Innovators Past & Present

The Development of Trenchless Technology

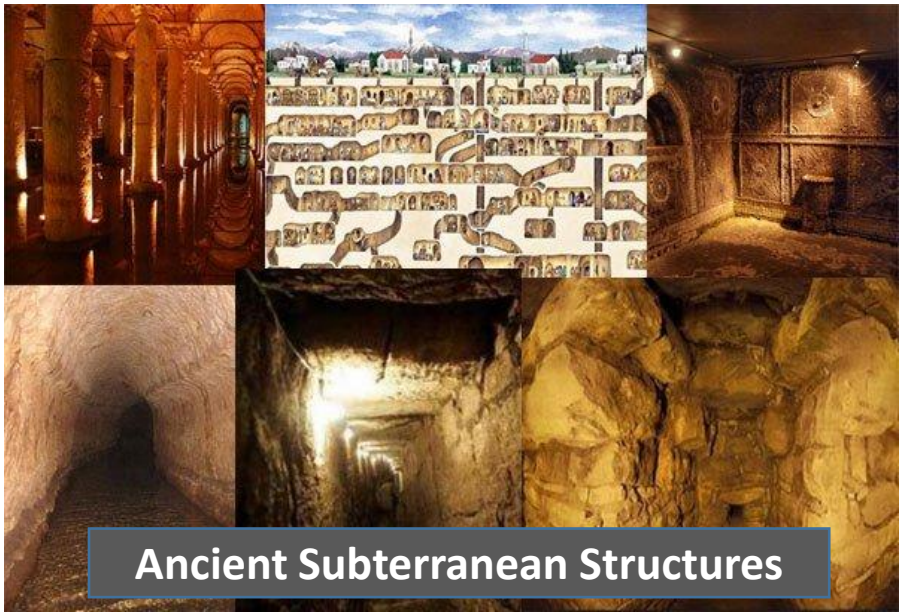
Presenter: Norman Howell

Agenda

- Introduction
- Initial Drivers for Innovation and Change
- Pioneers and the Development of New Technology
  - Cured in Place Pipe (CIPP)
  - Lining Systems using PE pipe
    - Pipebursting
    - Close fit Lining
    - Live Insertion
  - Spray Applied Resin Lining
  - Future Development to meet new Challenges
- Questions & Answers

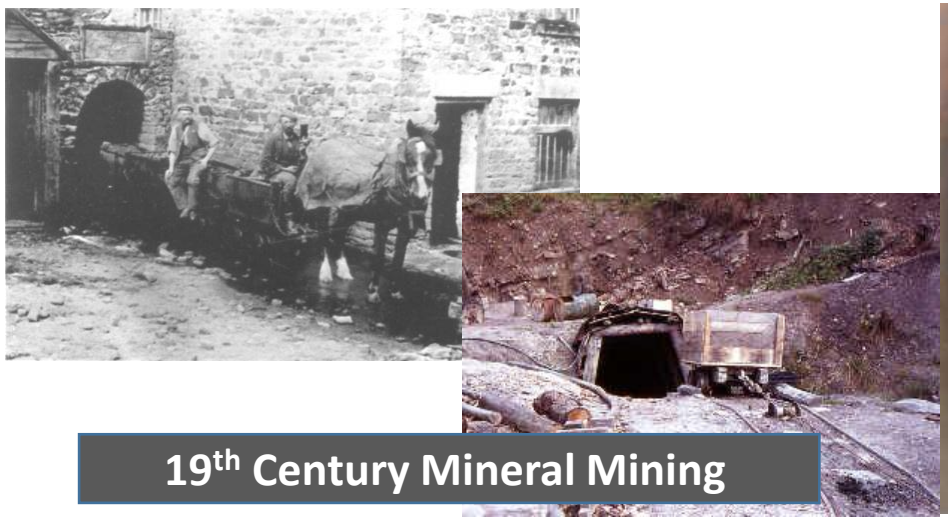
Introduction

Trenchless Technology is not new

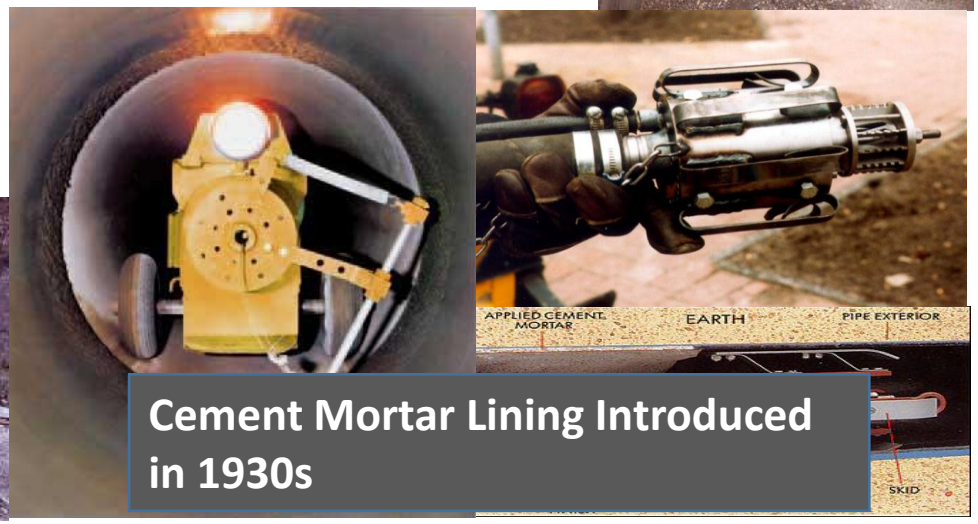


Ancient Subterranean Structures

Medieval Tunnels in Lincoln and Exeter



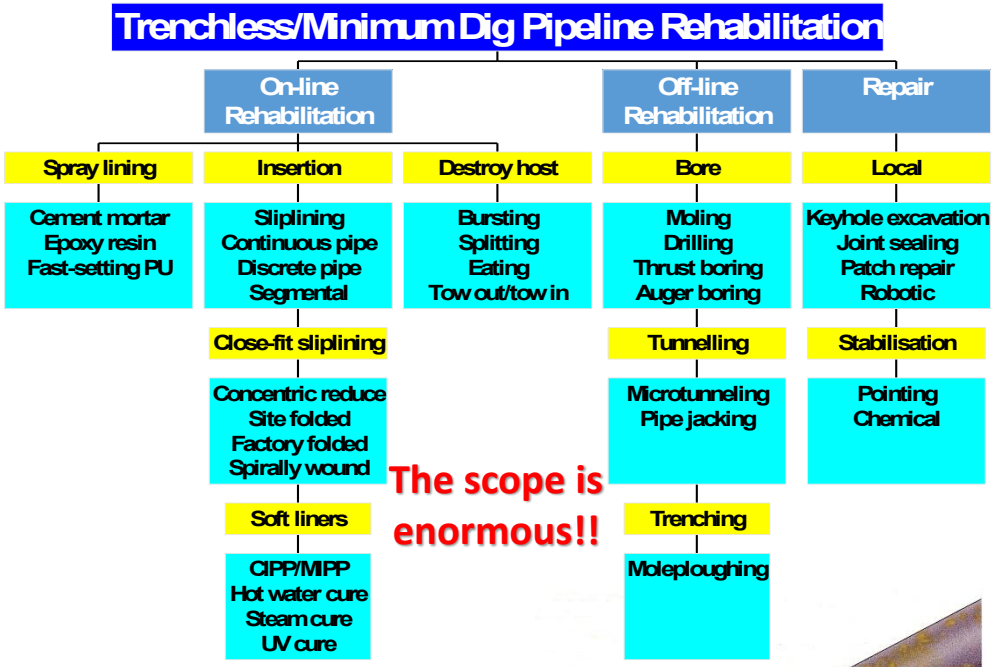
19th Century Mineral Mining

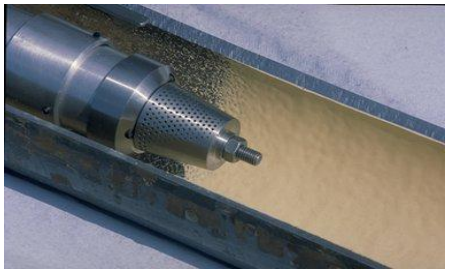


Cement Mortar Lining Introduced in 1930s

Introduction

- Review of the technology developed from the 1970s onward for the rehabilitation of pipelines
- The UK has led the world in the development of many of today's trenchless systems
- These techniques are now considered standard pipeline construction methods
- Now the preferred first option with excavation only used as a last resort
- They have been universally adopted around the world where pipeline networks require repair or renewal





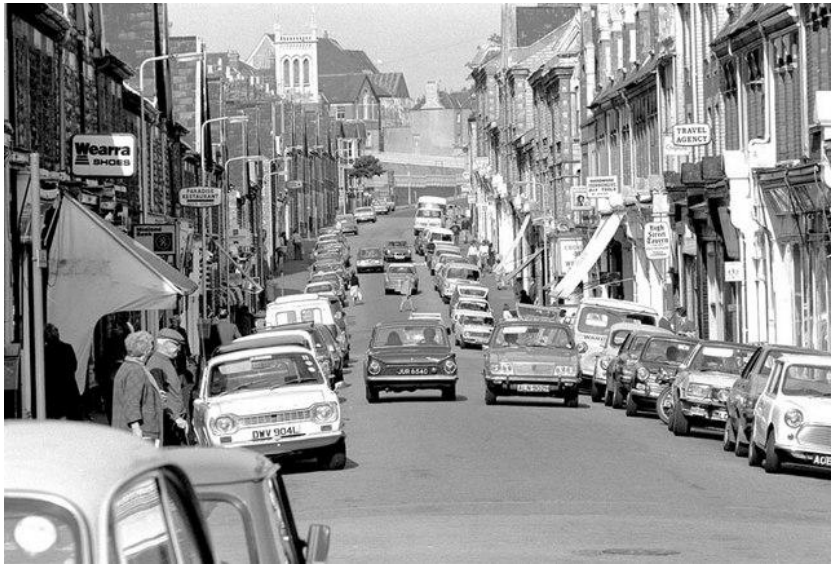
Innovation & Development Drivers

- In the early 1970s, the UK had ageing sewer, water and gas pipeline networks that were failing on a regular basis
- The management of these networks was extremely fragmented:
  - Water & sewer managed by over 170 publicly owned organisations
  - Gas managed by a gas council with 12 area boards
  - No consistent approach to maintenance and renewal
  - Underfunding increased the occurrence of failures

Innovation & Development Drivers

The UK experienced rapid economic growth in 1950s & 1960s

- The need for more reliable networks to meet the needs of industry and the consumer boom
- Reduce the environmental impact of an economy driven by energy derived from coal

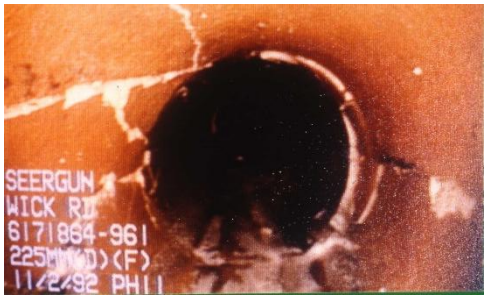


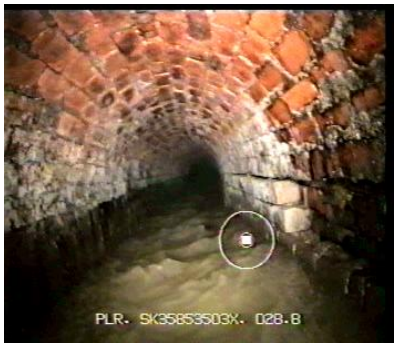
Innovation & Development Drivers

- Restructuring of the Industry – A time of Great Change
  - The Gas Act 1972 – Established British Gas Corporation
  - The Water Act 1973 – Established 10 regional water authorities
  - 1973 EU legislation – particularly water quality
  - 1986 privatisation of the gas industry
  - 1989 privatisation of the water industry
- Other influences
  - Introduction of North Sea Natural Gas 1967 to 1976
  - Government enquiry into serious gas incidents 1976/1977
    - The King Report - Recommendation: All high risk small diameter cast iron pipes to be replaced by 1984
  - Large increase in traffic volumes drove a need to change construction methods to avoid traffic disruption

The Challenge to Industry

- Need to address regular failures of utility pipelines:
  - Remove risk
  - Operate networks safely
  - Provided a reliable service
  - Reduced disruption
- Develop new installation systems and technology
  - To rapidly replace old cast iron gas and water networks
  - Prevent sewer collapses
  - Improve water quality





The Challenge to Industry

- Privatisation
  - Greater focus on efficiency of the networks and reduced operating costs
  - Need to repair, replace and extend existing infrastructure
  - Improved reliability and service
  - Improve stakeholder and customer impacts
  - Reduced disruption and inconvenience
  - Provide environmental benefits by reducing leakage & innovative construction
- Emergence of New Materials
  - Polyethylene pipe
  - Engineering fabrics - Polyester, Glass Fibre Carbon Fibre, Kevlar etc
  - Polymeric Resins – Polyester, Epoxy and Polyurethane

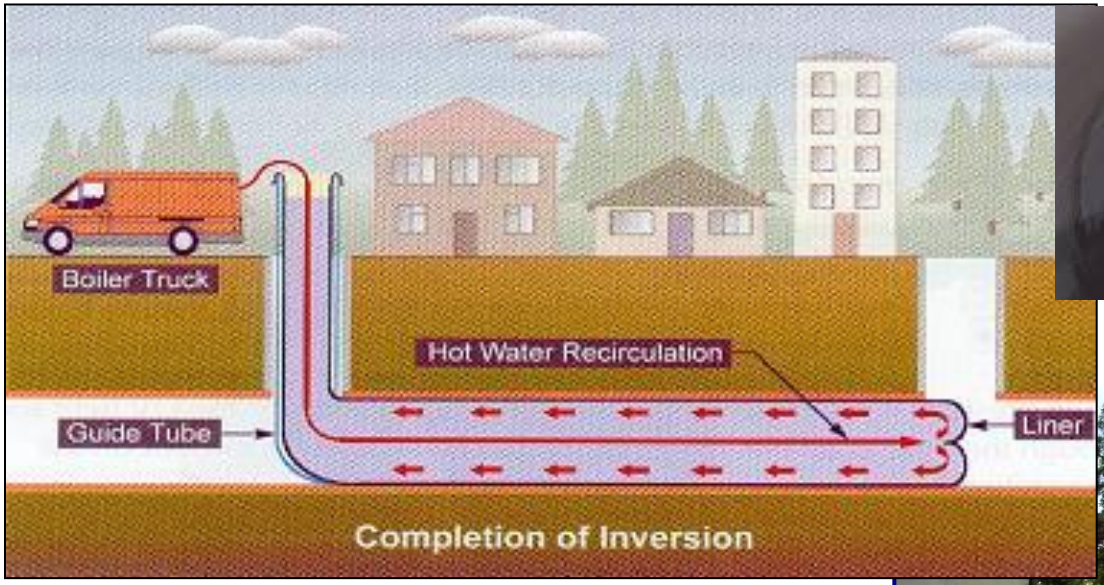


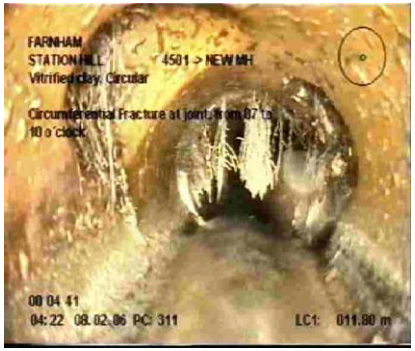


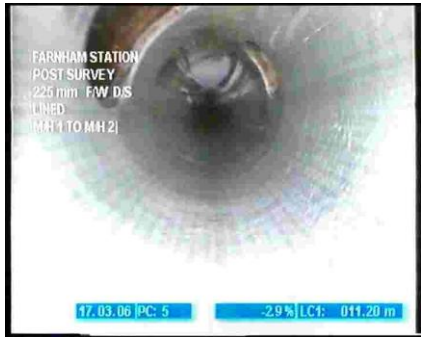



Cured in Place Pipe - Insituform

- Invented in 1970 by British Agricultural Engineer Eric Wood supported by entrepreneurs Doug Chick and Brian Chandler







Trenchless Technologies – Cured in Place Pipe

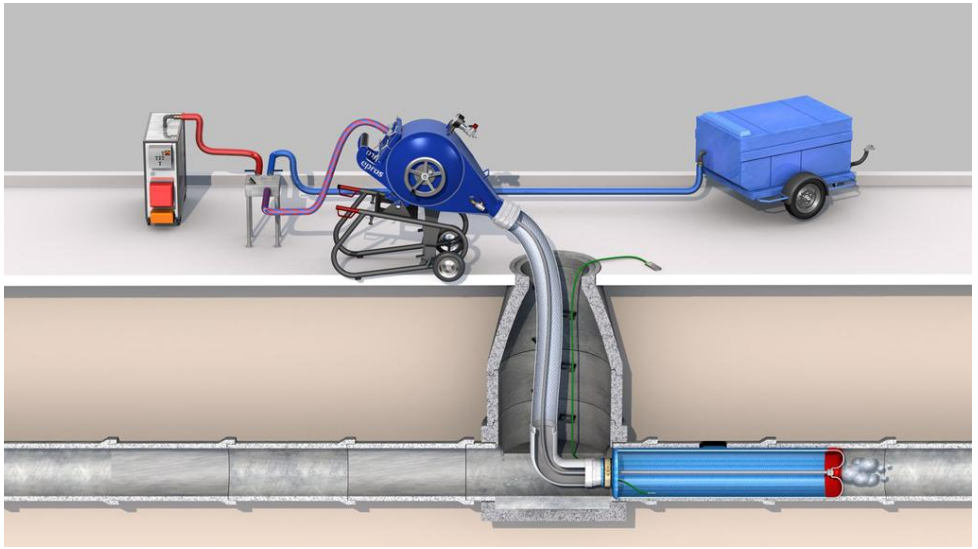
Steam Cured CIPP

Developed 1980 by the Tokyo and Osaka Gas Companies in Japan

Steam cured hose lining systems using woven polyester hose and epoxy and polyester resins

Establishing the PALTEM and Phoenix systems

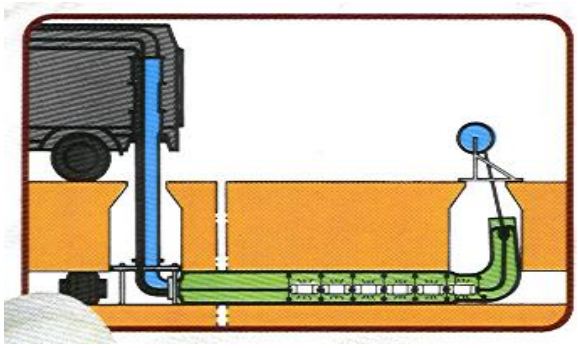
Introduced to the UK in 1983



Trenchless Technologies – Cured in Place Pipe

UV Light Cured CIPP – Patented by Insituform in 1984

Commercialisation inhibited by cost until late 1990s

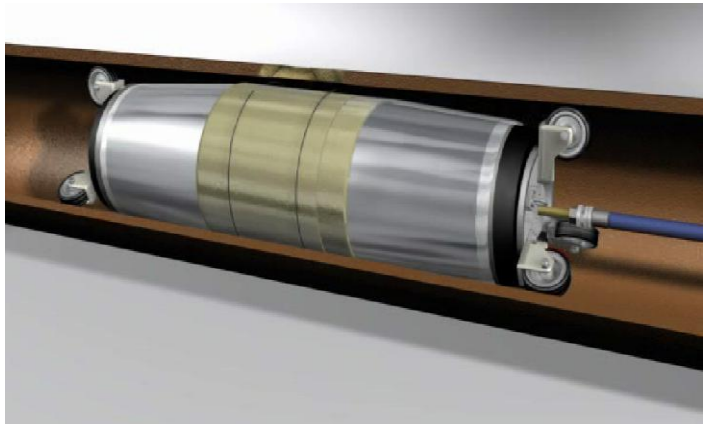


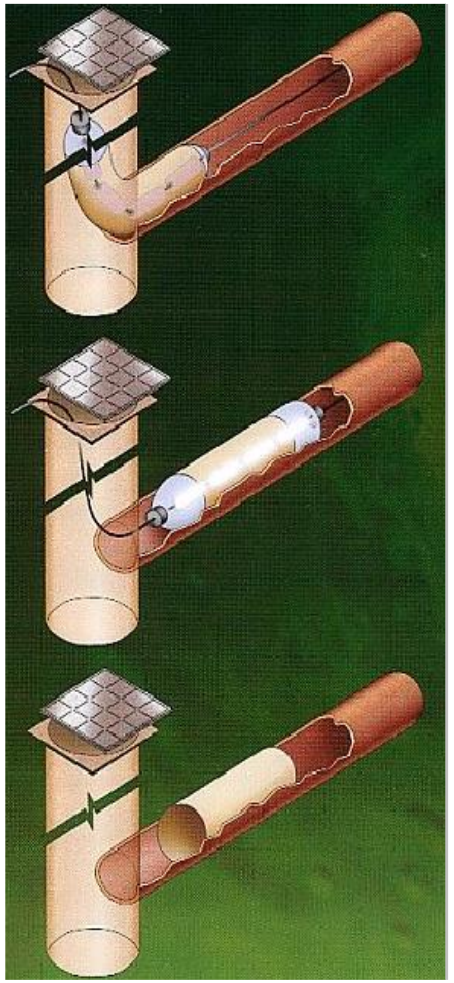
Patch Repairs – Introduced in 1990s

Positioning of a short sleeve of resin-impregnated material within host pipe

Cut-down versions of full-length cured-in-place pipes

More cost-effective than full-length liners where sewer defects are localised

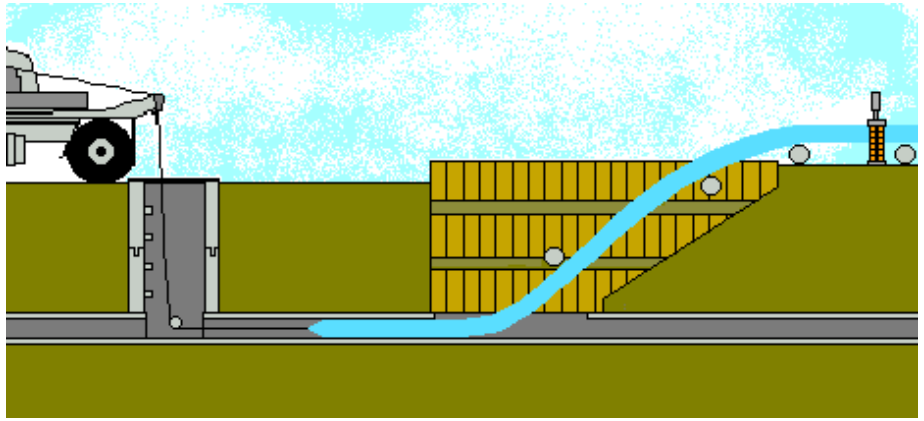




Trenchless Technologies – PE Pipe Systems

British Gas pioneered the introduction of Polyethylene Pipe in the 1970s

- Developed MDPE
- Tough, flexible and resilient pipe
- Sliplining with long lengths of continuously welded PE pipe
- Small diameter connection pipes replaced using impact moles



Pipebursting

Developed by a team of engineers at D J Ryan & Sons Ltd that included Roger England, Alex Whiteside and Roy Streatfield

Originally tested on small diameter gas mains in the Preston and Blackburn area through the foresight of Don Wilson Area Manager for British Gas

Developed into a highly successful system that was licenced throughout the UK and worldwide

Utilised on sewer replacement projects and then into the water industry

Trenchless Technologies – PE Pipe Systems

Trenchless Technologies – PE Pipe Systems

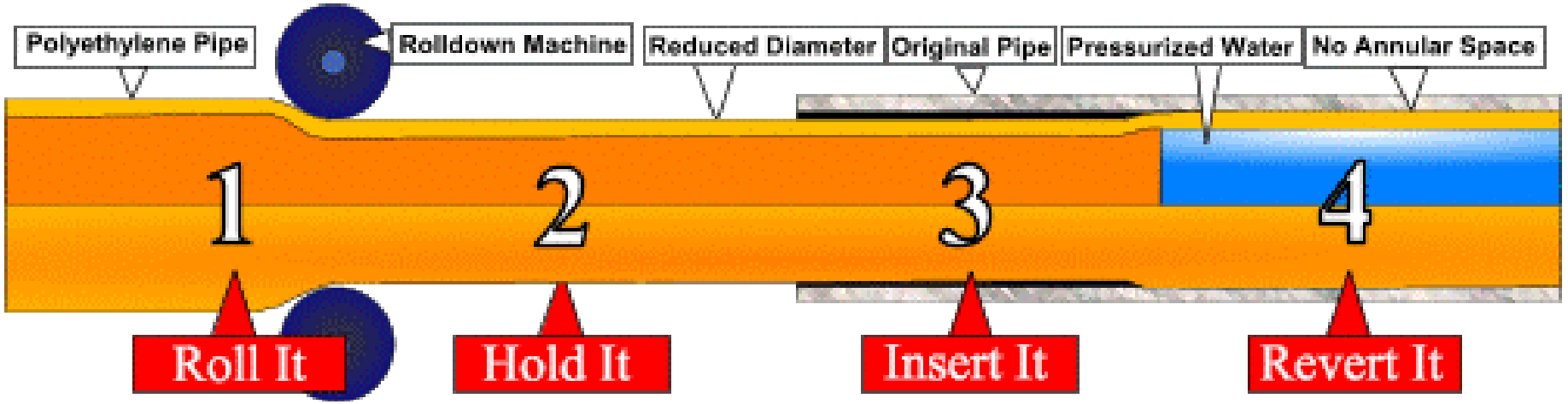
Pneumatic Sewer Systems

Hydraulic Machine Systems

Hydraulic Rod Systems

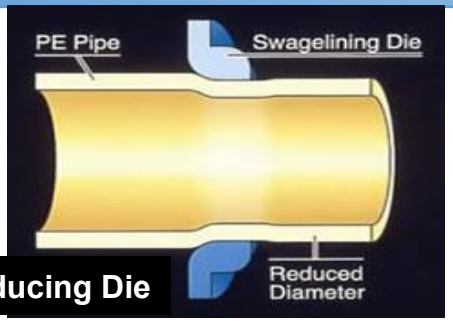
Close Fit PE Lining - Rolldown 1986

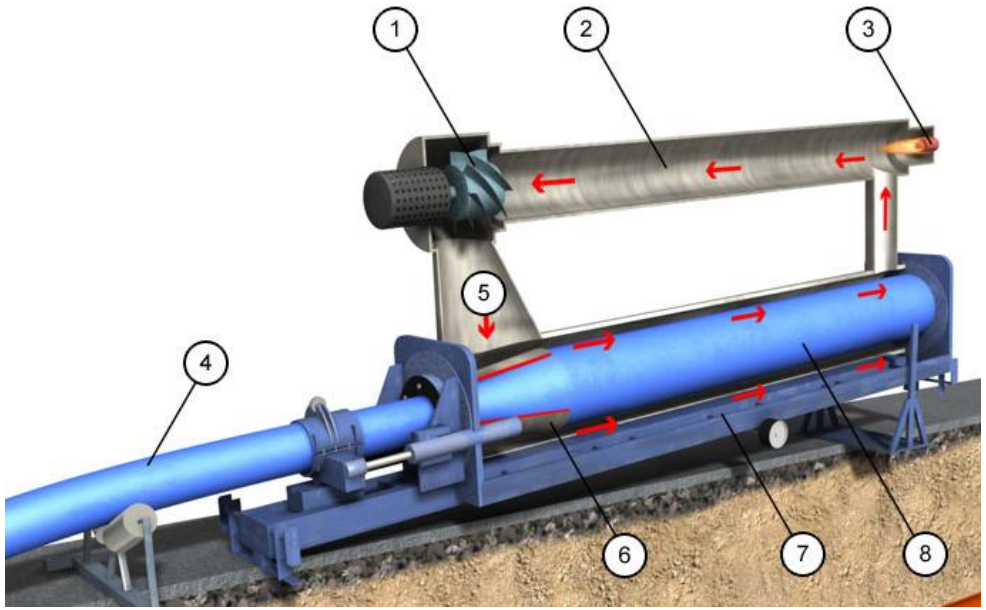
Developed by Subterra - Ray Lippiatt, Tony Poole and Ray Weaver with technical assistance from Alan Headford of S & L Plastics



Close Fit PE Lining – Hot Swagelining

Developed in 1989 by British Gas ERS at its Partington Depot in Manchester under the guidance of Brian McGuire

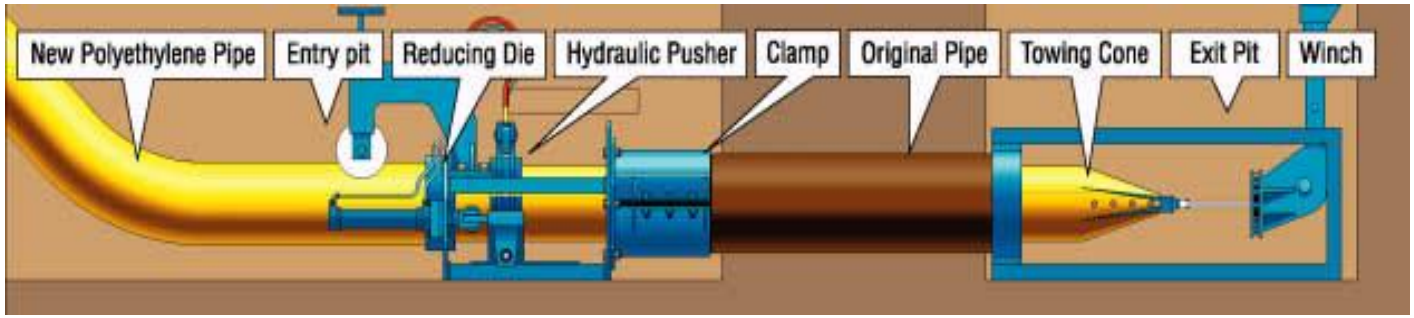


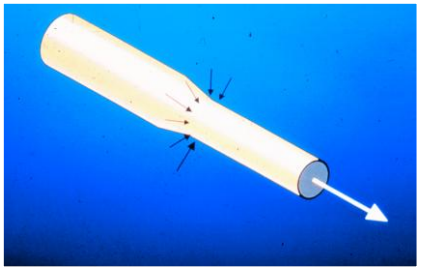


1. Hot Air Blower
2. Firing Chamber
3. Gas Burner
4. Swaged PE Pipe with Reduced Dia
5. Hot Air
6. Die
7. Rig Frame
8. PE Pipe

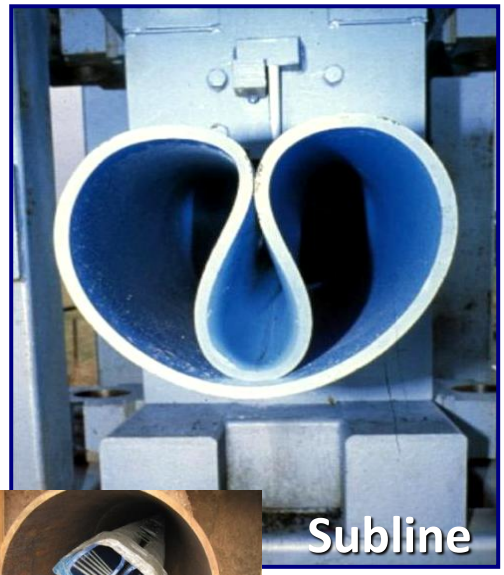
Close Fit PE Lining – Cold Swagelining

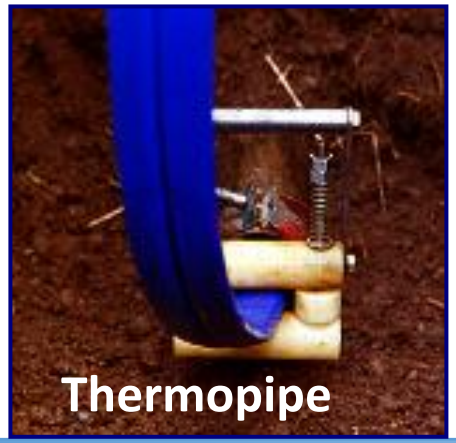
Developed 1990 by North West Water and Pipeline Developments Ltd under the Guidance of Phil Marshall, Malcolm Birch, Dave Pearson & Nick Preston





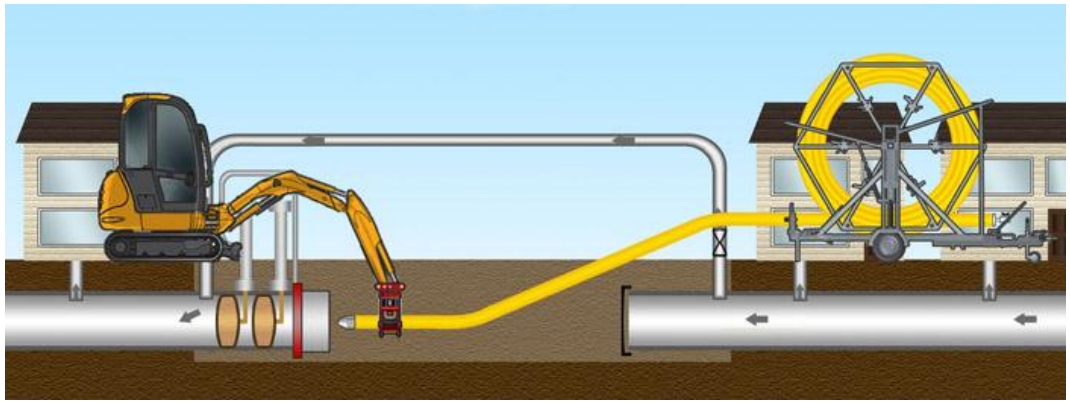
Close Fit Lining – Folded Systems





Live Mains Insertion

Devised in 1982 by Douglas Soper and Brian Gould of British Gas, known as The Blackburn Method



Steve Vick International - Commercialization of the system

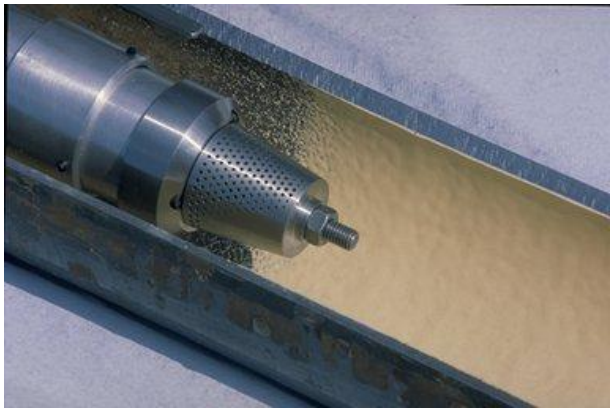
Further developed in 1989 by SVI and Gaz De France using the Lyontec Disposable Gland Box

Trenchless Technologies – Resin Lining Systems

Spray Applied Epoxy Resin Systems

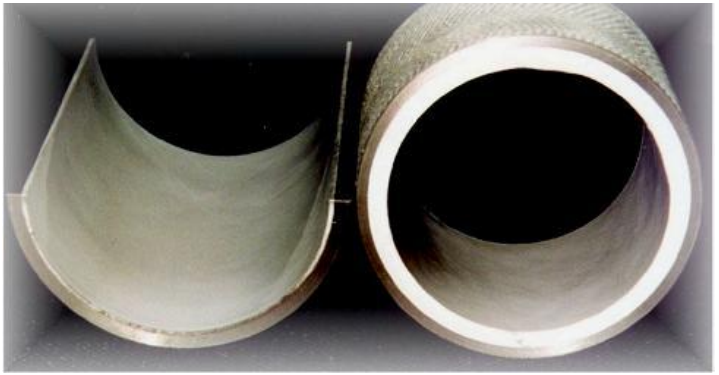
Developed by Mercol under the guidance of Bill Bradley, Noel Miller and John Weatherall, with technical assistance from Ian Warren of WRc – Geopox Resins

Epoxy Lining Consortium established by Ray Lippiatt of Subterra & Harry Hodge of QED, with representatives from 9 water PLCs with technical assistance from Ian Warren – ELC Resins



Spray Applied Polyurethane Resin Systems

Developed by E Wood Ltd under the guidance of Ian Robinson & Chris McDonnell – Copon/ Scochkote Resins



Trenchless Technologies – Resin Lining Systems

- **Low Build Application**
  - Non-structural solution
  - Epoxy or Polyurethane
  - Thin linings - 1mm thick
  - Combats water quality issues

- **High Build Application**
  - Semi-structural solution
  - Polyurethane only
  - Linings up to 5mm thick
  - Targeted to seal leaks & gaps and withstand typical distribution pressures

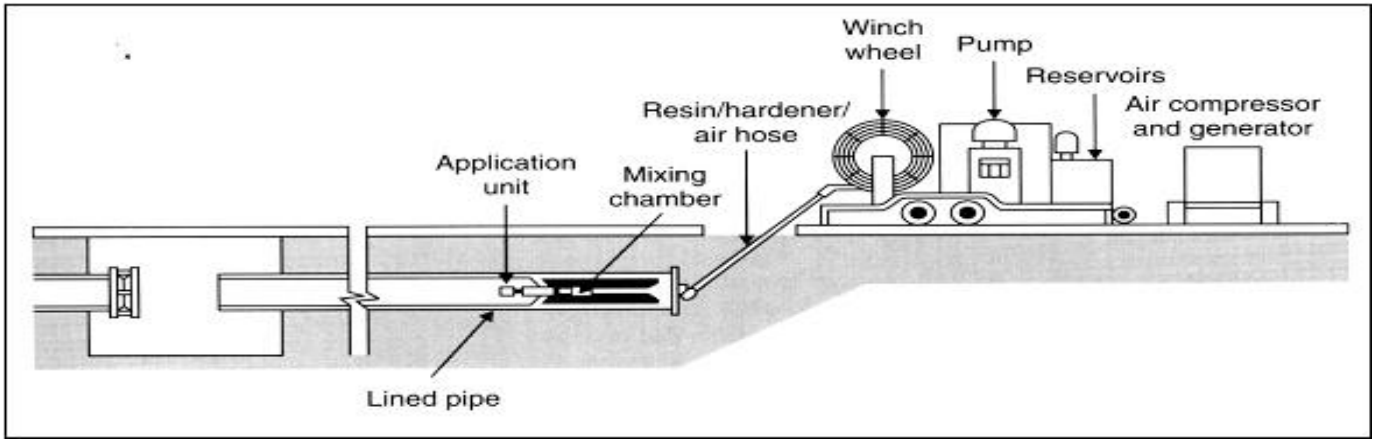
- **Key Considerations**
  - **Epoxy**
    - 16 hour cure by Regulation
    - customers off water for 36h minimum
  - **Polyurethane**
    - Maximum 2-hour cure
    - Same day return to service

Trenchless Technologies – Resin Lining Application

Lining Rig


Resin Pumps


Lining Rig




Spray Head

Umbilical Hose


Controller

Future Developments to Meet New Challenges

Drivers & Challenges

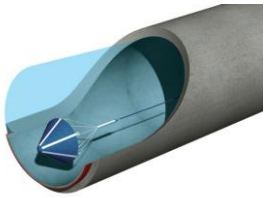
- Customer
  - No disruption to service
- Environment
  - No excavation
  - Carbon reduction
  - Limit impact of works
  - Reduce traffic disruption
- Economic
  - Smarter & faster
  - Reduced cost
- New live rehabilitation systems?
- Network owner support
  - Integral to success
  - Not all innovation succeeds!

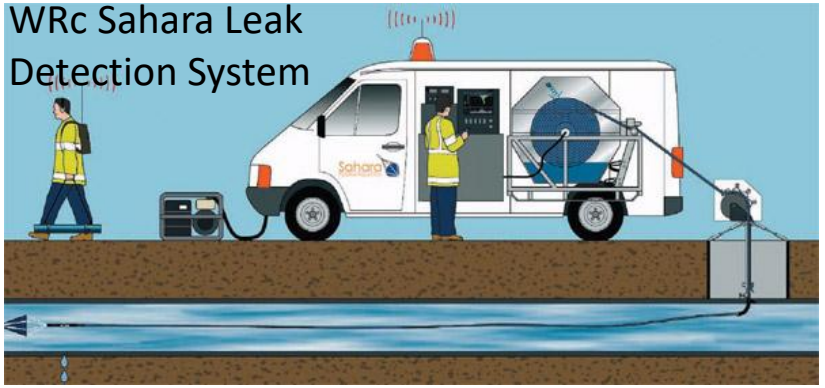
Synthotech Live
Gas Main Camera

JD7 Live
Gas Main Camera

Air Scouring

Aqualogy Ice Pigging





WRc Sahara Leak
Detection System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Norman Howell Associates Ltd
Innovation, Expertise, Experience