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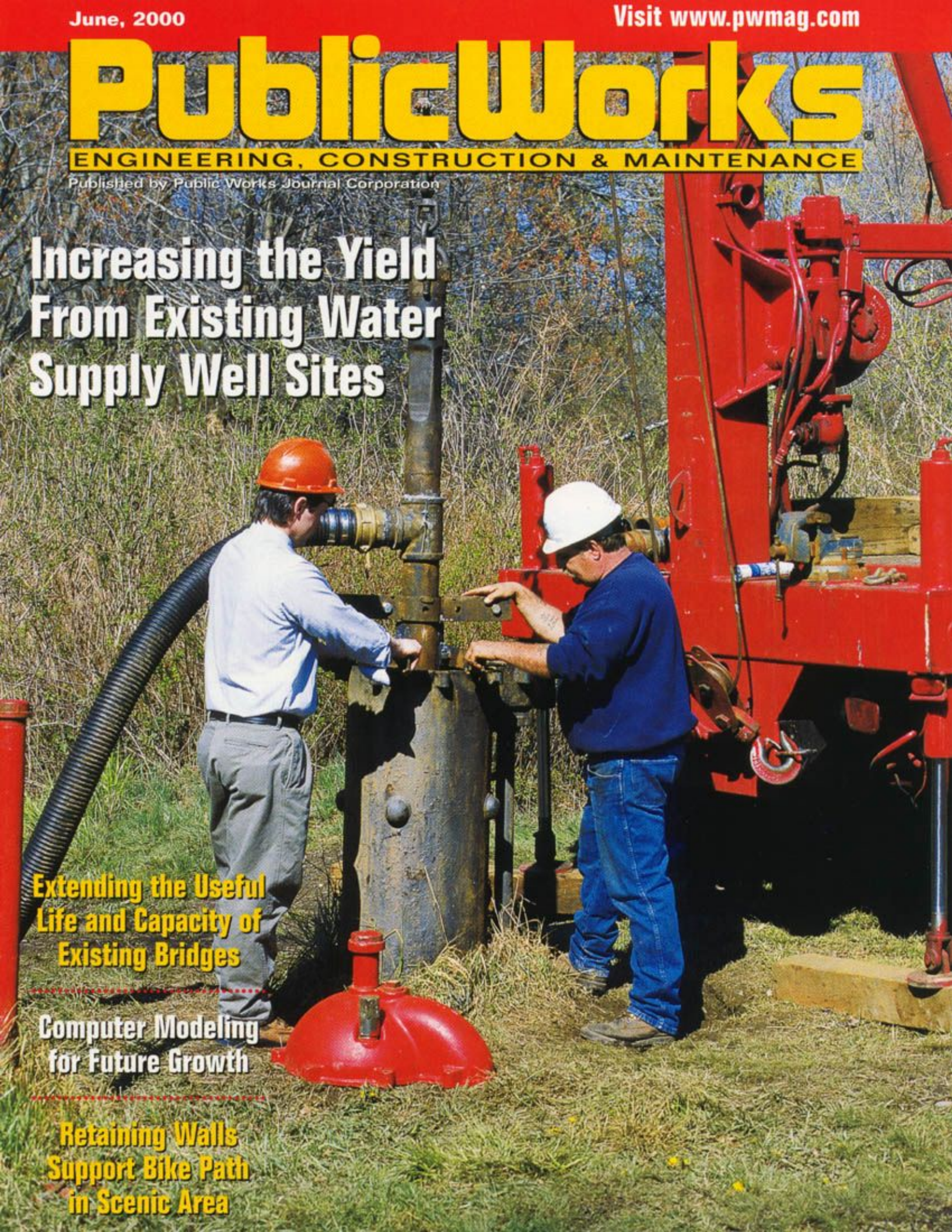
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Increasing the Yield From Existing Water Supply Well Sites

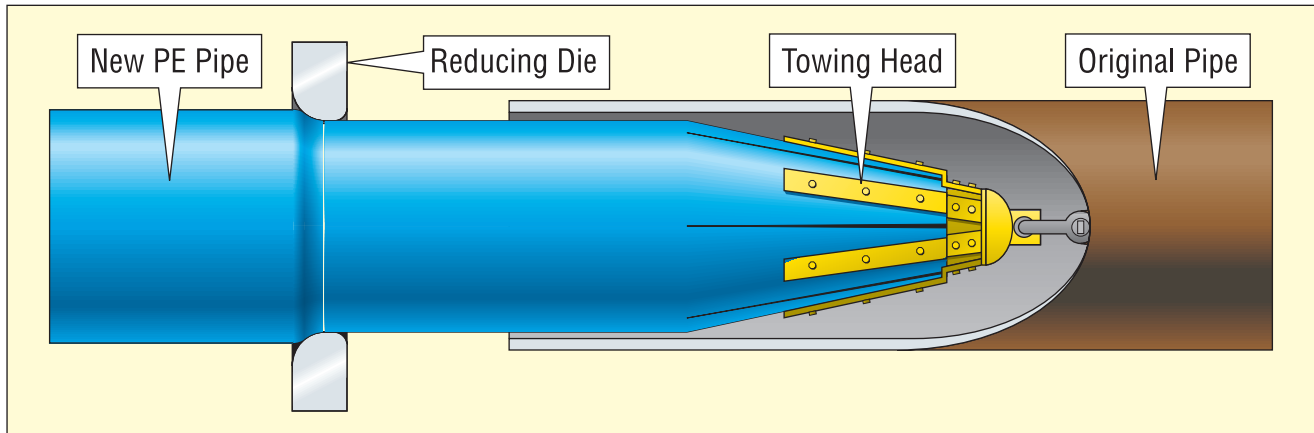
Extending the Useful
Life and Capacity of
Existing Bridges

Computer Modeling
for Future Growth

Retaining Walls
Support Bike Path
in Scenic Area



Pipes Successfully Relined



During routine testing, the Los Angeles Department of Water and Power's (LADWP) Trunk Line Testing Program identified leaks in two trunk lines. The identification of weak points in LADWP's large-diameter pipelines is designed to reduce emergency repairs, collateral damage, and prolonged service interruptions.

The pipelines were between 60 and 70 years old, and the weak sections of both were about 4,000 feet long. One line was 24"-diameter and the other was 36". Both were under moderately busy, multilane streets. The 24" pipe had welded joints and was pressurized to 211 psi. The installation crew had apparently improvised bells and spigots on the square-end pipe joints. It appeared that a tool such as a crescent wrench had been used to bend one end of the pipeline out, and the joining end of the next pipe joint in, before the two pieces were pushed together and welded. The joints in the 36" pipeline were riveted and the water was pressurized to 50 psi.

Mike Grahek

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REPAIR OR REPLACE?

Because of their locations, both pipelines could have been replaced, but they were also in good enough condition to be rehabilitated. Both pipelines were structurally sound, even though the inside of the 24" line was severely pitted, and the exterior of the 36" line was badly corroded. The 24" pipe had originally been coated, inside and out, with coal-tar enamel, but most of the coating on the inside had been worn away or lost to corrosion. The interior of the 36" pipeline had been lined with cement during

the 1960s, and was still in good condition.

When the cost and results of total replacement were compared to various rehabilitation technologies, rehabilitation proved to be the best choice. Rehabilitation would extend the life of the pipelines another 50 to 100 years, and could be accomplished much faster than total replacement, and would cost significantly less. Several rehabilitation options were considered, including built-up cement mortar lining (CML), cured-in-place pipe, and tight-fitting polyethylene (PE) pipe.

The PE liner is pulled through a die which temporarily reduces its diameter and allows it to pass through the host pipe without damaging either the pipe or the liner.

The die has no moving parts. It is a simple metal ring, slightly smaller than the outside diameter of the HDPE.



CML has served LADWP well in the past, but it is possible to get seepage through the material and that would exacerbate the existing external corrosion problem. A pressure-rated, cured-in-place technology is available, but in this case, it was prohibitively expensive. It would have cost almost as much as total replacement. After considering long-term serviceability, cost, and ease of application, a tight-fitting, high-density PE (HDPE) liner was specified for the rehabilitation projects.

Once the specifications were written, bids were taken and the contract was awarded to ARB of Lake Forest, CA. The contract amount for lining the pipes using the Swagelining process was about one-third the estimated cost of total replacement.

THE TECHNOLOGY

Because of its versatility, the Swagelining process has been used successfully to line over 600 miles of pipe, ranging from 3 to 36 inches in diameter. These pipes include water, gas, oil, forced sewer, and a wide range of industrial production lines all over the world, both onshore and off. The process allows an existing pipe to be lined with an extremely tight-fitting PE pipe. Because the PE pipe has an outside diameter slightly larger than the inside diameter of the pipe to be lined, it is pulled through a die during the installation process to

temporarily reduce its outside diameter. This reduction allows the PE pipe to be easily pulled through the host pipe.

Since PE pipes retain a memory of their original size and shape, they begin to return to their original diameter soon after the pulling force has been disconnected. Within hours, the PE pipe presses tightly against the inside of the host pipe, eliminating the annular space. The PE pipes used in the Swagelining process are manufactured to ISO, AGA, ASTM,

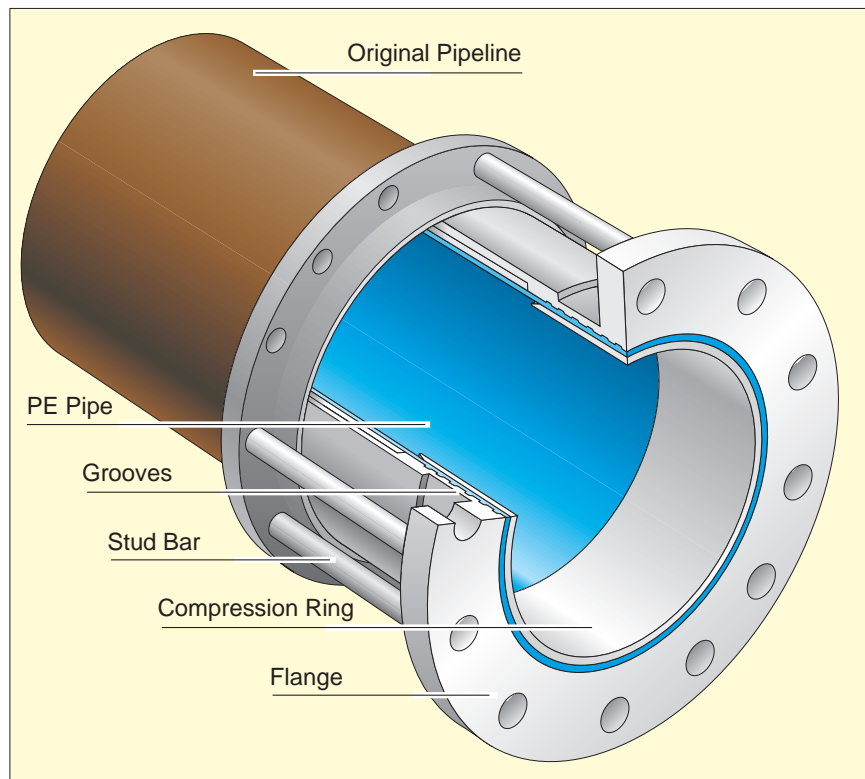
and API standards, so the linings have known physical properties and an established service life.

INSTALLATION

Both pipes were lined with SDR-32.5 HDPE which is rated for 50 psi. So, the liner could stand alone in the 36" diameter pipeline, even though it is not necessary in this case. Single pulls up to 1500' long have been made with the Swagelining process, but the longest pull in these installations was 822'.

Pits were excavated at 500' to 800' intervals along the pipelines to create entry and exit points for the liner. Before each insertion, individual 40' lengths of PE pipe were butt fused together to form a monolithic pipe long enough to extend from one entry pit to the next exit pit.

Just before the fused pipe entered the host pipe, it passed through a simple metal ring, or die, which temporarily reduced the outside diameter of the PE pipe. The reduced diameter was slightly less than the inside diameter of the host pipe, so the PE pipe could be pulled into place without exceeding 50% of the yield strength of the material. As long



as the yield-strength of the PE is not exceeded, no permanent deformation will occur.

Lubricants such as vegetable oil were used to reduce the pulling forces even more. Pulling forces averaged about 22 tons for the 24" pipe, and about 27 tons for the 36" pipe. The average insertion speeds were between 5 and 8 feet per minute.

After the PE liner is pulled through the host pipe, it is allowed to relax until it presses tightly against the inner surface of the host pipe, and its length is stable. In this state, the PE liner extends several feet beyond the end of the host pipe.

RECONNECTING THE LINED PIPE

The lined sections of the pipelines were fitted with special flanges sold by SPF, a fittings company in the UK. The flange assembly is similar to external mechanical couplings which slip over the end of the host pipe, and are bolted into place. The inner surface of the flange's collar

contains several parallel groves which are designed to grip the PE pipe when a compression ring is pressed into the open end of the PE pipe. When the flange is in place, the end of the PE pipe is cut off and dressed flush with the face of the flange.

After the flanges were in place, blind flanges were attached and each section was pressure tested to the operating pressure of the line. The spaces between lined sections of pipe are bridged with flanged steel nipples. These nipples contain air release assemblies, gate valves, blowoffs, or any other required fittings.

POTABLE WATER REHABILITATION

The use of trenchless rehabilitation technologies has been much more widely accepted in other areas than in potable water. That may be partly due to the fact that more stringent approvals are required for use of new materials with potable water. At a minimum, utilities

require all products to have NSF approval, and some require an AWWA specification. Other utilities may be looking at the Green Book for minimum specifications for technologies. All of these approvals take time, but several technologies, such as Swagelining, already have them.

The Cleaning, Lining, and Rehabilitation of Water Mains Committee of AWWA is in the process of publishing a new manual, M28, which will address many of the trenchless rehabilitation processes for potable water which are available today. This publication could help designers, engineers, and contractors research the products which are available to them now.

Based on the EPA Needs Assessment for Potable Water, the industry will need between \$200 Billion and \$300 Billion worth of rehabilitation work over the next 20 years. Faced with such needs, the cost savings offered by potable water rehabilitation processes such as Swagelining are tremendous.

Swagelining can renew pressure pipe quickly and cost-effectively.

Gas

Water

Sewer Force Mains

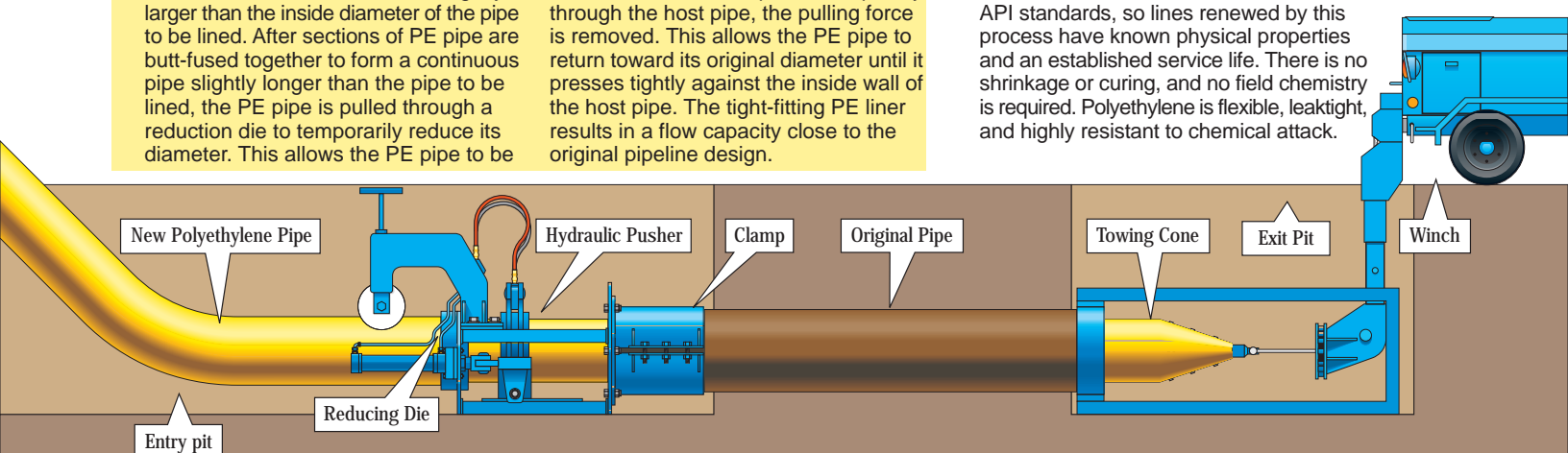
Quick, cost-effective installation saves time and money.

The Swagelining system uses PE pipe which has an outside diameter slightly larger than the inside diameter of the pipe to be lined. After sections of PE pipe are butt-fused together to form a continuous pipe slightly longer than the pipe to be lined, the PE pipe is pulled through a reduction die to temporarily reduce its diameter. This allows the PE pipe to be

pulled through the original pipeline. After the PE liner has been pulled completely through the host pipe, the pulling force is removed. This allows the PE pipe to return toward its original diameter until it presses tightly against the inside wall of the host pipe. The tight-fitting PE liner results in a flow capacity close to the original pipeline design.

Strong, long-lasting, and proven PE pipe.

PE pipes used in the Swagelining process are manufactured to ISO, AGA, ASTM, and API standards, so lines renewed by this process have known physical properties and an established service life. There is no shrinkage or curing, and no field chemistry is required. Polyethylene is flexible, leaktight, and highly resistant to chemical attack.



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