2010 Pipe Materials Guide

Taking a Look at the Pipe Materials Market

- Pipe Selection Guide
- 2010 Pipe Survey
- Pipe Fusion
- Case Histories

Trenchless Technology

A supplement to *Trenchless Technology*


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Editor's Message

2010 Pipe Materials Guide

It's All About the Pipe

One of the buzzwords in the water and wastewater sector over the past few years has been "sustainability." In fact, the U.S. Environmental Protection Agency developed a sustainability initiative it termed the "Four Pillars of Sustainable Infrastructure" that included: better management principles, full-cost pricing, water efficiency and watershed approaches.

But when it comes to the underground infrastructure — the collection and distribution systems — sustainability largely comes down to a decision about pipe. What pipe is best for your particular situation? What will provide the least life-cycle cost?

The question seems simple, the answer is anything but. The choice of pipe includes whether the pipe will be used for water, sewer or stormwater applications and whether it will be under pressure or gravity flow. It will depend on the installation method, which may be influenced by surface conditions (trenchless in an urban area vs. open-cut in a green field, for example). Initial cost, soil type, corrosion resistance, compatibly, ease of use, life expectancy, availability and a host of other factors combine to make the seemingly simple choice very difficult.

And there are several pipe materials from which to choose. In the trenchless realm, the most common pipe materials include concrete, ductile iron, vitrified clay, plastic (high-density polyethylene (HDPE) and polyvinyl chloride (PVC)), fiberglass, polymer concrete and steel. Here within the pages of the Pipe Materials Supplement we review the pros and cons of these different pipe types to help municipal engineers make the best decision possible to achieve sustainability.

We have enlisted the help of the major pipe associations in gathering information including the properties of the pipe and applicable standards. We have also compiled case histories that showcase how specific pipes were chosen within a given situation.

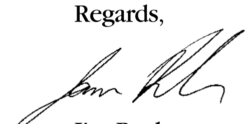
We also present for the third time our Sewer Pipe Survey. The survey was first published in 2004 and then again in 2008. By surveying municipal sewer pipe users, we attempt to gain an insight into what materials are being used and why, and what trends may be emerging related to pipe material selection.

Interestingly, the biggest problem identified by survey respondents concerning the trenchless installation of pipe was the lateral connections. In 2008, expense was identified as the biggest problem related to trenchless pipe. In terms of what operators are looking for, meeting standards and longevity/design life were the top two factors.

The results of the survey seem to reinforce the asset management approach more and more cities and utilities are taking in running their sewer and water systems — that is, achieving the least life cycle cost while meeting the basic needs of the customers (and regulators). While there are many challenges facing our sewer and water system, it appears that we are taking steps in the right direction.

We hope you find this supplement useful as you plan your sustainable sewer and water systems. As always, we value the opinions of our readers and welcome your input.

Regards,



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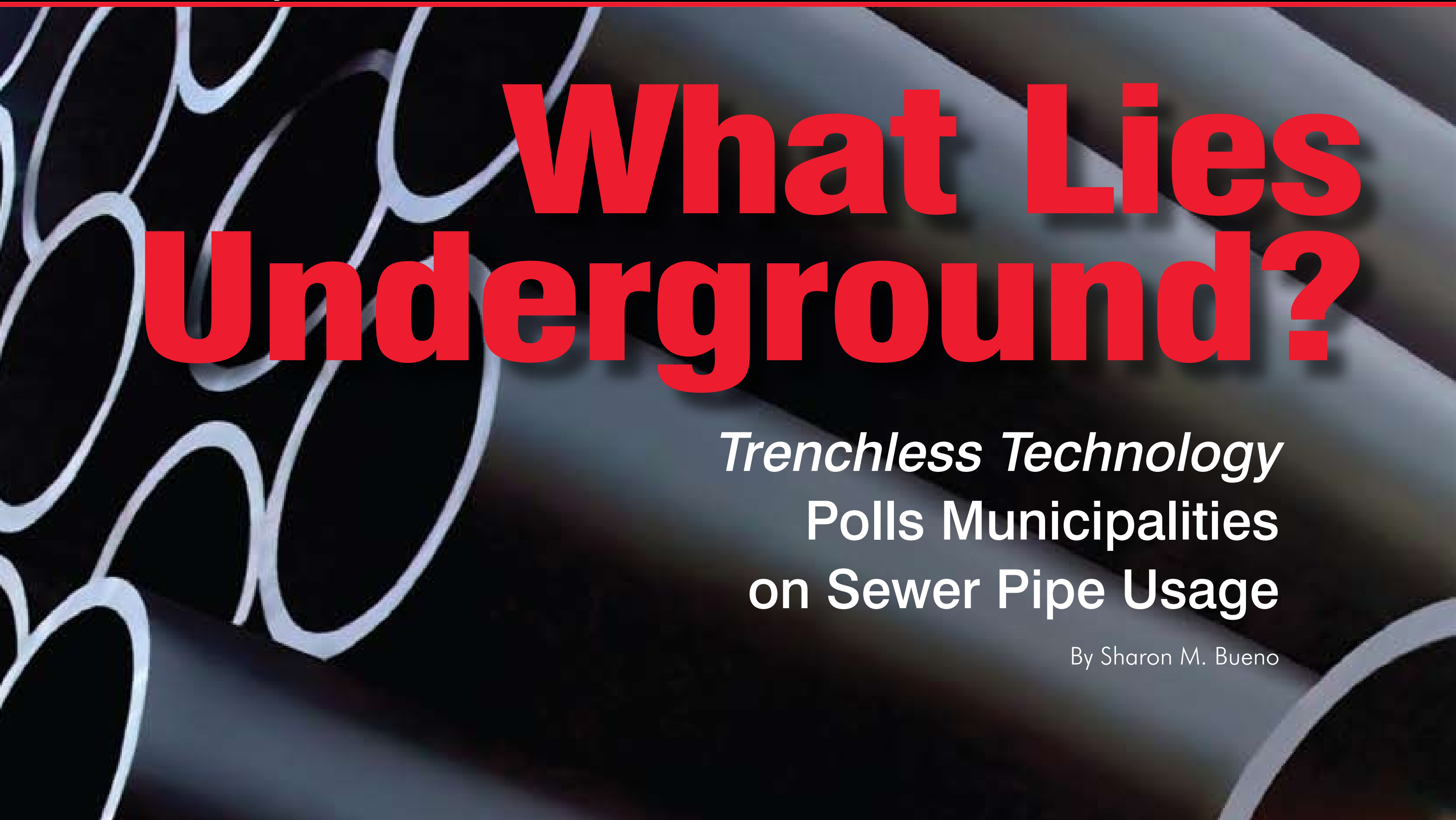


What Lies Underground?

Trenchless Technology Polls Municipalities on Sewer Pipe Usage

By Sharon M. Bueno

What type of pipe is lying beneath our landscapes across North America today? Ask that question more than 100 years ago and the likely answers would be either brick or clay, with some wood thrown in for good measure. The pipe choice back then was as narrow as the method of installation.

In 2010, choice is the word… actually multiple choice. The possibilities open to municipalities when selecting pipe and its installation method are wide open. While the aging infrastructure still contains that brick, clay or even wooden pipe, today HDPE, PVC, ductile iron, fiberglass reinforced, steel, concrete, polymer concrete and vitrified clay are all available for any given project, which may involve horizontal directional drilling, pipe bursting, sliplining or pipe jacking to name a few.

With such a plethora of options, today's sewers hold an array of pipe materials. We wanted to get a glimpse into what cities are using as their vessel to transport their wastewater, as well as what trenchless methods they are using to install or rehab their existing pipe.

In 2004, *Trenchless Technology* conducted a survey of municipalities to gauge what their pipe selections were and what criteria was most important to them when making these decisions, which costs millions of dollars. We conducted the survey again in 2008 and have asked for more information in 2010. In all three endeavors, we surveyed sewer system operators and consulting engineers from North America. Below are the results of the 2010 non-scientific poll.

(Editor's Note: For some questions, respondents were allowed to check more than one answer, making some of the percentages exceed 100 percent.)

1. How many miles of sanitary sewer are in your system?

We wanted to see how large a system our respondents dealt with and we got a wide range of answers from 25 miles to 5,000 miles. Most respondents seem to fall into the 500- to 1,500-mile range.

2. Rate the importance of the following characteristics when choosing pipe material.

The longevity and design life was the most important factor in choosing pipe, with 90 percent of respondents indicating that this was "extremely important." The second most important criterion was meeting standards at 85 percent. These two areas swapped top spots in the 2008 poll and again in 2004. Price and ease of installation had the least amount of "extremely important" responses at 38 percent, although 58 percent and 56 percent of respondents, respectively, indicated that these were "important."

3. What type of pipe do you have in your system?

PVC: ....90 percent
Clay: ....86 percent
Concrete: ....69 percent
HDPE: ....57 percent
Iron: ....54 percent
Asbestos Cement: ....50 percent
Steel: ....27 percent
Brick: ....23 percent
Fiberglass: ....17 percent
Polymer Concrete: ....15 percent
Other: ....15 percent

At 90 percent, PVC was the most commonly used pipe material among respondents in the 2010 survey, with clay a strong second at 86 percent, with a fairly large gap between it and HDPE at 57 percent. In 2008, PVC and HDPE were the top two responses, respectively. In one response in the "Other" category, wood was noted.

4. How much of your system is composed of the various pipe types?

PVC: ....90 percent
Clay: ....88 percent
Concrete: ....70 percent
HDPE: ....57 percent
Iron: ....56 percent
Asbestos Cement: ....51 percent
Polymer Concrete: ....22 percent
Iron: ....56 percent
Steel: ....33 percent
Brick: ....26 percent
Fiberglass: ....22 percent

In this question, PVC was the top response at 90 percent with clay pipe right behind it at 88 percent.

5. How old is your system?

More than 100 years old: ....44 percent
75 to 100 years: ....62 percent
50 to 75 years: ....77 percent
25 to 50 years: ....93 percent
0 to 24 years: ....88 percent

6. Do you have requirements for design life?

Yes: ....56 percent
No: ....44 percent

7. If yes, what is the minimum design life required?

More than half of our respondents noted that they require at least a 50-year design life for the pipe they select for their project. In some instances, 30 years was the response, as was 100 years.

8. Do you only accept certain pipe materials?

Yes: ....86 percent
No: ....14 percent

9. If yes, which pipe materials are accepted?

Clay: ....26 percent
Concrete: ....35 percent
Fiberglass: ....22 percent
HDPE: ....61 percent
Iron: ....38 percent
Polymer Concrete: ....19 percent
PVC: ....88 percent
Steel: ....8 percent
Other: ....8 percent

The results here were similar to the 2008 survey. With regards to underground infrastructure work, PVC was the top response at 88 percent, HDPE coming in second at 61 percent.

10. Did you receive/or will you be receiving ARRA/stimulus funding for your infrastructure work?

Yes: ....14 percent
No: ....86 percent

11. Have you changed your design life requirements in the last five years?

Yes: ....12 percent
No: ....88 percent

12. In your designs, do you specify pipe material?

Yes: ....91 percent
No: ....9 percent

The response of Yes to this question has been the overwhelmingly popular choice in our three surveys.

13: If yes, what type of pipe is the most commonly specified?

Clay:	10 percent
Concrete:	16 percent
Fiberglass:	5 percent
HDPE:	22 percent
Iron:	16 percent
Polymer Concrete:	2 percent
PVC:	79 percent
Steel:	5 percent
Other:	2 percent

PVC is the clear choice among our respondents for this question with a whopping 79 percent, compared to the second most selected answer of HDPE with 22 percent. In the 2008 poll, PVC was the top choice with 80 percent over HDPE with 36 percent. In 2004, 63 percent of respondents selected PVC and 14 percent selected HDPE.

14. What type of pipe is the easiest to maintain/rehab?

Brick:	2 percent
Clay:	17 percent
Concrete:	13 percent
Fiberglass:	4 percent
HDPE:	7 percent
Iron:	6 percent
Polymer Concrete:	1 percent
PVC:	66 percent
Steel:	4 percent
Other:	5 percent

There's little change in the top responses over 2008. PVC was selected by 66 percent of poll respondents, with clay finishing second with 16 percent, followed by concrete at 13 percent and HDPE with 7 percent. In 2008, PVC had a similar percentage with 69 percent but was followed by HDPE with 18 percent and clay at 15 percent.

15. What type of pipe is the most difficult to maintain/rehab?

Brick:	21 percent
Clay:	42 percent
Concrete:	22 percent
Fiberglass:	3 percent
HDPE:	5 percent
Iron:	8 percent
Polymer Concrete:	1 percent
PVC:	6 percent
Steel:	9 percent
Other:	8 percent

A low number is what you want for your pipe with this question. Taking the top spots with our respondents was clay pipe at 42 percent and concrete pipe at 22 percent — same positions they held in our 2008 poll. Polymer concrete pipe had the lowest percentage in 2010 and 2008 with 1 percent.

16. What percentage of your sanitary sewer system do you rehab and replace each year?

The most popular answer from our poll participants was 5 percent, with many selecting 1 to 2 percent.

17. What type of pipe achieves the longest ife cycle?

Brick:	5 percent
Clay:	22 percent
Concrete:	16 percent
Fiberglass:	2 percent
HDPE:	16 percent
Iron:	6 percent
Polymer Concrete:	2 percent
PVC:	52 percent
Steel:	2 percent
Other:	6 percent

Once again, PVC was the most selected choice, with 52 percent. Clay and HDPE swapped second and third positions from 2008 at 22 percent and 16 percent, respectively. Concrete also had 16 percent.

18. When performing trenchless applications, do you specify pipe materials?

Yes:	91 percent
No:	9 percent

This percent rose 8 percent over our 2008 poll and similar to results with our 2004 poll.

19. What types of pipe do you use for trenchless projects?

Brick:	0 percent
Clay:	10 percent
Concrete:	10 percent
Fiberglass:	22 percent
HDPE:	68 percent
Iron:	10 percent
Polymer Concrete:	9 percent
PVC:	45 percent
Steel:	7 percent
Other:	11 percent

Like our 2008 poll, HDPE was the top selection for this question, with 68 percent, followed by PVC at 45 percent. The gap between the top 2 has closed a bit over our previous poll, though, which had HDPE at 74 percent and PVC at 46 percent. This year, fiberglass leapt into the top three at 22 percent.

20. Rate the importance of the following characteristics when selecting pipe materials for a trenchless project.

In 2010, meeting standards and longevity/design life are in a virtual tie for "extremely important" factors, finishing at 74 percent and 73 percent, respectively. They finished in the same order in 2008 but had a bigger gap between — 9 percent. In 2010, these two were followed by life cycle cost at 60 percent, ease to maintain and rehab at 53 percent, ease of installation at 50 percent, compatibility at 46 percent and initial installation cost and price were both at 41 percent.

21. Does the type of pipe material required for a trenchless installation limit the use of trenchless techniques in your system?

Yes: ....35 percent
No: ....65 percent

Results for this question are on par with the 2008 results. In 2004, just more than 71 percent responded Yes to this question.

22. What is the biggest problem you face with pipe when completing trenchless installations?

Compatibility with existing system: .... 15 percent
Lateral connections: ....50 percent
Expense: ....28 percent
Longevity: ....4 percent
Pipe availability: ....6 percent
Pipe doesn't meet local codes: ....4 percent
Twisting: ....10 percent
Other: ....24 percent

Making the proper lateral connections finished first with this question, with 50 percent, followed by expense at 28 percent. Among the "Other" responses were: client acceptability, pipe movement over time, finding qualified installers, and future repairs.

Sharon M. Bueno is managing editor of *Trenchless Technology*.

Choosing Your Pipe

2010 *Trenchless Technology* Pipe Selection Guide

By Sharon M. Bueno

When it comes to selecting pipe for your trenchless application, there is no shortage of options — steel, iron, clay, concrete and plastic. Given the plethora of choices, the decision of which pipe to use for your project can be daunting. What you need is information on what each pipe brings to the table.

To help you out, *Trenchless Technology* contacted pipe associations and manufacturers of the eight pipes typically used in trenchless projects to point out what their particular conduit offers. The information presented is intended to provide just a preliminary glimpse at the different pipe on the market. For more detail information, please contact the manufacturer, pipe association or your consulting engineer.

All information presented was provided by the various pipe associations or manufacturers.

Sharon M. Bueno is managing editor of *Trenchless Technology*.

Concrete Pipe

Trenchless Applications: Jacking and microtunneling

Best Suited For: Jacking and microtunneling applications where pipe with high strength is needed for the jacking forces. Box culvert sections can be used for applications where square or rectangular shapes may be more beneficial, such as low clearance areas, pedestrian tunnels, etc.

Ill Suited For: Concrete pipe is not suited for applications having high internal pressure.

How It Is Delivered: Pre-cast concrete pipe is delivered in precast units that are ready for installation.

How It Is Joined: Pre-cast concrete pipe used for trenchless applications typically has a bell and spigot joint utilizing a rubber gasket.

Available Diameters: Circular reinforced concrete pipe is available in sizes from 12 to 144 in. Elliptical and Arch shapes are also available for locations with limited vertical or horizontal clearance. Additionally, square and rectangular shapes are available in standard dimension up to 12 ft by 12 ft, with larger nonstandard sizes also available.

Design Life: Concrete pipe has a proven design life in excess of 100 years.

Applicable Standards: ASTM C 14 (AASHTO M 86) Nonreinforced Concrete Pipe; ASTM C 985 Nonreinforced Concrete Pipe, Specified Strength; ASTM C 76 (AASHTO M 170) Reinforced Concrete Pipe; ASTM C 655 (AASHTO M 242) Reinforced Concrete Pipe Specified Strength; ASTM C 506 (AASHTO M 206) Reinforced Concrete Arch Pipe; ASTM C 507 (AASHTO M 207) Reinforced Concrete Elliptical Pipe; ASTM C 1433 Reinforced Concrete Box Culverts; ASTM C 1577 Reinforced Concrete Box Culverts; ASTM C 443 (AASHTO M 315) Joints for Concrete Pipe and Manholes; and ASTM C 1628 Joints for Concrete Pipe.

Latest Development over the Last Five Years: The concrete pipe industry continues to enhance its product through new innovations in concrete admixtures and production automation to develop a quality product with durable performance. Recently, the LRFD Design Requirements have been incorporated into the box culvert standards, and low head pressure pipe requirements are being updated.

What Is Notable about Your Pipe: Precast concrete pipe can be supplied in a variety of sizes, shapes, and strengths. Thus, when you use precast concrete pipe you can worry less about conforming to the products limitations, and more about performing to your expectations.

Source: American Concrete Pipe Association
Web: *www.concrete-pipe.org*

Ductile Iron Pipe

Trenchless Applications: Horizontal directional drilling, pipe bursting, microtunneling and pipe jacking.

Best Suited For: :Installations that require the pipe to have tremendous columnar and tensile strengths, gravity to high pressure applications and installations that require a robust/strong pipe.

How It Is Delivered: Normally, 18- or 20-ft lengths; however, shorter lengths can be obtained by cutting the pipe.

How It Is Joined: Push-on gasketed joints with allowable deflection up to a 5-degree deflection. Push-on flexible restrained gasketed joints.Other proprietary compression ring gasketed joints that facilitate trenchless applications.

Available Diameters: 3- to 64-in. diameter (3-, 4-, 6-, 8-, 10-, 12-, 14-, 16-, 18-, 20-, 24-, 30-, 36-, 42-, 54-, 60- and 64-in. diameters).

Design Life: Indefinite when properly installed.

Applicable Standards: ANSI/AWWA C150/A21.50 – Thickness Design of Ductile-Iron Pipe
ANSI/AWWA C151/A21.51 – Ductile-Iron Pipe, Centrifugally Cast, For Water
ANSI/AWWA C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C104/A21.4 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ASTM A746 – Ductile Iron Gravity Sewer Pipe
ASTM A716 – Ductile Iron Culvert Pipe
ANSI/AWWA C105/A21.5 – Polyethylene Encasement for Ductile-Iron Pipe Systems
ANSI/AWWA C110/A21.10 – Ductile-Iron and Gray-Iron Fittings for Water
ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings for Water Service
ANSI/AWWA C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances.

Latest Development Over the Last Five Years: In the past five years, the ductile iron pipe industry partnered with Corrpro and developed a risk-based matrix for determining the appropriate corrosion control for ductile iron pipe. Also, the application of ductile iron pipe for horizontal directional drill applications has developed.

What Is Notable About Your Pipe: Successful trenchless installations have firmly established ductile iron pipe as a viable, and in many instances superior, pipe option. The advantages of using ductile iron pipe for trenchless installations include:

1. Standard pressure capabilities up to 350 psi (greater upon special request).
2. Great material strength for handling pull-back, column, and external dead and live loading.
3. Better distribution of thrust or pulling forces around the bell and barrel.
4. Greater allowable pulling forces than other pipe options.
5. Generous allowable joint deflections.
6. Quick, easy joint assembly.
7. “Cartridge” installation option for limited easements or ROW.
8. Can be located from surface with commonly used locators.
9. Performance capabilities are not impacted by elevated temperatures.
10. Material strength which does not creep or decrease with time.
11. Pipe wall impermeable to volatile hydrocarbons, minimizing the potential of water system contamination in the present or future.
12. No significant residual bending stresses that could adversely affect future serviceability including tapping remain in the pipe after the pull-back.
13. No significant “recoil” and minimal pipe movement due to thermal expansion.
14. Eliminates potential for shearing of tapped lateral outlets due to thermal expansion and contraction.

With the increasing demand for water and wastewater infrastructure and a movement to reduce the social-economic impact on rate payers that is often associated with open-cut construction, trenchless installation will certainly play an increasing role. For these installations, public works personnel and contractors have the option of installing superior ductile iron pipe.

Source: Ductile Iron Pipe Research Association
Web: *www.dipra.com*

Fiberglass Reinforced Pipe

Trenchless Applications: Sliplining, microtunneling, directional drilling, pipe jacking, pipe bursting, tunnel lining and casings.

Best Suited For: Potable water transmission, force main or gravity sewer systems and all applications where there is a corrosive carrier or external environment.

Ill Suited For: Gas transmission and other hydrocarbon transmission lines.

How It Is Delivered: The typical delivered length is 20 ft; however both short sections (e.g., 5 ft and 10 ft) and longer lengths of up to 40 ft are available to minimize the number of joints.

How It Is Joined: Fiberglass pipe utilizes a number of different gasket-sealed joints. Typically the pipe joints are push-together coupling or bell-spigot joints. Restrained joints are available from some manufacturers for curved or otherwise stressed pipe sections.

Available Diameters: The pipe is available from 18 to 158 in. in diameter, depending on the manufacturer.

Design Life: In excess of 50 years.

Applicable Standards: ASTM D3262 for gravity systems and AWWA C950 for pressure applications. Fiberglass pipe can be utilized in a wide range of service conditions. Extreme cold does not affect the material and the pipe can be manufactured for operating temperatures up to 180 F and pressures up to 250 psi. Each pipe is designed for soil burden, external water pressure and live loading conditions. The pipe is extremely repairable and easy to modify in the field should conditions warrant. Hydraulic analysis shows superb flow characteristics, Manning's of n=0.009 and Hazen Williams of C=155. In addition, the pipe is extremely abrasion resistant.

Latest Development Over the Last Five Years: The U.S. market entry of additional municipal and industrial fiberglass pipe and manhole manufacturers to provide the capacity to serve an emerging large diameter pipe market. The Fiberglass Tank & Pipe Institute represents the following manufacturers listed alphabetically: Ameron International, Containment Solutions Inc., Fiber Glass Systems, Hobas Pipe USA and L. F. Mfg. The Institute website *www.fiberglasstankandpipe.com* maintains a direct link to these manufacturers.

What Is Notable About Your Pipe: "Fiberglass pipe is gaining in market presence due to its many benefits. When leak-free joints, inherent corrosion resistance, superior hydraulic characteristics and long life service are taken into account, fiberglass is a clear winner. There are cost-savings that accrue over the lifetime of the product due to lower maintenance and extended life expectance over competitive materials. However, cost-savings begin at installation savings from reduced onsite handling costs (i.e., high strength/weight ratio pipe) and reduced labor and installation time (i.e., longer pipe with fewer joints). Fiberglass pipe is an engineered product that may be custom manufactured with fiberglass manways and fittings to meet the most difficult jobsite applications." Sully Curran P.E., executive director, Fiberglass Tank & Pipe Institute.

Source: Fiberglass Tank & Pipe Institute
Web: *www.fiberglasstankandpipe.com*

High Density Polyethylene (HDPE)

Trenchless Applications: Horizontal directional drilling, pipe bursting, sliplining, plow and plant, submerged or floating pipe and others.

Best Suited For: All underground utilities including gas, water, sanitary sewer, electrical and communication duct, storm sewer, water service connection. Industrial applications where abrasion, corrosion and chemical resistance is critical.

Ill Suited For: Due to the wide applications HDPE pipe can be used in, consultation with the manufacturer for specific applications is encouraged.

How It Is Delivered:. Polyethylene pipe is produced in straight lengths up to 50 foot long and coiled in diameters up through 6 in. Coiled lengths over 1,000 ft are available depending on size. Corrugated pipe is normally produced in 20-ft lengths although other lengths are available.

How It Is Joined: Heat Fusion is the preferred method of joining. However, pipe can be either heat fused or mechanically joined with a variety of couplings; flange adapter; MJ adapter. Bell and spigot for corrugated pipe.

Available Diameters: 1/2 to 65 in. (solid wall); 2 to 60 in. (corrugated); up to 120 in. for spiral-profile wall and ½ to 3 in. for crosslinked PE (PEX) pipe.

Design Life: The polyethylene pipe industry estimates a service life for HDPE pipe to conservatively be 50-100 years.

Applicable Standards: AWWA C901 for PE water service lines; AWWA C904 for PEX water service lines; AWWA C906 for PE water distribution and transmission lines; AWWA Design Manual M55; Various ASTM standards including but not limited to F1962, F2620, D3035, D2737, D2239, D2774, F877, F876, , F477, F2306 and D2321. NSF Standard 14 "Plastic Piping components and related material;" NSF Standard 61 "Drinking Water System Components;" Factory Mutual Standard "Plastic Pipe and Fittings for Underground Fire Protection Service," FM1613. ISO Technical Committee 138; AASHTO M294, M252; PPI TR33.

Latest Developments over the Last Five Years: Development of high performance polymers such as PE4710: Properties include higher tensile strength, stiffness, compressive strength, pressure rating and exceptionally high resistance to slow crack growth.

What Is Notable About Your Pipe: "As municipalities face the daunting task of replacing their crumbling underground infrastructure they are finding a highly economical and sustainable choice in HDPE pipe. With a low carbon footprint and long service life, HDPE pipe is the preferred material for trenchless installation in water, waste water, gas and utility systems. Based on factors such as the pipe's strength, durability, joint integrity and long-term cost-effectiveness corrugated HDPE pipe continues to demonstrate its environmental benefits for storm water management systems," Tony Radoszewski, executive director, Plastic Pipe Institute.

Source: Plastics Pipe Institute
Web: *www.plasticpipe.org*

Polymer Concrete

Trenchless Applications: Microtunneling, pipe jacking, one-pass tunnel segments, structures/shafts for tunnel construction.

Best Suited For: For sanitary sewer or industrial sewer service where conditions require corrosion protection.

Ill Suited For: Currently, polymer concrete pipe is not designed for or approved for pressure of potable water applications.

How It Is Delivered: Pipe is typically delivered in 8- or 10-ft lengths by means of truck, closed container for ocean freight or rail. One-meter lengths are available for pilot tube installation methods.

How It Is Joined: Standard joint for jacking installations incorporates a double spigot joint joined by a flush compression fit fiberglass or stainless steel collar The collar mates against the gasket firmly joined to the pipe wall.The joint meets the requirements of several ASTM standards.

Available Diameters: Polymer concrete pipe is available in diameters ranging from 8 to 144 in.

Design Life: Polymer concrete pipe has a projected 100-year plus service life.

Applicable Standards: ASTM D6783. Other standards including ASTM C-76 and AWWA design methods can be used.

Latest Development over the Last Five Years: Production capacity of polymer concrete pipe and products has increased significantly in recent years. Product availability in several geographic locations will translate into freight savings for owners.

What Is Notable About Polymer Concrete Pipe: "In choosing a pipe material, owners have found that polymer concrete pipe, with its unique physical properties, combines the best attributes of the leading pipe materials-inherent corrosion resistance of FRP pipe along with the rigid properties of reinforced concrete pipe. Years back when we first introduced the reinforced polymer concrete pipe to the market we often described polymer concrete pipe as a hybrid to those unfamiliar with the product. Nowadays, everyone is much more familiar with polymer concrete and our product availability has increased significantly even in the last couple years with added production capacity in North America," Mike Olson, Polycast Structures Inc./Interpipe.

Source: Polycast Structures Inc./Interpipe
Web: *www.polymerpipe.com*

Polyvinyl Chloride (PVC)

Trenchless Applications: Segmental sliplining, directional drilling, close-fit pipe lining and pipe bursting.

Best Suited For: Buried water, buried reclaimed water, buried force mains, buried sanitary sewer and buried storm sewer.

Ill Suited For: Extremely high temperature applications where the temperature of the fluid conveyed in consistently greater than 140 F. Extremely high-pressure applications where the pressure consistently exceeds 300 psi.

How It Is Delivered: Standard lengths for pressure pipe are 20 or 22 ft. Sewer pipe lengths can be 13, 14 or 20 ft long. The pipe is sent bundled and is provided straight.

How It Is Joined: Slipliner pipe has a gasketed joint. Close-fit and pipe bursting is butt fused. HDD uses butt fusion, a spline-locked gasketed coupler or a bell-and-spigot joint locked together with steel pins.

Available Diameters: Gasketed PVC pipe starts at 1.5 in. and is available up to 60 in. for gravity sewer and up to 48 in. for pressure pipe.

Design Life: A properly designed, installed and operated system will last well in excess of 100 years.

Applicable Standards: Pressure Pipe and Fittings: ASTM D2241, AWWA C900, AWWA C905, AWWA C907 and AWWA C909. Sewer Pipe and Fittings: ASTM D3034, ASTM F679, ASTM F794, ASTM F949 and ASTM F1803.

Latest Developments Over the Last Five Years: Manufacturing improvements have increased the size range available for PVC pipe. Technological advancements have made possible the option of butt fusing in the field, which has opened a number of trenchless applications. Innovations have resulted in alternative joint designs more suitable for sliplining, as well as directional drilling and pipe bursting.

What Is Notable About Your Pipe: "PVC is the proven material when performance counts. It has an impressive track record for longevity, durability, low maintenance and ease of assembly. Owners attribute its exceptional performance to its corrosion resistance, chemical resistance and deep-insertion, bell-and-spigot, gasketed joints," said Craig Fisher, technical director for the Uni-Bell PVC Pipe Association.

Source: Uni-Bell PVC Pipe Association
Web: *www.uni-bell.org*

Steel Pipe

Trenchless Applications: Directional drilling, jack-and-bore and pipe ramming.

Best Suited For: Water and wastewater transmission, gas and oil transmission, water well casing, pile driving and caisson sleeves.

Ill Suited For: Chemical or corrosive service without internal or external protective coatings.

How It Is Delivered: Steel pipe is generally supplied in laying lengths 20 ft to 60 ft. Some diameters of pipe can be manufactured in lengths up to 120 ft or longer without a girth mid-weld.

How It Is Joined: The most common method of assembling steel pipe is by field welding or bell and spigot joints with rubber O-ring gaskets, other methods include threading-and-coupling or compression fittings.

Available Diameters: Steel pipe is available in diameters 4 in. and larger with virtually an unlimited choice of fitting and special fabrications possible.

Design Life: The design life of steel pipe is based on the mechanical strength of steel which is fully elastic and not time dependent. If properly installed, with the appropriate lining and coating, steel pipe with the addition of electrical bonding and cathodic protection (if required) can last indefinitely

Applicable Standards: AWWA standards include C200 and Manual of Standard Practice for the Design and Installation of Steel Water Pipe M11, ASTM standards for steel pipe include A53, A106 A139, A252. The most common API standard for steel pipe is API 5L.

Latest Developments over the Last Five Years: "The performance resume for steel pipe dates back to the early 1850s. This experience in pressure applications for water, gas, and other petroleum fluids cannot be matched by any other pipe material, particularly those made from plastic materials that are visco-elastic where the material strengths erodes overtime. Steel pipe with its' simple, straightforward design procedure, and pragmatic installation requirements, is also finding its' way into project specifications once dominated by pipes of composite construction. Member companies are certified for the SPFA Certification program by Lloyd's Register Quality Assurance. This provides owners and engineers with assurance that their steel pipe is manufactured is strict accordance with applicable AWWA, ASTM, and other standards and industry accepted practices.

Source: Steel Plate Fabricators Association, Steel Pipe Division
Web: *www.steeltank.com*

Vitrified Clay Jacking Pipe

Trenchless Applications: Pilot tube microtunneling, slurry microtunneling, static pipe bursting and sliplining casing.

Best Suited For: Gravity flow sanitary sewers.

Ill Suited For: Pressure applications.

How It Is Delivered: VCP is available in a variety of stock or custom lengths, depending on diameter. The maximum length is 10 ft.

How It Is Joined: Low-profile compression joints utilizing stainless steel collars.

Available Diameters: 8- to 48-in diameters.

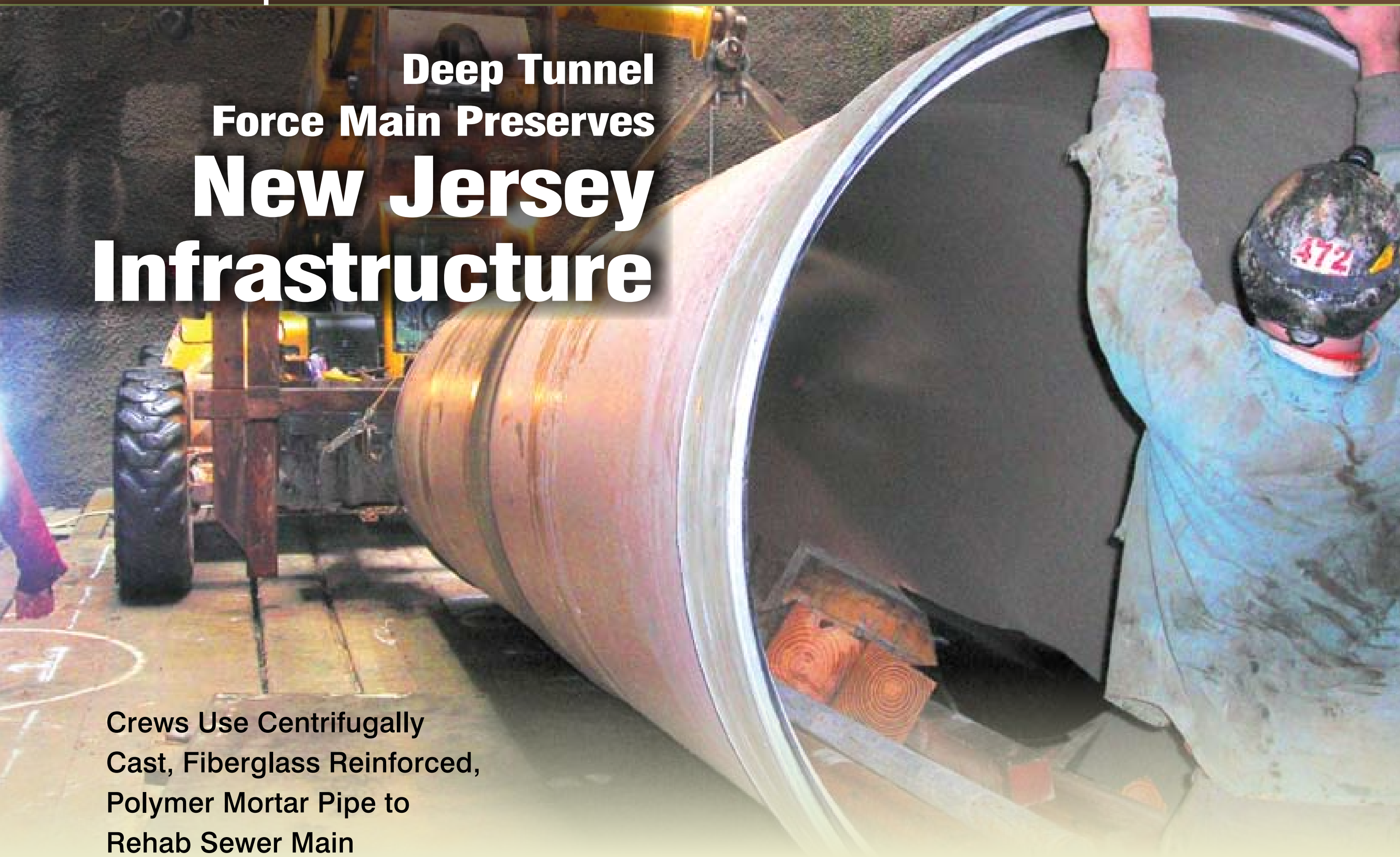
Design Life: 200 years.

Applicable Standards: ASTM C-1208, EN 295-7.

Latest Developments over the Last Five Years: Pilot tube microtunneling techniques with VCP are now achieving precision drives of up to 400 linear feet in pipe diameters up to 36." VCP is now being used for static pipe bursting resulting in a rigid, long-lasting, gravity flow conduit.

What Is Notable About Your Pipe: "Vitrified Clay Jacking Pipe has been the predominant jacking pipe material in the diameters manufactured due to its high compressive strength (18,000 psi average), low-profile zero-leakage joint, and proven lifecycle. The chemical resistance of VCP is unsurpassed, and the nature of ceramic material means it doesn't change over time. With today's high tech vitrified clay jacking pipe and today's installation methods, municipalities are able to design and construct systems that will provide dependable, low-maintenance service for centuries to come."

Source: National Clay Pipe Institute
Web: *www.ncpi.org*



Deep Tunnel Force Main Preserves New Jersey Infrastructure

Crews Use Centrifugally Cast, Fiberglass Reinforced, Polymer Mortar Pipe to Rehab Sewer Main

By Peter Kocsik and Erin Boudreaux

An ongoing priority for the state of New Jersey has been to improve the infrastructure for its 8.6 million residents. Overseeing the infrastructure improvements is the New Jersey Department of Environmental Protection (NJDEP), the government agency responsible for managing the state's natural resources and pollution control issues.

A recent project undertaken by the Middlesex County Utilities Authority (MCUA), "Edison Force Mains/Edison Pump Station Upgrade," consists of three phases of work which will be completed under the terms of three separate contracts: Phase One — Edison Pump Station Transformer Relocation; Phase Two — Construction of Tunnel and Edison Force Mains; Phase Three — Edison Pump Station Upgrade. This project is by the NJDEP and the New Jersey Environmental Infrastructure Trust.

This project is part of an overall goal to provide a redundant means for sewage conveyance from MCUA's Edison Pump Station (85 MGD) to its Central Wastewater Treatment Plant (400 MGD). The project consists of two parallel 3,940-ft long pipelines constructed in a tunnel beneath the 3,000-ft-wide Raritan River and some shorter connections constructed in open trench excavations on the pump station and treatment plant grounds.

Under Phase Two, a 3,940-lf, 15-ft, 6-in. diameter tunnel was constructed under the river. This tunnel has several uses with the most important being the connection of the Edison Pump Station, one of five contributing pump stations, to the Central Wastewater Treatment Plant. Within the primary tunnel are two parallel force mains. The new dual force main will replace MCUA's existing 60-in. diameter Arsenal Force Main, which was installed in 1969. The existing line made of prestressed concete cylinder pipe (PCCP) is supported on piles and is located several feet below the riverbed, which is a naviagble and dredged river maintained by the Army Corps of Engineers. The Arsenal Force Main accepts continuous flow of wastewater from the northern part of the county serving over 200,000 people. Since the pipeline has been in continuous service for 40 years with no ability to be inspected internally or externally, there was concern that the prestressing wire could fail, causing a catstrophic pipe failure and an uncontrolled discharge of raw sewage into the river.

To avoid the risk of a system failure, the NJDEP, through an Administrative Consent Order, required MCUA to construct a new redundant pipeline under the Raritan River. The first design concept was to build a tunnel in lieu of open-cutting the river and install a single 60-in. diameter pipe and upon placement into service, then rehabilitate the existing PCCP pipeline to develop a dual pipeline system. After researching potential rehab techniques and the possible cost and risk to rehab a 40-year-old pipeline, it was determined the most practical and economical solution was to enlarge the new primary tunnel diameter and install two new pipelines in lieu of rehabilitating the older PCCP pipeline. The new redundant line will allow for one line to be shut down and inspected or repaired without flow disruption providing for a safe, long-term solution.

Hatch Mott MacDonald, Freehold, N.J., was hired to design the new system. Angelo Bufaino, P.E., senior project engineer of the firm, explained their concerns, which included both installation and long-term performance criteria. "MCUA wanted a pipe that was corrosion-resistant both inside and out. Since the line was carrying raw sewage, the Authority wanted a pipeline that would be resistant to the biproducts of hydrogen sulfide gas (sulfuric acid).

Additionally, as the pipe was to be installed within a damp tunnel and partially encased in concrete and there would be no means to perform external repairs if external corrosion occurred. Centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM) pipe and HDPE were the only two pipes considered to meet both internal and external corrosion resistance. HDPE presented a concern in installation because of potential thermal expansion and contraction with varying wastewater temperatures. CCFRPM had the better thermal properties," explained Bufaino. Aside from the design aspects, because the pipeline was being constructed within a 3,900-ft long tunnel, it had to be light enough to be transported through the tunnel and lifted to be set to grade. "The CCFRPM pipe provided benefits with regards to weight and jointing, making installation easier," said Bufaino.

Due to these reasons CCFRPM pipe was the only material specified for the force main. Kenny Construction Co. (KCC), Northbrook, Ill., was awarded the tunnel portion of the project and purchased the 7,785 lf of 60-in., 100 psi pressure class, 46 stiffness pipe from HOBAS Pipe USA.

Successful Construction

Two deep access shafts were required on each side of the Raritan River. KCC subcontracted Bencor Corp. of America, to construct the shafts. Slurry wall construction methods were used to create the Southeast 36-ft diameter, 87-ft deep launch shaft and the 28-ft diameter, 70-ft deep Northwest receiving shaft. "In lieu of the specified jet grouted plug below the base slab to prevent soil heaving at the Southeast Shaft, Kenny Construction chose to excavate the final 15 ft of the shaft under water. Upon reaching an excavation depth of 70 ft, the shaft was flooded and the remaining 15 ft of soil was excavated underwater. Commercial Diving was then brought on site and divers were used to verify the depth of the excavation, as well as to set the final rebar mat and place the tremie concrete slab," stated Bob Rautenberg, KCC project manager. The two shafts are permanent and will remain after the project is completed.

MCUA decided to leave the tunnel partially open to permit inspection of the pipelines and to permit future utilities to use the corridor to cross the 3,000-ft wide Raritan River, In the final construction, two additional 16-in. diameter HDPE pipelines were installed to convey landfill gas across the river.

Once shaft construction was complete, the 3,900 lf of 15-ft, 6-in. diameter tunnel was built using a Lovat Earth Pressure Balance (EPB) tunnel boring machine. The EPB machine mined through various ground types including clay, sand, silt and gravel layers. Crews followed behind the TBM placing the 13-ft, 4.75-in. inside diameter, 9-in. thick precast gasketed concrete segments. The annulus void of approximately 3 and 5/8 in. was grouted as the machine moved forward.

"The contract documents specified the use of a pressurized face tunnel boring machine due to the presence of soft ground eposits and potential flowing soils under atmospheric conditions" stated Julian Prada, resident engineer for Hatch Mott MacDonald on the contract. KCC chose to use an EPB boring machine for the tunnel construction due to the soft ground conditions. Soil was mined with a rotating cutter head, and a screw conveyor carried a controlled volume of soil, allowing the contractor to control the volume of soil excavated. By this process the boring machine supported the ground during excavation, therefore balancing the earth pressure. Preservation of the insitu soil was especially critical since the existing 60-in. diameter force main alignment was within 15 ft at one point. "The 3,940-foot long tunnel hit its target for both line and grade," said Prada.

Once the primary liner was in place, installation of the carrier pipe began. "The entire line (twin force mains) was installed from the Southeast shaft, located on the Sayreville side of the river. The pipe was installed on two shifts with our best day having installed 20 pipes," stated Rautenberg. Kenny Construction utilized a Caterpillar telehandler with a custom fabricated handling device, to bring the pipe into the tunnel.

"As the pipe was installed, each joint was air pressure-tested to 75 psi per the project specifications for two minutes using a full circle pipe joint tester to ensure leak-free performance. Upon completion of the shaft piping, each of the lines was subjected to a hydrostatic test of 75 psi. The pipeline passed all tests without a single leak," explained Rautenberg.

One of the original problems with the existing line was the limited access. For this newly designed and redundant system, the Authority established man access points to permit internal inspection of the pipeline. Epoxy-coated, steel T-base manway entry fittings with alloy hardware were installed at three points along each pipeline.

Full inspection of the pipeline can be conducted within 500 ft of every tee location, which was a criteria established by local fire rescue teams. The 60- by 42-in. diameter tees were manufactured by Smith Blair. CCFRPM was continuous through the T-base, with a 42-in. diameter hole cut for the access manway.

The next phase of construction included grouting the dual lines in place. A blocking scheme was designed and installed to anchor the pipe and resist the uplift. "With the blocking in place, the backfill plan called for the first lift of material to be a lightweight cellular grout with a density of 35 pcf. The cellular grout encased the pipe to 8 in. below the spring line. Once the cellular grout was in place, both of the pipes were filled with water for ballast, and then encased to a point approximately 4 in. below the outside crown of the pipe with 4,000 psi structural concrete," explained Rautenberg. This design allowed for a 6-ft high open walkway along the center of the tunnel for future access.

The CCFRPM pipe in the tunnel was connected to 60-in. diameter ductile iron pipe risers at the Northwest and Southeast shafts. These risers connect to the surface piping and are under a separate contract in Phase Three.

Once installed, access to the pipe for future repairs would prove quite difficult at depths of 70 to 90 ft. Centrifugally cast fiberglass pipe's successful history of tunneling projects, ability to withstand the corrosive environment and leak-free joints made the pipe ideal for this force main project.

Peter Kocsik is vice president of Hatch, Mott MacDonald. Erin Boudreaux is a marketing assistant with HOBAS Pipe USA.

How to Properly Butt Fuse Polyethylene Pipe

A worker checks the high-low of two pipe lengths coming together in the jaw carriage.

By Larry Gordon

With the continued growth of high-density polyethylene (HDPE) pipe for use in trenchless applications, more and more pipeliners are becoming increasingly interested in learning butt fusion procedures.

Butt fusion is a process that differs from the theories and practices of other pipe jointing techniques, but has a rich history both domestically and abroad. Whereas other pipelines are created by joining lengths of pipe by mechanical means such as compression fittings, bell and spigot connections or other techniques — butt fusion is a widely accepted process that joins two pieces of fusible pipe together with heat and pressure. A fusion joint is formed by pressing the ends together under a controlled force. The resulting fusion joint is as strong as or stronger than the pipe itself. Third-party industry research indicates that HDPE pipe and joints can have a lifespan of more than 100 years.

Butt Fusion Standards

The polyethylene piping industry has fusion procedures written into standards for professionals to use. Standards are important in identifying the steps of a procedure so that those performing the actions can use a repeatable process for consistent results.

One of the most common documents is the Plastics Pipe Institute's (PPI) *Technical Report TR-33 Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe*. The TR-33 is a

critical document that many standards now reference. The document includes a section for the generic butt fusion procedure for field joining of ASTM D2513 gas piping and the generic butt fusion procedure for field joining of ASTM F714, ASTM D3035 and AWWA C906 piping.

The PPI Task Group that developed TR-33 consisted of plastic pipe and resin manufacturers and fusion equipment manufacturers. At the end of the project, the plastic pipe manufacturers drafted letters of approval for these procedures and parameters and included them in the document.

Several years later, these same parameters and procedures were included in the new ASTM standard *F2620: Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*. The American Society for Testing and Materials (ASTM) document is popular as a standard for butt fusion, as well as for other types of fusion, such as socket and saddle.

The Six-Step Procedure

In generic terms, butt fusion is summed up in six steps. Each step has nuances that are perfected through practice and training:

1. **Clean and Install** — Before loading the pipe into the fusion machine, a fusion operator cleans the pipe to remove contamination on the pipe before clamping. The pipe is then loaded into the fusion machine and clamped to prevent slippage of the pipe and to re-round the pipe.

2. **Face** — Facing is the step where the ends of the pipe are shaved away to create two clean, parallel mating surfaces for the heating operation. At this point, any oxidation or contamination on the pipe ends is removed.

3. **Align** — One key to good fusions is to make sure the two pipe ends line up. This is referred to as checking the "high/low." When not perfectly aligned, one end of the pipe will appear higher than the other. Usually a simple tightening of the inner jaw of the fusion machine can correct the alignment.

4. **Heat** — The aligned pipe ends are brought together under pressure against a heater plate. When an indication of pipe material melting is visible around the circumference of the pipe, the pressure is reduced for the heat soak cycle.

5. **Fuse** — After the proper amount of melt bead has formed, the carriage is opened, heater removed and pipe ends brought together at a predetermined fusion pressure.

6. **Cool** — The fusion pressure is maintained for a set amount of time in the jaws of the machine while the fusion joint cools. This allows the pipe to regain its pre-heated form. After the joint cools, the pipe is moved from the machine and two new pipe ends come together to repeat the process.

Available Training

Many training regimens, including McElroy University, use F2620-09 as their document of choice in teaching the fusion process. These procedures and parameters have found their way into other standards such as the *American Society of Mechanical Engineering (ASME) N-755 Code Case and International Organization for Standardization (ISO) 21307*.

No matter what standard is used for your fusion operations, training on the equipment used on the job is necessary to get consistent, professional fusions.

The growth of polyethylene industry in both gas and water applications has increased the number of training opportunities available to those that verify and document their skill and aptitude. One such opportunity for training is through McElroy University, located in Tulsa, Okla.

McElroy University holds more than 20 classes throughout the year, with each class culminating in an examination to prove classroom-taught concepts and hands-on training. Each trainee that passes is awarded a card and certificate documenting completion. McElroy has offered this service for more than 20 years.

Others in the industry are training as well. It's not unusual to find that whoever supplies your pipe or pipe fusion machines will know of an outlet for training, whether it be in-house with their people or directly from a pipe or equipment manufacturer.

The great thing about butt fusing HDPE pipe is that there are a number of quality control and assurance measures that can be taken during and after the fusion process. The first and simplest is a visual inspection of the joint. The beads should be rounded and uniform in size around the pipe's circumference.

A data-recording device can also log each fusion joint. This device provides inspectors and supervisors a record of each joint for quality assurance purposes. A review of these records will tell if proper procedures were followed and if they were not followed, the joints can be cut out and re-fused before burying the pipe.

Keys to Success

The six-step process of fusing pipe is easy to perform after getting the appropriate training and putting that training to work. However, just with any task, there are always things you can do to ensure successful fusions.

First, make sure that your fusion equipment meets the manufacturer's specifications and is in good working order. Just like an automobile, a fusion machine that is regularly serviced performs better than one that is neglected.

Trained and qualified fusion technicians, trained on the fusion equipment used on the job, are critical to good fusions.

Finally, use the quality assurance guidance available by doing the visual inspection of the joint and reviewing the data-recording record to make sure the proper procedure was followed in the fusion process.

By getting the proper training and following the keys to success, you can give a town, municipality or other organization a leak-free piping system for the next 100 years or more.

Larry Gordon is the training and operators manager at McElroy. Gordon is the director of schools for McElroy University.

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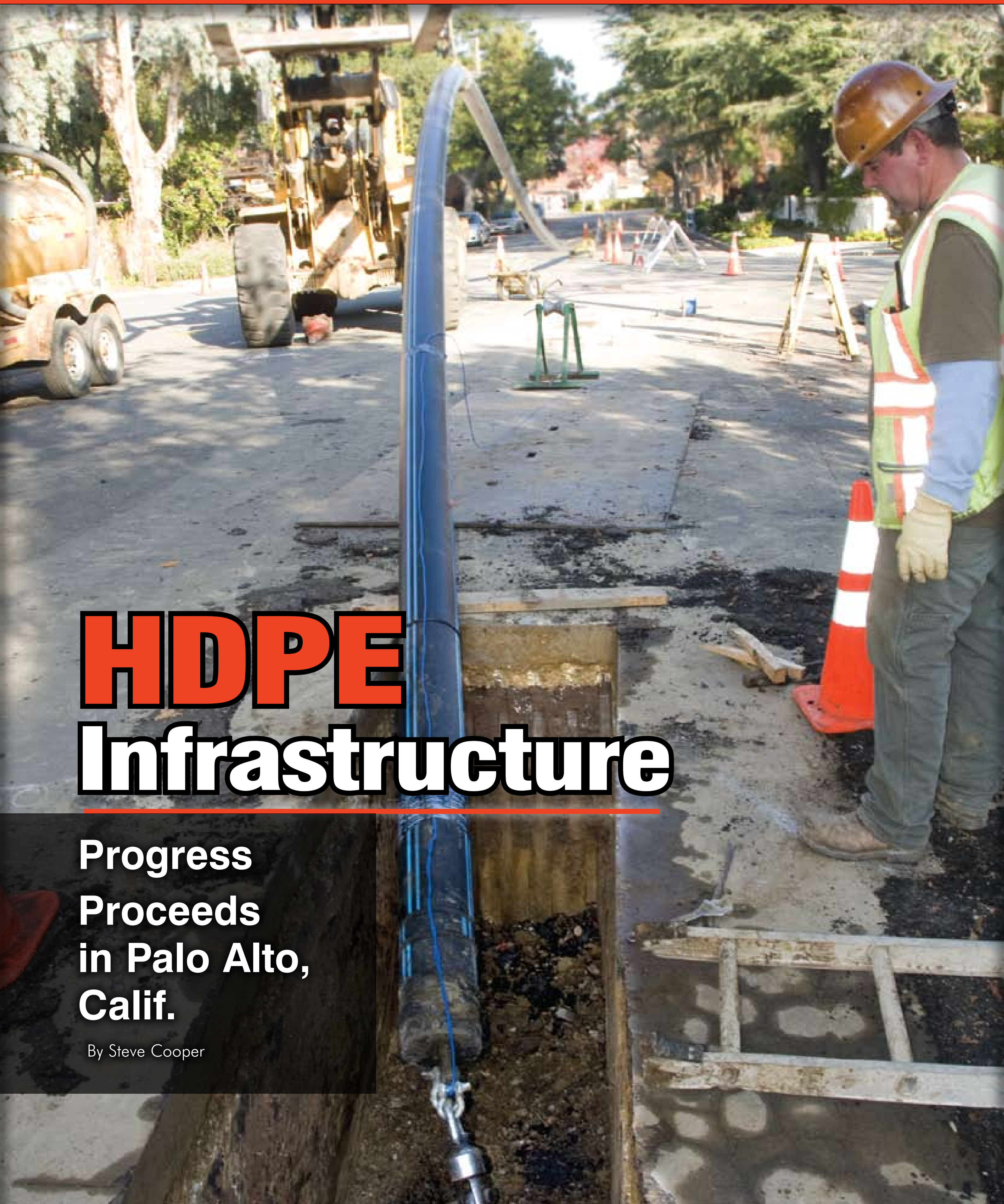


HDPE Infrastructure

Progress Proceeds in Palo Alto, Calif.

By Steve Cooper

Long known as a forward-thinking area, the West Coast City of Palo Alto, Calif., has completed approximately one half of a 300-day project that has replaced three miles of targeted cast iron water main pipe reaching the end of its useful life out of a project total of six miles to help secure the future delivery of reliable water service to its residents.

The success of this initiative has propelled the City to adopt PE4710 pipe, installed as much as possible by horizontal directional drilling (HDD), for ongoing system replacements. The City is on track to replace the entire 214-mile system.

Palo Alto is considered the economic hub of Silicon Valley. Covering some 25 sq miles, the city has a resident population that swells daily to 198,000 people, employed by some 7,000 businesses including Amazon, Facebook and HP, along with being home to Stanford University.

"This is a very high tech community," explained Greg Scoby, P.E., manager of water, gas and wastewater engineering for the City of Palo Alto Utilities Department. "Consequently, the city is fairly progressive and a lot of new approaches are investigated and used in the utilities department. The latest project involves replacing targeted water mains to eliminate leaks and improve the reliability of the system. Current studies indicate that PE materials will provide extended useful service levels over materials previously used for system replacements."

The water main system currently consists of pipe made from asbestos cement, ductile iron, concrete cylinder, PVC and more than 388,000 ft of cast iron.

The city started to use HDPE pipe because it could be installed by boring instead of the open-trench method. The water main replacement program is focused on converting cast iron pipe because the material corroded away over time and leaks.

The advantage of being able to use HDD or boring the HDPE pipe on a horizontal plane is that this method is less disruptive to surroundings, minimizes hauling associated both with excavation and paving and can result in both lower costs for both installation and material life cycle. The HDPE pipe is also resistant to internal buildup or abrasion and provides a leak-free, fully-restrained system.

"There has been a continuing increase in the number of water systems that are using HDPE pipe," stated Tony Radoszewski, executive director of The Plastics Pipe Institute (PPI), a non-profit trade association. "This is because more and more systems are failing each and every day. The old pipes split, crack and the connections leak. This loss can be stopped, not just slowed or diminished to an acceptable level that communities feel they have to accept as a normal part of having an outdated product. A new system with fused HDPE pipe sections will not leak."

The city started to use HDPE pipe because it could be installed by boring instead of the open-trench method. The water main replacement program is focused on converting cast iron pipe because the material corroded away over time and leaks.

The process to use PE pipe in Palo Alto started in the mid-1980s with its adoption by the City's gas utility.

"Because of the age of our infrastructure, we recognized at that time that there were issues with our gas, water and waste water systems," explained Scoby, who was working on the gas system at the time. "The City Council agreed to accelerate the replacement program. The gas system was first. Then wastewater, then we went to water.

"We started the increased level of replacement using trenching methods. We actively pursued leaking mains and areas reaching the end of their respective useful lives, focusing initially in the gas system."

Later, in the mid-1990s, there were several developments in the construction of pipelines, one being directional drilling.

"Again, always looking to be progressive, we were one of the first to test early versions of directional drilling equipment through the Gas Research Institute. We have been using that method since around 1997," Scoby said.

"Just before that development, we were doing about 20,000 ft a year with cut-and-cover and were able to increase our replacement by 50 percent by moving to directional drilling, not only because of the time saved, but also because of the reduction in costs caused by tearing up streets and replacing the pavement. Directional drilling allowed us to do a better, faster job and install more feet of pipe for about the same dollar amount."

Scoby became responsible for the water system in March 2009. "The water department started the year before to develop a project putting in PVC. The water engineers had traditionally used PVC as our primary replacement material. I, however, convinced my then supervisor that we had to get out of putting in a mechanical-type joining system in favor of a heat-fused one."

Scoby's experience on the gas side provided the real-world results that backed up his recommendation. "We had just conducted a 100 percent leak survey of our gas system and we had zero leaks on PE mains, some of which had been around since 1985-86. Since we had the familiarity with the PE material and great results, we decided it was prudent to conduct a pilot project for water."

Specifications were developed and the job was sent out to bid involving about six miles of replacement mains, the majority being 8-in. with some 10-in. and 12-in. diameter pipe. The project called for half the system to be installed with open cut and cover, and the other half using directional drilling.

"We really didn't have a feeling for installing large diameter pipe by directional boring," Scoby explained, "because we directionally drilled the gas system using 1-in. CTS through 8-in. IPS diameter medium density polyethylene pipe. So for the water system that would use pipe up to a foot in diameter, we had to determine at what point does it become more cost-effective to use the open-cut method.

"We couldn't predict at that time how long it would have taken to install the larger diameter pipe, and we had about 6,500 ft in all."

The project began in September 2009 with a contractor from San Francisco-based Ranger Pipelines Inc., which was knowledgeable about HDPE pipe. "The contractor installed at a much quicker rate than we projected. This included both open-cut and directional — the mix came out about 50 percent each way," Scoby related. "It's been a very successful project to date." After the installation was complete, the mains were disinfected, tested and tied in starting in early December 2009. The water delivered by the San Francisco Public Utilities Commission contains approximately 1.88 mg/L of chloramine, which was adopted as the primary disinfectant in 2004.

A recent study by Jana Laboratories was commissioned by PPI to investigate the effects of disinfection on the lifetime of polyethylene pipes. Based on this methodology, Jana developed case studies and confirmed that 100-plus year life is projected for pipes made from the higher performance PE 4710 materials that are being installed in four utilities. Palo Alto was one of the participants. The study is found at *www.janalab.com/pdf/PE%20Chlorine%20Report%20-%20Final-2.pdf*.

The city's water main replacement project used PE 4710, SDR 11 potable water pipe from Performance Pipe Inc., a division of Chevron Phillips Chemical Co. LP and a PPI member. The DriscoPlex 4100 pipe is certified to ANSI/NSF Standard 61 for potable water applications and is manufactured from a PE compound with an ASTM D3350-02a cell classification of PE 445574C. The fittings utilized in the piping system were also molded PE 4710, Class 200 fittings. DriscoPlex 4100 piping components are made from a pressure-rated PE 3408/4710 extra-high molecular weight, high-density polyethylene material. Palo Alto's operating pressure is 65 psig.

"The PE 4710 designation basically notes an improvement in materials over the older, more general PE 3408 designation, which has been the standard specification for pipe in a typical potable, pressure water system," explained Scoby.

According to PPI technical director Stephen Boros, "Advances in PE polymer chemistry and manufacturing have resulted in the creation of high performance PE 4710 compounds that exhibit greater resistance to the development and propagation of cracks when subjected to localized stress intensifications typically found in water piping systems. These compounds can be utilized with a design factor of 0.63 if they meet key additional performance criteria as established by the Hydrostatic Stress Board. This translates to the ability for the piping system to have a higher design pressure with increased flow capacities and without compromising safety or long-term service."

"Improvements in HDPE pipe resin and in manufacturing are a continuous process, and the codes and standards evolve to reflect these changes," explained Radoszewski. "Therefore, as these improved materials are introduced, pipe manufacturers may imprint the pipe with the old and new codes in order to meet engineering design or purchase specifications. It is typical to see, for example, PE 3408/4710 on the same pipe."

The PPI's reference guide called *The New PE Pipe Material Designation Codes* lists the historical and new codes, as well as the associated design parameters, which is helpful in deciphering the data.

The solid wall pipe grade typically used in potable water systems historically was PE 3408 as per ASTM D 3350-02a. Because this designation was broad in scope, it was not possible to differentiate newer materials with increasing performance characteristics. In 2004, ASTM D 3350 was modified so the high-performance materials could be recognized and thus differentiated in the marketplace taking advantage of the improved performance properties.

Product specifications in various industries and end-use applications are being revised to recognize these newer material designation codes as well. Because of their increased performance capabilities, PE 4710 compounds were required in developing ASME code for the use of PE pipe in nuclear power plant safety water systems.

Connecting the new HDPE solid wall pipe to the existing system was one of the most important considerations for Scoby and his department. "Since PVC has been the primary material used for water main replacement, the city specifications, standards and installation procedures required major revision to incorporate HDPE," explained Aleksandr Pishchik, P.E., senior project engineer, City of Palo Alto Utilities Department, and the project manager.

A number of fittings were considered for integrating new HDPE pipe into the existing water distribution system. The following fittings were selected:

- Mechanical Joint Adapters (MJ) for joining HDPE to Ductile Iron and PVC pipes. The MJ adapter connection is fully self-restrained.
- PE Flange Adapters for joining HDPE to existing flanged valves.
- Mechanical coupling Smith-Blair 441 series were selected for joining HDPE and Asbestos Concrete pipes.
- Mechanical coupling Smith-Blair EZ-W series were specified for joining HDPE and Cast Iron pipes.

"The advantage of the HDPE system is that pipes and fittings can be connected by heat fusion and form joints that are fully restrained against pullout," stated Pishchik. "The butt-fusion method, which creates permanent leak-free joints, was specified for connecting lengths of HDPE pipe, as well as for fittings such as valves, tees, ells and reducers."

In order to minimize the number of mechanical joints, the staff specified American AVK6 resilient seated gate valves with polyethylene pipe ends. These valves can be joined by butt fusion with other components in an HDPE water system.

Electro-fusion Frialen VA service saddles manufactured by Friatec Gas Water Inc. along with saddles manufactured by George Fisher Central Plastics were selected as tapping hardware for reconnecting existing services.

For proper installation of tapping hardware, the specifications required the use of a top loading clamp for 8-in. inch and larger saddles. Electro-fusion couplings by Friatec and Central, both PPI members, were specified for connection to HDPE pipe at locations where butt fusion was not feasible.

"On the strength of the success of PE pipe in our gas and now our water system," Scoby summarized, "we're currently revising our standards to reach our goal to have a 100 percent fused, no-leak system."

Steve Cooper is a technical writer with SCA Communications.

HDD, Restrained Joint PVC Pipe

Keeps Disruption Low in Northwest Ohio Water Main Replacement

By John Coogan

When the Ohio Department of Transportation (ODOT) signed off on plans to repave a portion of Ohio Route 531 in Ashtabula, last year, it presented the Ohio American Water Co. with a valuable opportunity to replace an aging water main occupying the same space.

Nearly 8,000 ft long, the cast iron main was more than 50 years old and had experienced several breaks over the years. ODOT's plans were well received, as the aging water main had become a maintenance challenge for Ohio American Water, as well as a significant community problem.

"This water main was nearing the end of its expected life," says Bill Dingledine, superintendent of operations for Ohio American Water-Ashtabula District. "I counted 36 repairs made to this section of 12-in. water main over the years, so it was time to replace it. We obtained funding from the EPA's Revolving Load Fund and moved ahead with the project."

ODOT needed Ohio American Water to move the location of the water main, as it had migrated underneath the highway, following various road-widening projects over the years. It was determined that the new water main be constructed in the "tree lawn" — the grassy area between the sidewalk and the curb — along Route 531, so future water main repairs would not require excavations into the roadway. This, of course, presented a challenge to the project team, as digging up the landscape and cutting down trees was not a desired option.

To work through these issues, Ohio American Water hired Gannett Fleming Inc., of Akron, Ohio, as consulting engineer and then Precision Directional Boring LLC, of Valley City, Ohio, as contractor.

"After discussing the sensitive nature of the project area with Ohio American Water, we decided to allow the option of directional boring or open-cut in the bid documents," says Len Rychlik, P.E., manager of water and wastewater practice at Gannett Fleming. "Of the three contractors that bid the job, two bid it as open-cut, and one, Precision Directional Boring, bid the job as a HDD project. Precision Directional Boring was the low bidder and was hired for the job."

Precision Directional Boring's directional drilling suggestion made the most sense, especially when considering the water main's surroundings. The Ashtabula portion of Route 531 is often congested with tourist traffic and is bordered by nearly 130 homes and a satellite campus of Kent State University, as well as several old sycamore trees near the shoulder of the road. It was suggested (and ultimately proven) that HDD would help the project team avoid costly landscaping and tree removal costs and minimize traffic and residential community disruption.

Another critical project selection that ultimately streamlined the installation of the critical water main was Gannett Fleming's specification of 12-in. DR18 CertainTeed C-900/RJ restrained-joint PVC pipe with Certa-Lok Restrained Joint System. Based on the recommendation of Precision Directional Drilling, the restrained-joint PVC pipe was selected as the better alternative to butt-welded pipe in this application. In addition to the PVC pipe product offering high durability and a non-corrosive surface in support of a longer useful service life for the new water main, its Certa-Lok restrained-joint technology allowed for fast and easy system assembly in a congested area.

With the installation crew able to assemble the pipe system in 20-ft lengths while concurrently securing it with spline-locked couplings as the pullback continued, the job went along smoothly and quickly.

Precision Directional Boring began work in May 2009, with two crews, each consisting of up to six workers. The biggest challenge of the project came at the beginning, when the project team had to locate gas, water and sewer lines for each of the 127 homes served by the water main and find an optimum location for the new water main.

"We had to carefully investigate the location of each home's utilities in order to obtain a clear bore path, and the homes were very close together in some areas," says Brian Willis, project manager for Precision Directional Boring. "We had eight homes every 200 ft, with three utility lines per home, so we would have to dig 24 potholes on one block. That was a very challenging and time-consuming part of the project."

After the utility location was complete, the crews began making bores through clay soil with a Ditch Witch JT920L directional drill and a Ditch Witch JT4020 Mach 1. Bores varied in depth from 5 to 6 ft. After a bore was made, the 12-in. restrained-joint PVC pipe was attached to a backreamer and pulled back through. Due to the presence of storm sewers, the crews had to use open-trenching to install pipe across street intersections. Fortunately, the need to use open-trenching was kept at a minimum, amounting only to approximately 1,000 ft of the entire water main line.

Once the pipe was in place, Precision Directional Boring used a Ditch Witch JT2720 directional drill to install 127 copper service lines to all the homes along Route 531. The crews finished the job in October 2009.

The project ran smoothly and made a very good case for the use of directional drilling in pipe installation. By using HDD, Precision Directional Boring was able to avoid many expenses and hassles. For example, there was no need in the project to close lanes of traffic or call in electric company workers for help with supporting utility poles. The contractor also avoided extensive landscaping by boring under driveways and trees along the route. These benefits were a big hit with the customer, as well as the end users of the water main.

"I know we saved Ohio American Water somewhere between $20,000 and $30,000 by using HDD in this project," Willis says. "This project turned out well for us and the customer. It was good for the end users as well because there was nothing in their daily lives that was disturbed. I don't think the project could have been done successfully with any other method than directional drilling and any other material than restrained-joint PVC pipe. The combination of the two really helped keep disruption down."

Ohio American Water was pleased with Precision Directional Boring's work. This was the first time the company had approved the use of HDD for pipe installation, and they were happy with the results.

John Coogan is marketing and business development manager at CertainTeed Corp.

Vitrified Clay Pipe

Specified for Sacramento Microtunneling Project

By Pat Symons and Jim Pelletier

Sacramento County's Upper Northwest Interceptor 9 (UNWI 9) project featured extreme depths, tight timelines and high groundwater issues. The design solution included open-cut installation using Controlled Low Strength Material (CLSM) and long microtunneling drive lengths.

The Sacramento County Regional Sanitation District (SCRSD) and the Sacramento Area Sewer Districts (SASD) manage more than 3,000 miles of pipe, stretching throughout much of the Sacramento region. UNWI 9 was just one part of the larger Upper Northwest Interceptor (UNWI) system that will travel approximately 20 miles from Citrus Heights, through North Highlands and Rio Linda to Natomas. UNWI carries wastewater flows from northeast Sacramento County to the new Natomas Pump Station.

SASD has specified vitrified clay pipe (VCP) for gravity sewers for more than 100-years and has come to rely on the long-term, low maintenance performance of this material.

The open-cut portion of the project was in one of the busiest areas of Citrus Heights. There was an active retail area nearby, creating high traffic volumes. The contractor, Steve P. Rados Inc., had restricted working hours at three major, signal-controlled intersections and a 14 calendar-day timeline from the time traffic was first blocked till the road was fully returned to service.

The open-cut workspace was a very narrow stretch of historic Highway 40. Using CLSM allowed the trench width to be limited to just 60 in., with trench depths of up to 39 ft. The insitu soils were primarily alluvial deposits and allowed the contractor to maintain stable trench walls. These soils, when excavated, had high-moisture contents. They had to be dried off-site before they could be brought back and used as acceptable backfill material. There were also several lenses and pockets of pure sand. The use of solid wall "mega shores" enabled the trench production to not be severely impacted by these pockets and lenses of granular material.

The open-cut manhole shafts were all excavated prior to the construction of the pipeline. This allowed the pipeline to proceed through the manhole areas without the customary slow down. A separate crew followed the mainline crew and installed the manhole base and riser sections after the pipe operation was out of the area. This sequencing allowed installation to consistently be ahead of the planned schedule.

"The choreography Rados Inc. created to accomplish the multiple goals of this project was impressive," according to Can-Clay president Mark Bruce. "It was actually quite an elegant solution, probably one of the best I have ever seen."

"Big Stan" from Anderson Drilling dug 41 vertical shafts for the microtunneling portion of the project, with diameters ranging from 15 to 21 ft and depths of 34 to 71 ft. "Big Stan" also drilled all of the eight manholes in the open-cut portion of the projects. These shafts were 8 ft in diameter and ranged in depth from 26 to 36 ft.

Steve P. Rados, Inc. used three excavators to form a "train" for the length of the trench.

The first excavator dug the trench to the design sub grade. A long reach machine was used to complete the excavation in a 550-ft long section of trench that exceeded the 34-ft limit of the first machine. The second excavator served three functions. Its tracks were spread and raised with a custom-built track and undercarriage so that it could straddle the trench while allowing for ongoing work in and around the area. The excavator placed the 36-ft high "mega shores" in the trench as soon as the first excavator completed its task. Then the machine positioned the pipe in the trench so laborers could shove the joints home. At the end of each day, this machine placed steel plates over the open trench. At the beginning of each day, this machine was used to remove these plates and reposition the mega-shores for the coming day's work.

The final excavator served just one purpose. It compacted the backfill that was placed in the trench in controlled 1-ft lifts.

Another critical part of the whole choreography was the brigade of dump trucks. As the trench was excavated, the native soil was loaded into a truck and hauled to a nearby site for drying and aeration. Once conditioned, that soil was loaded back into the truck and taken back to the site as backfill. The truck would dump soil on one end of the trench and be reloaded on the other end of the trench.

That was the process on the surface. In the trench, crushed rock was placed to a depth of 1 ft, wrapped in geofabric and consolidated. Next the pipe was positioned and the trench around the pipe was backfilled with CLSM. The CLSM used for this project has a maximum strength of 150 psi and a slump between 8 and 11 in. Xiangquan Li, P.E., project engineer with HDR Engineering, explained, "The material's excellent flowability made it easy to backfill the trench. The VCP will also obtain good haunch support, which will result in a stronger load carrying capacity."

The CLSM would generally dry and cure sufficiently to start backfilling with the conditioned native material within 12 hours.

To date, 40 tunneling drives have been completed, with one drive remaining. One of them was among the longest microtunneling drive lengths ever achieved for a 36-in. diameter pipe at 892 lf, at depths of up to 61 ft below grade and 40 ft below the existing groundwater table.

"The really remarkable thing about this project, beyond its scope and size, is the shear magnitude of preplanning required to make it all work," according to Bruce. "Sacramento County and its consultants performed an incredible amount of community outreach. That combined with the innovative sequencing and staging completed by the contractor created a very successful project."

Pat Symons is director of engineering services for Gladding McBean, a division of PABCO LLC, a vitrified clay pipe manufacturer, Lincoln, Calif. Jim Pelletier is the assistant Northern California manager for Steve P. Rados Inc. and serves as a project sponsor on SPR projects.

The Tale of the Tape

Methods	Open-cut with CLSM Slurry Microtunneling
Open-cut pipe	5,222 ft of 36-in. VCP from Gladding McBean
Trenchless pipe	23,100 ft of 36-in. Denlok VCP 4,324 ft of 24-in. Denlok VCP Both from Can Clay
Longest Microtunnel drive	892 ft
Depth	≤ 39 ft for open-trench ≤ 61 ft for microtunnel
Consulting Engineer	HDR Engineering Inc.
General Contractor	Steve P. Rados Inc.
SCRSD Project Manager	Bill Chavez

ADS

SaniTite HP is engineered for long-term service life and is available in a dual wall or exclusive triple wall design. Manufactured with an advanced polypropylene resin, it is chemically resistant to sanitary hydrogen sulfide gas and sulfuric acid concentrations typical of sanitary sewers to provide superior durability and performance.

SaniTite HP's joint utilizes composite reinforced bells and dual gaskets to provide added safety. Its smooth interior provides excellent flow characteristics.The 13-ft length offers a lightweight, maneuverable pipe section, preferred for tight work conditions.The standard 20-ft length allows for faster installation with fewer joints.

Arntzen Corp.

Arntzen Corp. is a leading producer of large diameter rolled and welded steel casing pipe from 26-in. OD to 192-in. OD. Pipe Mills in both Rockford, Ill. and Woodstock, Ill., enable Arntzen to respond quickly to customer needs and ship on schedule. Typical applications for Arntzen casing pipe include: road boring, pipe ramming, auger boring, caissons and drilled shafts. Pipe ramming contractors depend on Arntzen "ramming quality" pipe for their projects.

RAMMING QUALITY™

Blue Diamond Industries

Blue Diamond Industries is a leading manufacturer of HDPE (High Density Polyethylene) innerduct and conduit. Blue Diamond manufactures conduit for telecommunications, power, UL listed, CIC (Cable in Conduit) and PE 3408 pressure applications in sizes up to 6-in. in diameter. Blue Diamond now manufactures geothermal HDPE. Geothermal exchange is a clean energy method of heating and cooling commercial and residential buildings. Blue Diamond manufactures geothermal coils in sizes from 3/4- to 2-in. and u-bend coils from 3/4- to 1.25-in. Blue Diamond is also a member of the International Ground Source Heat Pump Association.

BLUE DIAMOND Industries, LLC

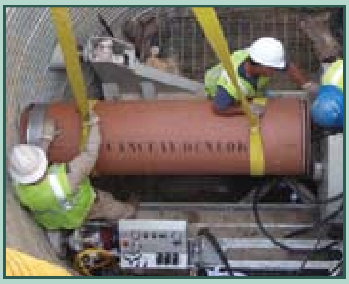
Boreflex Industries

Boreflex Industries introduces a new high-pressure composite polyethylene pipe to replace steel in the oil and gas collection industry. Unlike steel, Boreflex's Composite Pipe is non-corrosive, requires virtually no maintenance, is approximately half the cost of an installed and maintained steel pipeline and is available in continuous lengths of up to 4,000 ft. Boreflex Composite Pipe, available in ANSI 300/740PSI and sizes 3-in. through 6-in., requires no welding and can be installed by horizontal directional drilling, plowing, open trench or pulled through existing failed steel lines.

BOREFLEX

Can Clay

Can Clay manufactures Denlok jacking pipe for the trenchless installation in sizes ranging from 6-in. through 48-in. and lengths to 10 ft. Joints are rated at 70 ft of water head. Jacking strengths range from 154 to 3,141 tons.



Denlok pipe provides the most sustainable and green trenchless sewer pipe installation available. Ceramic construction of Denlok pipe does not deteriorate as it ages nor corrodes from chemical attack of sanitary sewers effluents, even at elevated temperatures.Tunneling, sliplining and pipe bursting with Denlok provides unsurpassed long-term economical performance.

CertainTeed

CertainTeed engineered the first completely non-metallic, corrosion resistant restrained-joint PVC piping system for trenchless construction, and offers a variety of contractor-proven Certa-Lok products for water, sewer and conduit applications. Certa-Lok requires no special heat-fusion equipment, saving contractors a significant amount of time and money; joints are assembled as the pullback continues, so streets remain open and clear.

Compared to alternate thermoplastic materials, higher-strength PVC requires a much thinner wall in order to achieve the same pressure rating which results in significantly improved flow performance and efficiency.

Fast Fusion

Fast Fusion's MobileFusion Trac 12 offers a better way to weld pipe by eliminating weld failures. The MobileFusion Trac 12 increases productivity and profitability, reduces costs and results in 100 percent more fusion welds per day than conventional methods. It

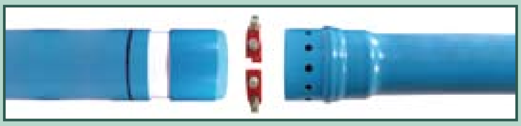
is designed for operator safety and efficiency, offering an all-weather cab for welding pipe in any environment. The MobileFusion Trac 12 also has micro-processor controlled pipe fusion and weld temperature control, is designed with the environment in mind and is rubber-tracked for use on any surface.

HOBAS

HOBAS pipe is in the infrastructures of most U.S. municipalities. The centrifugally cast, fiberglass-reinforced, polymer mortar pipe is ideal in new construction and rehab for critical applications, and its use is growing faster than ever. It is inherently corrosion resistant with a life expectancy of 100 years or more, providing very low life-cycle cost. Key applications are sanitary sewers, potable water and corrosive environments. It is ideal for a variety of installation methods including open cut, sliplining, jacking, microtunneling, two-pass tunnel, casing carrier and above ground. Pipe diameters range from 18- to 110-in. for both pressure and gravity applications.

IPEX Inc.

Introducing TerraBrute CR — engineered for Horizontal Directional Drilling (HDD) and other trenchless applications — TerraBrute CR is a 100 percent non-metallic, AWWA C900 PVCpressure pipe system. Non-corroding and installation friendly, TerraBrute CR allows you to standardize on PVC throughout your municipal infrastructure. Whether you're using open-cut or trenchless methods, there are no more problems matching materials and couplings. No more butt fusion equipment headaches. No more surprises.



ISCO

Since 1962, ISCO Industries, a total piping solutions provider headquartered in Louisville, Ky., stocks and sells HDPE pipe and other materials to provide piping solutions for various mining, industrial, municipal, environmental, geothermal, golf, culvert-lining and landfill applications throughout the United States and Canada. The company also rents, services and sells fusion equipment. ISCO has more than 20 facilities in the United States, as well as in Canada and Australia — inventorying large stockpiles of pipe, usually within a one day delivery of most projects.

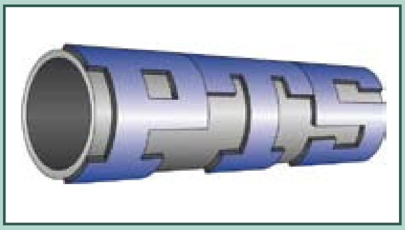
Logan Clay Products Co.

The vitrified clay pipe manufactured today by Logan Clay capitalizes on the benefits derived from 3,000 years of using clay as the preferred sanitary sewer pipe product. Logan Clay pipe also utilizes advanced ceramic engineering and technology to produce the most durable sanitary sewer pipe you can specify or install. It resists corrosion from more types of aggressive chemicals than any other pipe material, provides structure in the trench, is environmentally friendly and delivers the longest life-cycle of any pipe product available today.

McElroy

The new DynaMc Hand Pump (HP) machines provide the power and pressure required to butt fuse pipes size 2-in. IPS to 12-in. DIPS (63 to 340 mm) with a hand-powered pump. The double-action hand-pump paired with high-velocity cylinders create faster carriage speeds for critical opens and closes during the fusion process. The DynaMc 28, 250 and 412 HPs — each available in two- and four-jaw configurations — comes with an easy-lift cradle that can be removed to make the machine smaller for tight working environments. The electric facer that comes with the fusion machines is powerful and can be loaded from either side of the fusion machine.

Pipe & Tube Supplies Inc.



Pipe & Tube Supplies Inc. has been awarded the following mill contracts: Stupp ERW 10 3/4- to 24 in., Spiral Weld 36- to 42-in. and PSL Spiral Weld 30- to 42-in. The contracts give Pipe & Tube Supplies a large supply of American made pipe in the Houston metro area. PTS is a stocking distributor in Pearland, Texas, with an inventory of 20,000-plus tons of structural carbon steel pipe 6 5/8- to 60-in.

Pittsburgh Pipe

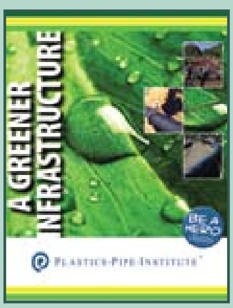
Pittsburgh Pipe is an industry leading manufacturer and distributor of high quality casing pipe for the underground utility industry. For more than 30 years, we've been providing steel casing pipe, HDPE and PVC plastic pipe, and steel piling pipe to underground utility contractors across the United States. In 2008, we built a new state-of-the-art facility for the manufacture and fabrication of steel pipe in sizes from 10 3/4-in. OD through 120-in. OD.

Polymer Pipe

iNTERpipe by Polycast Structures Inc. has technical expertise with decades of polymer concrete experience. iNTERpipe offers rigid jacking pipe, manholes, tunnel segments and custom castings. iNTERpipe has demonstrated superior durability over existing products by combining inherent corrosion resistance with steel reinforcement per ASTM and industry standards. Composite pipe products are widely accepted by municipalities due to corrosion resistance and life expectancy in excess of 100 years making composites the product of choice.

Plastics Pipe Institute

Plastic pipe systems are environmentally responsible and unmatched at conserving natural resources. Strong,



durable and flexible, these systems require significantly less energy to manufacture, transport and install than alternatives. Superior rust and abrasion resistance, incomparable joint performance — leak free or water tight — high ductility and low carbon footprint all add up to exceptional service life for a truly sustainable infrastructure. The Plastics Pipe Institute (PPI) is the major trade association representing all segments of the plastics pipe industry. Dedicated to promoting plastics as the material of choice for all pipe applications where plastics can be used, PPI is the premier technical, engineering and industry knowledge resource.

RIDGID

The RIDGID Press Snap soil pipe cutter expands the capabilities of RIDGID standard press tools by providing a fast and easy way to cut cast iron soil pipe. The Press Snap cutter eliminates the need for manual ratcheting when it is connected to a RIDGID press tool. To make a cut, the Press Snap cutter is attached to the press tool, the Press Snap chain wraps around the pipe, and the user presses the trigger to make the cut. There is no need to score the pipe beforehand. The Press Snap cutter cuts most 11/2- to 4-in. no hub and service weight soil pipe. It works with all RIDGID standard press tools, including the CT-400, 320-E, RP 330-B and RP 330-C. RIDGID pressing technology consists of electro-hydraulic press tools with interchangeable jaws and rings that press and connect copper, stainless steel and PEX tubing in seconds. The Press Snap soil pipe cutter is backed by the RIDGID lifetime warranty.

Ritmo America

Ritmo America is introducing their new line of Multipurpose Electro Fusion Machines, capable of fusing any brand of coupling (HDPE, PP, PP-R) available on the market. The "Elektra Light" is available in both 110V + 220V, capable of fusing ½- to 5-in. IPS (160mm) and a memory of 350 welding cycles. The Elektra 400, 110V is capable of fusing up to 16-in. IPS and has a memory of 4,000 welding cycles. The Elektra 800, 220V is capable of fusing up to 32-in. IPS and has a memory of 4,000 welding cycles.

All units can download via USB Adapter and Ritmo Transfer Software.

Underground Solutions

Underground Solutions has emerged as the fastest grow-

ing provider of water and sewer pipe reflecting the overwhelming acceptance of the fused PVC pipe technology embodied in its Fusible PVC product line. In just a few years, millions of feet of Fusible PVC pipe have been successfully installed in thousands of projects — saving clients millions of dollars. Ease of re-connection, better chemical resistance and better ID/OD comparisons with respect to other plastic pipe materials drive both initial and lifecycle savings in trenchless and open-cut installations.

WL Plastics

WL Plastics is proud to offer the latest advancement in High Density Polyethylene Bi-Modal Polymer Technology, PE 4710 pipe, which provides you with increased capacity, a lower cost per foot and is proven tougher, stronger and longer lasting. PE4710 pipes offer the ability to obtain higher service pressures or reduced wall thicknesses (cost savings per foot) and increased hydraulic capacity at the same pressure in comparison to PE3408/PE3608 pipe.

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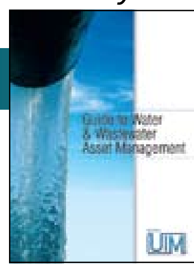
Phase 1 – Fundamentals

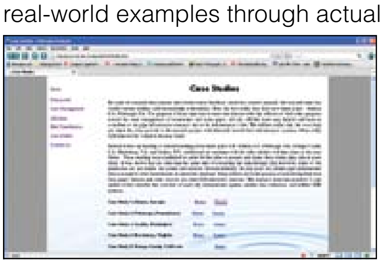
Mastery of fundamental concepts, chapter exams and exercises, studying for the certification exam and taking the online exam.

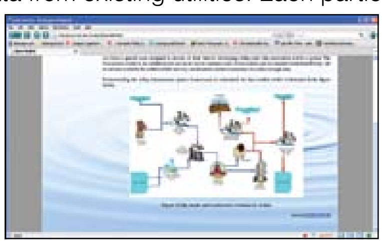


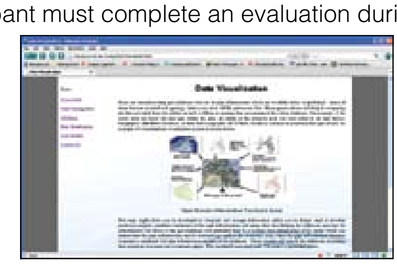
This key reference manual immerses students in the subject matter.

Phase 2 – Practical

Introduces virtual CEMAM (Center of Excellence for Municipal Asset Management). Learn how to utilize the virtual CEMAM with real-world examples through actual data from existing utilities. Each participant must complete an evaluation during this phase.

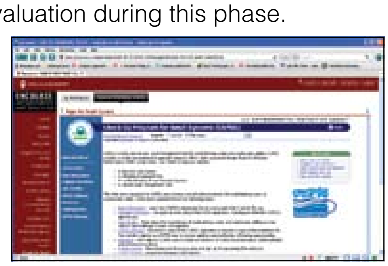






Phase 3 – Application to the Industry

You will become familiar with organizations, institutions, fairs, events and many other activities and resources in the industry. Each participant must complete an evaluation during this phase.



Course registration fee is $345 USD, which includes your manual *Guide to Water and Wastewater Asset Management* (an $80 value), chapter exams, exercises, industry access and your certificate of completion.

For more information & to register visit bami-i.com/index.html, call 330.467.7588 or email vlosh@benjaminmedia.com.

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Earn 1 CEU/ 10 PDHs upon completion

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- It keeps the water flowing without bursts, flooding or eruptions.

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- JM Eagle products have always met—and will continue to meet—the standards of the American Water Works Association.
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Big Blue™ (C905)

Meets AWWA C905 and ASTM D1784 cell class 12454; Gaskets meet ASTM F477; Joints meet ASTM D3139; ANSI/NSF-61, UL 1285.

Ultra Blue™ (C909)

Meets AWWA C909 and UL 1285; Gaskets meet ASTM F477; Joints meet ASTM D3139.

HDPE Solid Wall (AWWA C901/C906)

Meets AWWA C901/906, ASTM D2239, ASTM D2737, ASTM D3035, ASTM F714, cell class per ASTM D3350, PPI listed material (TR-4) PE3408/3608 & PE4710, ASNI/NSF-14.

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