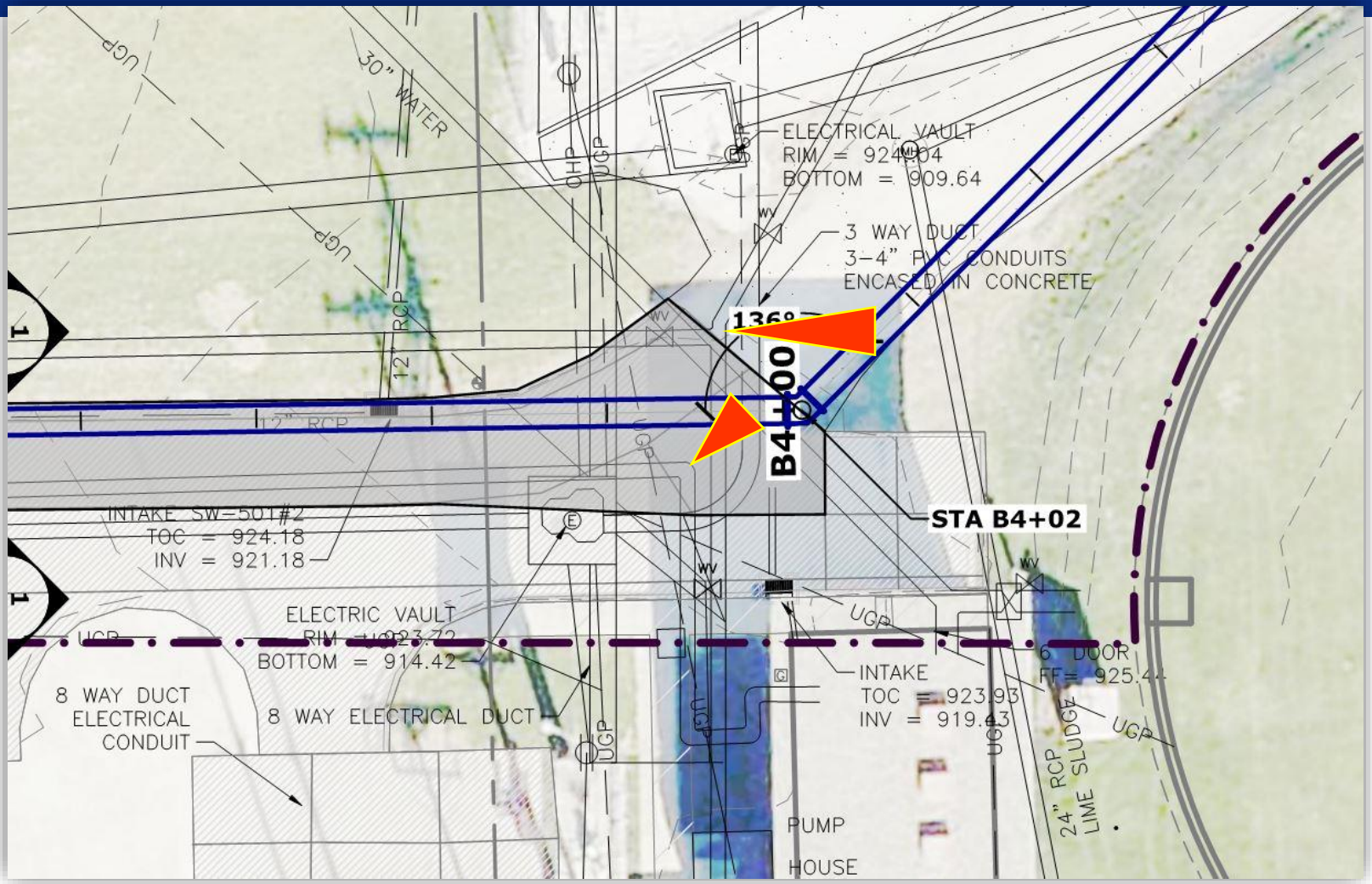
Existing Utilities, Thrust Blocks



Existing Utilities, Thrust Blocks

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Existing Utilities, Thrust Blocks

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Existing Utilities, Thrust Blocks

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Existing Utilities, Thrust Blocks

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Existing Utilities, Thrust Blocks

Existing Utilities, Thrust Blocks

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Water Main Breaks

FOX engineering

Water Main Breaks

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FOX engineering

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Engineering Tips

Trenchless & Encased Pipe – Restrain Joint Pipe

River & Utility Crossings – Restrain Joint Pipe

Vertical Bends – Restrain Gland

Engineer Specs & Plans - Restraint Length Table

Observation in Field during Construction