Doc No	Year	Conference	Title
	2000	Perth	**Underground Transport of Goods Through Tubes**
	2000	Perth	**Microtunnelling Status To Date and Future Development**
	2000	Perth	**Developments in Microtunnelling Technology and its use in Australia**

2000 Perth **The Expanding Role of Trenchless Technology in Underground Construction**

2000 Perth **He Who Pays The Piper**

2000 Perth **Tomorrows Solutions - Protecting The Environment Through Exposure of Utilities and Site Remediation**

2000 Perth **Where is there a place for Trenchless Technology in Major Wastewater System Upgrades**

2000 Perth **Rotaloc - Australian Designed and Developed No-Dig Process. A Stunning Advancement in Renovation Technology**

2000 Perth **Northside Storage Tunnel - An Innovative Alliance and Community Relations Approach**

2000 Perth **GC Method - Glass Reinforced Insituform Liners - for Large Diameter Structures**

2000 Perth **Selecting the Right Downhole Tools**

2000 Perth **Pipe Defect Characterization by Multi-Sensor Systems**

2000 Perth **Microdirectional Drilling in Thailand**

2000 Perth **Partnering: When a Contract Is Not Just A Contract**

2000 Perth **Environmental and Social Costs Evaluation for Innovative Dig Techniques**

2000 Perth **Geophysical Survey Systems Inc. Ground Penetrating Radar (GPR) Systems Pathfinder**

2000 Perth **Low Cost Solutions For Managing Large Diameter Pipelines - High-Tech Systems for Assessment, Maintenance and Refurbishment**

2000 Perth **A Risk Approach to Lining Design and Selection**

2000 Perth **Continuous High-Precision Position-Detection System Utilizing Fiber-Optic Gyroscope for Microtunnelling Machines**

2000 Perth **The Use Of Micro tunnelling for the Infill Sewerage Program**

2000 Perth **Evaluating No-Dig Companies for Potential Investment**

2000 Perth **Failure of Joints Between Manholes and Sewer Pipes Due to Live Loads**

2000 Perth **SW-101, A Bentonite Based Drilling Fluid for Brackish and Seawater Applications**

2000 Perth **Development and On-Site Introduction of Super Long Distance Pipe-Jacking Method (Double Layer Injection Method)**

2000 Perth **Horizontal vector jacking force and tail void measurements for sharp curve jacking as well as the mechanisms involved**

2000 Perth **Walk-over Locating Technology**

2000 Perth **Research Concerning the Reduction of Resistance on External Pipe Surfaces**

2000 Perth **Close-Fit HDPE Relining up to 3500mm Diameter With the Trolining® System**

2000 Perth **CIPP - Cured in Place Liners**

2000 Perth **Assessments of Face Loads During Microtunnelling Operations**

2000 Perth **R & R Aspects of Trenchless technology at the Heart of Europe - in the Czech Republic**

2000 Perth **New Developments in Trenchless Lateral Collections**

2000 Perth **Stormdrain and Culvert Rehabilitation - The New Market in Trenchless Technology**

2000 Perth **Danish Quality Control Scheme for Pipeline Rehabilitation**

2000 Perth **Development of the new Pipe-Roof Jacking Method Named "Return-Recovery Type"**

2000 Perth **Advancements in Directional Drilling Guidance Technologies**

2000 Perth **Present Scenario and State of Awareness of Trenchless Technology in India**

2000 Perth **Geophysical Methods for Defect Mapping and Pipeline Integrity Surveys also Utility Risk Analysis**

2000 Perth **Rehabilitation Method by Mortal Injection Using Slurry Pipe-jacking**

2000 Perth **New Australian developed and patented trench pipe-line technology for water, waste water and gas pipelines**

2000 Perth **A New Design Method for Non-Circular Sewer Linings**

2000 Perth **Trenchless Technology Market in Australasia**

2000 Perth **The Economics of Sewer Lateral Rehabilitation**

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Abstract
This paper deals with the development on underground transport of goods through tube systems as an option to aboveground transport alternatives. It is an additional development to the traditional transport of liquids and gasses through pipelines and it could be seen as a system innovation comparable to the introduction of the metro. When considering all aspects the preferred solution for an Underground Logistic System (ULS) for goods would be a network of (concrete) tubes with a diameter for around 3 metres at a depth (top of tube) of 3 to 5 metres below grade. As regards the transport system in the tube itself, it should be unmanned and the pallets/containers should be simply incorporable into the existing system of sea, road, railway and aeroplane containers.

In the past 20 years, microtunnelling has gone through a stormy development from both a technical and economical point of view – beginning in Japan followed by Germany. Gigantic infrastructure-related programs played a deciding role in the fact that this development became a necessity. We know today what microtunnelling can achieve and know of its high value in particular with regard to infrastructure-related projects in high density areas. The question arises: What will the future bring? To be honest, I am not sure myself. However, I will try to sketch some tendencies and options for development in order to show the direction we are headed for. First, though, let me determine where we are regarding the state of the art. If we define microtunnelling as trenchless, remote controlled, high precision pipejacking, we can assume the upper limit for possible inner diameters to be about 3000mm, because larger pipe sizes are rather the rare exception due to the transportation problems involved.

Microtunnelling technology is changing quickly with new digital guidance and control systems, higher power and greater exibility to changing ground conditions. The size of equipment is changing with systems supplied at over 3 metre diameter and new technology allows cutters to be changed underground. At small diameters, equipment in Perth is now successfully installing 150mm pipe over 100 metres in single drives, so allowing trenchless installation for a greater number of projects. Small diameter rock heads, which in the USA have been used successfully at 900mm OD for drives of 250 metres. The paper will discuss the latest techniques and developments with examples from Australia.

This paper summarizes the types of changes in underground construction and repair expected in the coming decades and how trenchless technologies can be further developed and integrated into the planning, design and management of underground facilities. The historically erratic advances in underground construction technology are reviewed and compared to the rapid current developments in trenchless techniques. Future application opportunities and problems are identified both within the underground utility system arena and as special techniques within a broad variety of underground works

Over the past twenty years, contracting in the UK water industry has changed dramatically. Specifications produced by the client's 'in house' technical resources used to ensure that he not only paid the piper, but called the tune as well. Now, the 'in house' technical resources have gone, contracts are let on a 'design and build' basis, and all too often, the piper himself calls the tune, and is paid for the privilege. Partnerships attempt to reconcile the client's objective of minimum cost and the contractor's objective of maximum profit, but only work if the terms are drafted fairly and clearly. Contractors profit or perish, and buried infrastructure can hide a multitude of sins. Great progress has been made in rehabilitation techniques, yet the benefits are squandered unless sufficient technical expertise is applied to design, selection, procurement, and installation. To achieve cost-effective rehabilitation, the network must first be fully described in terms of its present performance and condition, and then in terms of the performance required of it in the future. Techniques and materials m
The intent of this presentation is to introduce the concept of Vacuum Excavation and Remediation. This will be accomplished by initially discussing the three most common methods: pneumatic, mechanical, and slurry. To further reinforce this methodology, the paper will break down the system into component parts, and elaborate on how these individual pieces contribute to the effectiveness of the total system. Finally, this paper will show the unit in actual operation on a directional drill jobsite to give the audience a flavor for how the system can benefit the construction industry. With the rapidly increasing use of Directional Drilling techniques being used for the installation of buried utilities, it is becoming imperative that non-destructive location and exposure of those services along the bore path be done prior to the boring operation. Even though exposure, in one form or another, has been used in the United States for almost 40 years, it is just beginning to be realized as beneficial for addressing a vast array of problems when working near buried service lines. The intent of this paper is to

Trenchless Technology for wastewater system rehabilitation has developed as a process most suitable to solve structural problems in conduit systems to prevent collapse. This limited approach view has resulted in the restriction in most cases of trenchless technology to the one off difficult repair job. This has to a large extent restricted the use and spread of trenchless techniques in the wastewater industry to a level way below what has been anticipated. The efforts of contractors to direct the application of trenchless technology without proper engineering planning and control have compounded this. There is a need for upgrading the performance of most wastewater collection system to meet ever increasing community and regulatory requirements. Asset management strategies and plans are being developed to address current collection system deficiencies and to cater for future system needs. The opportunities of Trenchless technology to meet a significant portion of these needs is dependent on a paradigm shift in the trenchless technology industry to realise that contractor process heralds a new era in pipeline renovation. The Rotaloc process is fundamentally different to Rib Loc's current renovation process as it incorporates a unique winding machine that travels through a deteriorated pipeline, producing a structural spirally wound plastic liner as it progresses. The winding machine has the ability to expand and contract in diameter as it winds thereby making it possible to negotiate dimensional changes in the host pipe. Additional features allow the winding machine to locate and mark lateral connections for subsequent reinstatement. The system uses a factory manufactured plastic profile which will eventually be steel reinforced where increased stiffness is required. As the profile is preformed in a factory, installation becomes the simple action of locking together successive wraps using a rotating mechanical process. The combination of this preformed profile and the Rotaloc winding process leads to a system that has a high speed of installation. This is not only due to the speed of the windin

Pollution of Sydney Harbour following wet weather is a key issue of community concern. Faecal contaminants in sewage overflows can make many harbour beaches unsuitable for swimming after heavy rain and can raise public health concerns for recreational use of the harbour. The $451 million Northside Storage Tunnel is the State Government's single largest early action measure identified by Sydney Water's WaterPlan 21 to manage harbour pollution. The Tunnel, with the prime objective of reducing pollution of the harbour by capturing wet weather sewage overflows was deemed a high priority by the NSW State Government to ensure a cleaner Harbour for the Sydney 2000 Olympics.

The lining of large and non circular conduits with cured in place liners is often limited by the thickness of the polyester liner necessary to withstand hydrostatic buckling due to ground water pressure. Iida Kensetsu have developed and refined a method for strengthening critical areas of an Insituform cured in place pipe liner by positioning glass reinforced plastic panels at critical sections of the host pipe which bond effectively to the inverted polyester impregnated lining tube during curing of the resin. This process, now patented in Japan, is recognised as an improvement of the original Insituform Process™. By positioning the reinforcing panels at zones of the liner subject to the highest buckling forces the installer can utilise a composite of lesser overall thickness than would be required from a regular polyester liner. The use of reinforcing panels in the composite liner can enhance project feasibility in large and irregular shaped pipelines such as box culverts and ovoids. The design principles involving detailed structural analysis were determined through a programme of work u
One of the most important aspects of horizontal directional drilling technology is downhole tool performance. This paper describes new downhole tool developments and factors to consider for selecting the correct downhole tools for various subsurface conditions. The attributes of different downhole tools will be examined in a manner that will explain what characteristics make certain tools more effective in various soil conditions.

Worldwide, pipeline systems differ in age, manufacture, length and system configuration. However, in all cases they require a large infrastructure investment, which for many cities and towns is one of their largest capital investments. Pipe leakage for these towns and cities can be a major problem, both from an environmental point of view, as well as the costs that are incurred due to overdesign of the sewerage systems and the treatment of additional potable water, lost due to leakage. It is essential to maintain pipelines to guarantee that they operate correctly and that external costs (i.e. contamination of ground water) associated with exfiltration and infiltration are minimised. To minimise these problems, damaged pipelines have to be replaced or repaired. Pipeline repair and rehabilitation methods can provide utility owners with cost effective alternatives to total replacement. However, making the correct choice of a repair or rehabilitation method is critical as it can significantly affect the total lifecycle cost of the system. A key issue governing the selection of correct rehabilitation technologies is the a

This paper will discuss the uses of micro-directional drilling techniques on a Bangkok Municipal Authority (BMA) sewer project in Bangkok, Thailand. This sewer project was installing new 2.2 meter storm water tunnels and laterals to separate the storm water system from the sanitary sewer system. The main tunnels were installed by microtunneling and have been completed. The laterals to connect smaller storm water pipes to the main tunnel through a series of interceptor chambers are on going. Current methods of conventional pipe jacking for storm water laterals to connect interceptor chambers to the new main storm water tunnels have been time consuming and ineffective. The lateral connections tie in an interceptor chamber to the main tunnel with a drop in elevation of 6 to 7 meters. In the original plan a coring contractor was hired to core the main tunnel and a separate pipe jacking contractor would then come in to jack the pipe. This was ineffective because of obstacles, lack of steering control and time consuming set up and tear downs.

Prior to 1998/99 nearly all sewer pipeline renewals for South East Water Limited were carried out via a competitive tendering process on a project-by-project basis. While this provided work for a number of contractors, it was not continuous for any of them. As nearly all the work is carried out using trenchless technology, this meant there were times when expensive machinery was lying idle. Consequently, contractors had no incentive to invest in new equipment or new technology. On South East Water's part, considerable time was spent preparing detailed plans and specifications. All parties then devoted time and resources in preparing and submitting tenders and then going through a detailed tender assessment. A better approach was considered to be through the development of a longer term contract similar to that adopted by South East Water for its Civil and Mechanical/Electrical Maintenance Contracts. Following the success of an initial 12-month contract in 1998/99, Advanced Underground Technologies P/L was awarded a three-year contract (1999/2000 to 2001/2002). The contract was awarded on the basis of their price and past perfo

New dig technologies, as no-dig techniques and minitrench/microtrench, can help to reduce some negative impacts on the environment and on the community when infrastructures for outside plants are building. These impacts can be represented as costs. In this paper the following components of the global dig cost are investigated:

1. Construction and restoration costs are direct costs needed to carry out the construction or maintenance activities and then to restore roads and/or pavements, in terms of materials, machinery, permissions and fees.
2. Social costs arising from interference with other transport infrastructures are generated when the construction yards occupy the transport ways, partially or fully. For example: additional costs for the user of the transport infrastructures, related to a longer journey time or to the additional fuel necessary for a journey.
3. Risk costs are related to the damages that can be caused when a dig technology is used. For example: damages to other infrastructures and services, accidents occurred to the workers or to other persons.

The GSSI PathFinder System opens a new generation in GPR technology. It is designed for fast and accurate mapping of pipes and other underground utilities. The antenna array continuously collects multiple polarization subsurface data, which guarantees that no targets are missed and closely spaced utilities are detected individually. The system position is monitored by the LaserGrid positioning system or differential GPS. Assisted by the positioning system, the processing software assembles survey lines into a 3-D model of the surveyed area – a true picture of the subsurface. This is a significant improvement over single-line data analysis. All radar hardware is contained in a wheel-mounted Main Unit – no more cables and boxes to drag around. The operator controls the system and collects data using a compact wearable PC with a heads-up display.

The world's ageing pipeline infrastructure continues to decline. Large diameter pressurised pipelines are reaching the end of their economic lives and their owners and operators have few tools available for reliably assessing their condition, analysing their renewal options, and extending their effective lives. Through a successful nine-year research programme, the Water Corporation of Western Australia has developed groundbreaking asset optimisation techniques, equipment and capabilities. These methods result in renewal costs a little as 25% of the benchmark cost of conventional alternatives and defer the major cost of wholesale pipeline renewal by 20 years or more. This is the key to slashing the whole of life
costs for the asset by 50% or more. Over the past 20 years, much focus has been placed on developing trenchless inspection and repair techniques for small to medium diameter gravity pipelines, whilst their large diameter pressurised cousins have been ignored, largely due to the difficulty and cost of accessing these pipelines for condition assessment and repair. This has resulted in a lack of relia
The rehabilitation of conduits by lining is implemented by asset owners to improve the operation or to prolong the life of their pipeline assets. The decision is usually made prior to the conduits reaching the end of their useful life and is based on the premise that preventative maintenance is more cost effective than wide scale renewal or replacement. As such the decision to rehabilitate is one based on risk, in this instance, the risk of averting possible future costs if the conduit fails to satisfy its functional obligations. However, the consideration of risks does not stop here, as all future decisions on the design and selection of the lining must also consider risks associated with the installation and long term performance of the lining. This paper discussed how a risk approach can be used in the establishment of design criteria and selection of lining systems to ensure the asset owners' original intent are continued to be met after the decision has been made to rehabilitate their conduits.

NTT has developed a new position-detection system incorporating a high-precision fiber-optic gyroscope, as a technology for use in detecting the position of trenchless microtunneling machines. This system has eliminated the limitations on applications seen in earlier position-detecting methods resulting from line configuration, and it also makes possible continuous real-time measurements, thus lowering the risks accompanying the management and control of microtunneling machines, while also making it possible to achieve more efficient and automated position detection. In sum, the integration of this continuous, high-precision position-detection technology with microtunneling directional control technology allows the realization of a high-performance microtunneling control system.

This paper reviews the role of trenchless technologies in the construction of sewers for the Infill Sewerage Program. The majority of sewers constructed have a diameter of either 150mm or 225mm. It is the small size of these sewers which has led to the development of new methodologies to assist this program achieve its aims. The paper provides:
• An overview of the types of trenchless techniques used in the In.ll Sewerage Program, plus the areas they are best suited, the limitations of each method and the expected production rate.
• The design requirements to maximise the effectiveness of trenchless techniques.
• The geotechnical investigations required to ensure trenchless techniques are successful.
• A comparison of the cost of trenchless techniques compared to open excavation.
• Highlights the disadvantages of open excavation compared to trenchless techniques.
Trenchless technology deserves to be considered for the social advantages it confers. It not only reduces the damage that may occur to property and services below the roadways, but also reduces the indirect costs associated with the project caused by the No-dig technologies have seen substantial growth over the past two decades. Yet, the most profitable years are in the making while the industry is going through a shake out, consolidation, mergers, and acquisitions. As engineers, planners, contractors, manufacturers, public officials, often we tend to focus mostly on the technical aspects of such technologies. Rarely, we look at No-Dig technologies as possible investment opportunities, given the myriad of publicly trading companies encompassing what we eat, drink, wear, live-in, drive, use in our daily lives. And often as professionals in the business of No-Dig technologies we tend to go more only with the advice of our trusted investment advisor. In the financial services industry, little analyst coverage exists for the companies in the No-Dig discipline. Therefore, the stocks in No-Dig companies are not as groovy as those of Internet .avor and often trade thin given a rather small audience. This paper provides a concise summary of the criteria to use to identify investment opportunities among No-Dig companies. Sales, profit margins, earn

It is considered that failure of joints between manholes and sewer pipes laid under roads is caused by repeated live traffic loads transferred from the road surface to sewer pipes through manholes. Though various states of the road around manholes cause complicated waveforms of repeated loads, there have been few basic data with regard to the failure properties of joints between manholes and sewer pipes subjected to repeated live loads having different waveforms. The authors conducted model experiments using two types of waveforms, sinusoidal and trapezoidal, with other parameters being the method of connecting manholes and sewer pipes, method of laying manholes and overburden pressure on sewer pipes. As a result, different waveforms of repeated live loads were found to lead to different failure modes of
manhole-sewer pipe joints.

results for Wyo-Ben's seawater drilling fluid called SW-101. Drilling with a fresh water fluid in a salty environment – can it be done? Not too long ago the answer was "sometimes" at best. How many bores were lost, or how much extra horse power, wear and tear was needlessly placed on the drilling machine by pulling excessive amounts of force caused by poor hole conditions? If these "poor hole conditions" were due to seawater/brackish water contamination of the drilling fluid, the product is here to correct those symptoms. Our test data enclosed within indicates the performance of commonly used products that are being utilized in a sea water environment. Materials evaluated were SW-101, Hydrogel 90 (API material) Extra High Yield, and Attapulgite, in varying concentrations mixed into seawater. When a normal bentonite is mixed in fresh water, it has the positive characteristics of viscosity, suspension, and wall cake building for stability. When this mixture comes in contact with seawater, all three of these attribu

distance pipe-jacking, problems such as lubricant tending to be thinned down by groundwater or permeating into the ground resulting in an increase of friction between the jacking pipe and the soil occur. The double-layer injection method has solved these problems. Regarding reduction of friction between the jacking pipe and the soil, which is an indispensable factor for long distance pipe-jacking, we realized good results by forming an impermeable lining material between the jacking pipe and the soil then injecting lubricant between the lining and the jacking pipe. Before introducing this procedure on-site, we confirmed the soundness of the lining material using simulated ground. On-site introduction results (1200, L=277m) showed that maximum thrusting force was approximately 40% of the estimated thrusting force (approximately 1270kN). This revealed the potential of meeting our target pipe-jacking construction of over 1000m by using low thrusting force. Use of this method to realize long distance pipe-jacking constructior

Underground facilities and road traffic have become so congested by urban sprawl that today the demand for sharp curve/complex curve jacking methods used to lay large and/or medium diameter pipes is soaring, and pipe laying using sharp curve jacking methods is becoming more common every year. Unfortunately we lack a clear understanding of the theory and mechanisms involved in sharp curve jacking methods at
this point. To that end, we focused in the present study on measuring the horizontal vector jacking force (jacking force in the normal direction) and tail void (conditions between the jacking pipes and soil) associated with sharp curve jacking methods. Here we will present what we know about jacking mechanisms in curved sections resulting from those measurements and their analysis in hopes that it will lead to further developments in sharp curve jacking technology.

This paper describes the walk-over locating technology used in horizontal directional drilling. It covers both the fundamentals of the technology and practical applications. The paper begins with a comparison of the two types of magnetic fields used for in-ground locating. The cylindrical magnetic .eld is used for locating wires, pipes, and conduits, while the dipole magnetic field is used to track drill heads. Plots show the magnitude of the signal intensity as detected by various receiver antenna configurations for the two types of fields. The paper then goes on to show the flux patterns on the surface of the ground and their importance to locating. A description is given of the various ways that different dipole tracking receivers can process the magnetic field information to locate the in-ground magnetic field source and determine its depth and orientation. The methods described include the use of magnetic field intensity, flux line orientation, and gradients of the field intensity. The ability to predict the location and depth of the boring tool at a point in front of its current position is discussed, incl

Abstract not on list.
Traditional sewer rehabilitation methods can result in a reduction in cross sectional area and capacity of the sewer line of up to 40%. Another significant drawback of these methods is the need for the construction of large insertion pits where access is generally limited. These limitations led to the development of a new NO-DIG renovation system – the TROLINING® System – developed using proven high-density polyethylene (HDPE) technology gained from 30 years of successful landfill and tunnel lining. Polyethylene is strong and flexible, and fulfils strict requirements for chemical resistance and the service life will equal or exceed the design life. The TROLINING® System is a structural lining system that can be used to reline pipelines from 200mm diameter to 3500mm diameter. The HDPE inliners are available in a comprehensive range of prefabricated section lengths and cross-section shapes and sizes for various applications. The flexibility of the system permits designs in accordance with individual application requirements, providing total confidence for the design engineer. Te

There are a number of different Cured In Place Pipe (CIPP) systems currently available worldwide. The CIPP system where the curing is initiated by exposure to light has been in use for about 15 years and is now proven technology.
Curing a liner by exposure to light of a specific wavelength has a number of advantages:
• pre impregnation under closely controlled factory conditions with a comparatively long storage time
• short set up time on site
• minimal access required
• does not disturb adjacent services
• inner and outer foils reduce styrene emissions to a minimum and prevent resin migration up laterals
• easy handling – the liners are pre packed, sealed and crated after manufacture ready for use
• fast curing
• no environmental problems associated with disposal of hot process water
• controlled degree of cross linking
• close fit minimises reduction in bore
• high strength.
The quick and controlled installation process is of great importance in today's congested streets and working environment.

This paper deals with the different forces involved in the jacking process during microtunneling. This research is based on a continuous monitoring of 14 projects, allowing the estimation of the face resistance from the collected data. Those experimental results are compared with analytical or empirical calculation models and with experimental data from JSTT. This study concludes in proposing elements of recommendation about design and implementation of microtunneling project.
The enormous advancement of trenchless technology in the Czech Republic, shield tunnelling and uncontrolled pushing through in particular, started after World War II. Used for the construction of new utility services as well as for the rehabilitation of those existing, progressive trenchless technologies have largely expanded over the last ten years. Making possible the construction and rehabilitation of utility networks without digging up roads and other surfaces thus causing inconvenience, they highly apply in historical, tourist-attractive cities and towns. The cities and towns have their history and so has the majority of their utility systems.

Impact Moles have been known to the trenchless pipe laying industry for about 30 to 40 years and are used worldwide in their thousands. These systems were used over lengths up to approximately 40 to 50 meters. Since the inception of moles there has been the desire to steer them, as we are able to steer horizontal directional drilling heads (HDD). End of the 80´s developments in the USA and Germany have been striving to achieve this goal, however, these guided moles always required steel rods and a hydraulic rig to carry out any steering action. Both air compressor and hydraulic drive were necessary and large size pits were needed. This development has been completely replaced by HDD equipment. It was only towards end of the 90´s when German manufacturer Tracto-Technik in co-operation with the US Gas Research Institute developed the world's first free flight guidable mole which does not need large pits and requires only a small capacity compressor. This free-.ight navigable mole is called Grundosteer® (patents pending) and operates completely free of rods and drilling fluid. The steering action is carried out by a special Stormdrain and culvert rehabilitation is poised to become the next major market segment for companies offering No-Dig and environmentally sensitive solutions for pipeline repair. This paper will discuss the diversity and size of this emerging market and will also consider the range of issues confronting both Clients and contractor bidders. Issues include service life; pipeline inspection and duty of care; details on the extent of the problem; the variety of options available; structural design philosophies; hydraulic performance and environmental considerations. Cases are presented throughout to highlight the problems associated with the infrastructure that is now approaching the end of its design life.

Rehabilitation is the first of its kind in the world. The Danish Quality Control Scheme for Pipeline Rehabilitation is an impartial and voluntary system, which has been established by the NO DIG Group after years of pressure from some of the largest Danish municipalities which use renovation techniques and other no dig methods for pipeline rehabilitation. The NO DIG Group is a subsection of the Cable and Pipe Section of the Danish Contractors' Association. The Danish Quality Control Scheme for Pipeline Rehabilitation has been in force in Denmark since 1997, when the statutory annual meeting was held on 21 March. The Control Scheme had been under preparation for some years, as Legal and Technical Regulations had to be developed, members of the Control Committee had to be nominated and several tests of Cured-in-place Pipes had to be carried out as a consequence of the conditions of admission. The Control Committee consists of three members representing three associations of users. The Pipe Centre of the Danish Technological Institute was engaged in 1993 a

Now, we have a new pipe jacking method with non-arrival shaft. We carried out a new long-distance "Return-Recovery Typed Pipe-Roof Method" for The New Trunk Line through Kagoshima Route in Japan.

The ability to accurately steer an underground bore path sets horizontal directional drills apart of other types of utility construction equipment. Indeed, steering capability is what defines horizontal directional drilling (HDD). Guidance systems permit drilling crews to track the location of the drill head while making the pilot bore, and they provide information necessary to make steering adjustments as the bore progresses. Many of today's advanced guidance systems also can help plan a HDD installation, store data documenting the details of the job, and can produce an as-drilled map of the installation. There are two basic types of guidance tools: walk-over systems and wireline systems.

Efficient utility and communication services have become an integral and essential part of the modern day life. As the urban population increases and as India jumps into the technology band wagon, the quantity and complexity of the underground utilities rises the demand for potable water, energy, telecommunication and sewage services. Unfortunately the existing systems in India have been created over a period of many decades and are bursting at the seam unable to cope up with the situation. They need constant maintenance and need to adapt to new demands, which means they have to be expanded. Now, with conventional methods the more extensive the pipeline network the more intensive is the use of the surface. This results in more disruptions to streets, roads, parks, pedestrian zones and intersections. Thus there is going to be an
ever increasing demand in underground installations for an alternate to trenches. What else can this be than the "Trenchless" or "No Dig" technology.

Ground-penetrating radar systems are now commonly available to assist with non-destructive testing of pipeline and sewer system utilities. These surveys can also provide additional information relating to the rock condition beyond the pipeline or sewer wall. Suspect zones detected in Brisbane have been confirmed by drilling and repair work has been completed prior to collapse. Radar systems are considered to be an effective technique but productivity can be questionable. A cost effective solution is now required to limit radar and geotechnical surveys to cover suspect areas alone. Consequently several additional geophysical techniques have now been extensively tested in Brisbane to complement CCTV and radar data. Encouraging results have been obtained with TEM resistivity data to provide an indication of structural integrity in terms of variations in substrate resistivity. However high definition seismic systems are now required to provide more detail on the nature of the target and new research programs have been developed for this purpose.

Recently, small-diameter shallow tunnels have been often built by using pipe-jacking. This is the sewage tunnel drivage method. This system involves the pushing or thrusting of a drivage machine through concrete pipes ahead of jacks. This method utilizes mud slurry that is formed around the pipes in order to stabilize the surrounding soil. However, the behaviours of the soil and the mud slurry around the pipes, and the mortal injection around the pipes as the rehabilitation method are not clearly understood. From this point of view, this paper discusses the performance of mud slurry around drivage pipes and the mortal around the pipes by means of two-dimensional Eulerian-Lagragian seepage analysis.

A new trenchless pipe lining technology called ShieldLiner‘is under development by SORD Technologies Ltd with the assistance of the CSIRO. Worldwide patents are pending or have been granted. These represent the first major development in patentable pipe lining technology since the early 70’s. Whilst there have been significant process enhancements to pipe lining technology in the last 30 years, the basic principles have not changed. The ShieldLiner™ system is based on new principles. SORD Technologies Ltd are developing and proving these technologies with CSIRO Sustainable Materials Systems group and in house expertise drawing from extensive knowledge of composite aerospace material technology. ShieldLiner™ lines, seals, repairs and reinforces a pipe in one process step by applying a structural textile, generally fibreglass with a water/gas impermeable wear resistant coating in a resin matrix. The technology differs in many respects to present Cured-in-Place methods and systems. A major difference is that the coated fibreglass is introduced in the pipe in two or more longitudinal segments that are joined together in the ap
The French National project of research and experimentation named RERAU (Rehabilitation of Urban Network Sewers) has developed a design method for non circular linings subject to groundwater pressure. The method is based on an analytical approach and gives a formula, recently obtains by O. Thépot, for the buckling pressure of a close-.t noncircular lining subject to external water pressure (with initial annular gap). The method puts the liners into two categories according to their shapes: “critical linings” that are liable to buckle but where the blister remains localized and “subcritical linings” that do not buckle but where the blister may extends to the entire lining. For critical lining (most eggshapes are critical), this paper presents formulas for buckling pressure, bending moment, hoop force and deflection. Thus the engineer is enabled to calculate safety factors for stability and strength. Comparisons with nonlinear finite element analysis are presented for three different non-circular shapes. Buckling pressure calculated by the analytical formula conform closely to the

The international surge in the development and application of trenchless technology over the past decade continues in Australia and New Zealand. Despite their remoteness, geographic spread and comparatively small populations, the potential of the technology is being realised in these countries by an ever-growing number of progressive utilities, private organisations, contractors and consultants. Service industries worldwide are realising the need to become increasingly competitive. The National Competition reform agenda in Australia has driven a broad range of micro-economic reforms and institutional changes. Corporatisation, privatisation and the consequential restructuring in the electricity, water, gas and telecommunications industries has changed the very face of these service organisations. As a consequence, we now see competitive, customer focussed and environmentally and community aware client organisations willing to adapt their approach to the traditional business of installing and maintaining services. This has been supported by an equally progressive contracting industry aware of the commercial opportuni
In recent years some Australian Water Authorities have placed particular emphasis on the need to rehabilitate sewer laterals when rehabilitating the main. But what methods are used to make such decision? How is the primary data gathered? Is there a better way and how can authorities obtain maximum value for money when rehabilitating sewer laterals.