Trenchless Technology:

NOT A BORING SUBJECT

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Trenchless Technology: NOT A BORING SUBJECT

What is Trenchless Technology?

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The name pretty much says it all – trenchless technology is a means to construct, rehabilitate or inspect existing underground pipes and structures with little or no need to dig a trench. The North American Society for Trenchless Technology’s (NASTT) technical definition is as follows: “A family of construction techniques for installing or rehabilitating underground infrastructure with minimal disruption to surface traffic, businesses, and residents. It also includes technologies for inspection, leak location, and leak detection with minimal disruption and minimal excavation from the ground surface.”

This edition of NC Currents will focus on the trenchless industry, with several articles about the topic. In addition, this article provides an introduction into trenchless technology by outlining the three main areas of trenchless practices: construction, rehabilitation and condition assessment. The following table identifies some prominent trenchless methods within each particular category.

**TRENCHLESS CONSTRUCTION**
Many options are available for construction of new buried assets without the need for significant excavation. Determining which method is most appropriate requires an understanding of many factors including, but not limited to, purpose (e.g., water main, gravity sewer, force main), utility size, length to be installed, soil conditions, surface features, subsurface features, groundwater, and possible environmental contamination. A brief summary of each method follows:

1. **Horizontal Auger Boring (Bore and Jack)** – Auger boring involves the use of an auger machine to bore a cylindrical hole in a linear fashion. The surrounding soil is stabilized by a casing pipe (inserted by powerful jacking devices) while the spinning auger removes the soil from the face of excavation back to the launching pit. Once the casing is installed, a carrier pipe can be strung through the casing. Mixed soil conditions of rock and soil or encountering obstructions such as boulders or manmade items may result in a failed installation.

2. **Horizontal Directional Drilling (HDD)** – HDD creates a pilot bore along the design pathway and reams the pilot bore hole to a larger diameter in one or more additional passes to a diameter suitable for the carrier pipe, which is pulled into the prepared bore in the final step of the process. The process is steerable and follows a vertical arc and possibly a horizontal arc, too. One significant advantage of HDD is that no excavation is necessary to install the pipe. HDD in rock is possible, but can be more costly than other trenchless methods because of the equipment and number of reams necessary to remove rock. In addition, HDD is not recommended in mixed soil conditions with rocks/boulders.

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3. **Pipe Jacking** – Pipe jacking is the installation of a casing pipe using jacks that force the casing pipe forward while workers remove soils from the face of the jacked pipe. Jacking requires a minimum casing pipe diameter of adequate size (say 48-inches) to allow for working space and soil removal. Jack hammers, picks, shovels and even rock blasting are used to remove material.

4. **Pipe Ramming** – Pipe ramming is accomplished by percussion hammering a casing pipe through the soil, and is used in softer soils, but not solid face rock. As the casing is progressed forward, the soils are simply ‘gobbled up’ and then removed by an auger, air or water jetting. Pipe ramming is non-steerable, and as such, not typically used for gravity sewer main installation. Pilot tube pipe ramming can, however, be used to achieve accurate grades, but the current technology is not widely available.

5. **Tunnel Boring Machine and Micro Tunnel Boring Machine (TBM and MTBM)** – NASTT defines a TBM as “A full-face circular mechanized shield machine, usually of man-entry diameter, steerable and with a rotary cutting head.” TBM is used for larger diameter casing pipe projects. Where smaller diameter casings of approximately 30 to 96-inch are required, MTBM can be used. MTBM is similar to TBM, except that it is remotely controlled from above the ground (i.e., too small to fit a person within the equipment). Sometimes, the casing pipe serves as the carrier pipe in which case the process is referred to as a ‘one pass install.’

6. **Handmining** – A handmined tunnel is the oldest method available in the trenchless industry. The tunnel must be large enough for equipment and personnel to manually remove soil from the face of excavation. This method is slow and costly, but provides accuracy and handling of hard rock or obstructions. Nearly any shape, size or distance can be handmined.

**TRENCHLESS REHABILITATION**

Many trenchless rehabilitation methods are available for the water and sewer industry.

Oftentimes the myriad of options can be overwhelming when determining an appropriate rehabilitation method. When determining which method is most appropriate, many factors should be considered. Some factors include structural or non-structural repair, traffic impacts, corrosion resistance, duration of temporary bypass pumping around work, gravity flow pipe or pressure pipe rehabilitation, need for additional capacity, nature and severity of defects, little or no allowable excavation and so on. The following list of trenchless rehabilitation methods is intended to simply introduce readers to the various available options.

1. **Cured-In-Place (CIP) Lining** – CIP involves impregnating a fabric with a resin and, once inserted into the pipe or structure, air or water is forced into the liner so it expands to the inside shape of an existing pipe or conduit and allowed to cure. Curing can be done by steam, hot water, ultraviolet light or ambient air temperature. In addition, CIP can be used on different shapes and sizes of structure. Liners do not bond to the host pipe or structure, but...
rather fit to the host pipe's shape. CIP offers many benefits, and depending upon the liner thickness can provide either partial or full structural stability.

2. Pipe Bursting – Pipe bursting involves either pushing or pulling new pipe through existing pipe and as the process proceeds forward, a bursting head (which is larger than the existing pipe) causes the existing pipe to fracture and be expanded into the surrounding soil. With this method, excavation is necessary for launching pits, receiving pits, service reconnections, and appropriate existing pipe repairs. Pipe bursting offers moderate pipe upsizing, and the existing soil conditions and the host pipe type, fittings and bends can affect its success.

3. Slipping – Slipping is the simple method of installing a smaller pipe inside a larger pipe. Once installed the void space between the two pipes is filled with grout and the ends sealed. While this method reduces cross sectional area because of the smaller pipe diameter, it does limit excavation to entry points, service reconnections, and defect repairs necessary such that the new pipe can successfully pass through the host pipe. Carrier pipes can be continuous length (e.g., HDPE or fusible PVC), segmental (i.e., sections of pipe) or even spiral wound. A ‘U’ shaped liner that is reformed inside the host pipe is a modified slipping method.

4. Coating Systems – Coating systems can include polyurethanes, polyurea, epoxy, and cement. Within each of these categories, even more coating system options are available. The success of these products is highly dependent upon existing surface condition, quality of surface preparation before application, existing water infiltration and the applicator’s care and ability. Determining which product to use depends upon chemical resistance, abrasion resistance, cure time, substrate condition, structural or non-structural rehabilitation, and application environment (potable water or sewage) – just to name a few.

5. Grouting – NASST defines grouting as “filling voids or modifying/improving ground conditions. Grouting materials may be cementitious, chemical, or composed of other mixtures.” Pipe grouting is typically performed by use of a packer whereby the grout is forced into cracks, joints or service connections. Structural grouting is achieved by forcing grout through injection holes (ports) drilled into the structure. As grout is injected, it permeates through the void into the surrounding soil thereby creating a seal.

TRENCHLESS CONDITION ASSESSMENT
Trenchless condition assessment is a field with many available options and worthy of extensive discussion beyond this brief summary. Structures, gravity flow pipes and pressure pipes can be inspected within the assessment process. The Environmental Protection Agency (EPA) has divided inspections into five groups; camera, acoustic, electrical/electromagnetic, laser and emerging technologies. Some inspection devices can cross over into location and leak detection as well. In addition, they can also be categorized into destructive and non-destructive methods.

1. Camera – Camera inspection is the most commonly used method in the sewer industry, and includes the traditional closed-circuit televising (CCTV) camera and sewer scan technology. Cameras can crawl, can be pushed or pulled through...
pipes, and can be pole mounted with zoom cameras. CCTV inspection is not intended for full-pipe flow conditions.

2. Acoustic – Acoustic inspection (and leak detection) detects vibrations and sound waves by use of devices either on a pipe or traveling through a pipe. Some acoustical methods are non-intrusive as they are attached to or rest upon some feature of the pipe network. Other technologies are inserted within the pipe and travel some distance while collecting data and ultimately retrieved/captured. The data from acoustical devices is then downloaded and interpreted to determine condition based upon leaks. Regarding sanitary sewer applications, sonar systems can be used for full-pipe conditions such as surcharged sewers, siphons and submerged outfalls.

3. Electrical/Electromagnetic – Electromagnetic inspection methods are based upon either the magnetic flux leak (MFL) or eddy current (EC) principals. Thus, they only apply to either a ferrous pipe or a pipe with a ferrous component (e.g., wires, bars). Magnetic flux methods detect metal loss by changes in magnetic flux, and EC measures changes in impedance to detect defects and failures.

4. Laser – Laser profiling creates an image of the pipe’s interior wall by transmitting a 360-degree beam. By determining pipe shape, many aspects of the pipe’s condition can be determined such as shape, debris accumulation and service connection location. Lasers are often used in conjunction with cameras or acoustic methods as an added assessment tool.

ADDITIONAL INDUSTRY INFORMATION
There are many trenchless industry trade associations. Two prominent organizations include the National Association of Sewer Service Companies (NASSCO) and North American Society for Trenchless Technology (NASTT). Each association provides a forum for education, training, guidance documents, sample specifications, and even employee certification in some cases. NASSCO also has divisions such as the International Infiltration Control Grouting Association and International Pipe Bursting Association. The Environmental Protection Agency (EPA) and the Water Environment Research Foundation (WERF) also offer guidance documents.

Within North Carolina, the NC AWWA-WEA Wastewater Collection and Water Distribution Systems Committees provide a forum that offers information on important water and sewer topics including systems operation and maintenance and the regulatory climate. As such, these groups often discuss trenchless practices as they pertain to the water and wastewater industry.