Pipe Bursting

Pipe bursting is a trenchless method of construction utilized in the rehabilitation of underground infrastructure, with minimal disruption to traffic, business activities, and environmentally sensitive or significant areas. It is an emerging technology that has only recently been utilized in North America, though has been used extensively throughout Europe over the past 20 years.

In general, pipe bursting is accomplished by the advancement of a cone shaped bursting head through an original, or host, pipe that due to its geometry translates forward thrust into radial expansion forces. These radial expansion forces overcome the host pipe's tensional and shear strength capabilities and subsequently bursts or splits the pipe. Attached to the rear of the bursting head is the new, or product, line that is simultaneously installed as the bursting head advances and bursts the pipe. To decrease the friction experienced by the product pipe during installation the bursting head is of slightly larger diameter than the outside diameter of the new line. This difference in diameters is commonly referred to as the over burst. The degree of over burst largely depends on the pipe material being burst as well as the soil conditions surrounding the existing line.

Pipe bursting is recognized as the only method of trenchless pipe replacement or rehabilitation, where an existing pipe can be upgraded with a completely new pipe of equal diameter or greater, thus maintaining or increasing the capacity of the line being rehabilitated. The new pipe is a complete structural replacement that functions independently of the original line. These are two distinct capabilities that are unique to the pipe bursting in comparison to other rehabilitation methods in the trenchless arena.

Advantages of Pipe Bursting

In comparison to conventional cut and cover methods of pipe replacement, pipe bursting has several advantages that make it a rehabilitation option that is not only practical, but also cost effective.

Upsizing:

One of the principal advantages of pipe bursting is the ability to increase original line diameter by several pipe sizes to increase the capacity and operational life span of the new installation. This can be accomplished without excavation along the same line and grade of the original pipe.

Structural replacement:

Pipe bursting provides a total pipe replacement, with a new line that is structurally independent of the original line.

Significantly reduced rehabilitation time:

With minimal excavation required to facilitate installation, considerable time is saved compared to open cut methods. This is turn reduces site and surface restoration, which lowers the total time to complete the installation, and lowers overall project costs.

Reduced impact on residents and businesses:

Pipe bursting reduces the social costs associated with a construction project. Generally, when replacing pipe beneath a roadway, at maximum, only road lane

is required to place the equipment necessary to complete the replacement. Subsequently, there is no need to close roads, which in turn, maintains near normal traffic patterns and access to businesses and residential property around the construction site.

Saves expensive or historic landscapes and structures:
The pipe bursting method of construction minimizes the need to remove expensive landscaping or endanger historic structures with excavation, allowing the site to stay in its original form.

Increased worker and site safety:
In pipe bursting, a minimal amount of excavation is required to place the machine and insert the new pipe into the original. These excavations need only be pits that can be shored to prevent collapse or cave-ins, thus increasing worker safety during the rehabilitation process.

Replacement Procedures

Depending on the product being installed and nature of the host pipe, there are two main methods of installation associated with the static pipe bursting system. Typically, installations can be divided into continuous or sectional, based on the configuration of the product pipe as it enters the host pipe. Pipe materials such as high-density polyethylene (HDPE), polyvinyl chloride (PVC), and steel can be connected or fused to form continuous strings of pipe, this is termed as a continuous installation. This pipe string is typically as long as the section of pipe that is being replaced. Sectional installations use sectional pipe including clay, concrete, and fibreglass, and are generally installed using a push-pull method during installation. The installation progresses as each new section of pipe is added.

In general, the pipe bursting project is divided into sections or lengths that the bursting equipment being used can burst based on the geometry and layout of the total length of pipe being replaced. The length that can be burst is highly dependent on the type of pipe being burst, degree of upsize, soil conditions, and geometry of the original installation. In addition, whether the installation is continuous or sectional has the greatest influence on the type of equipment required and the pit set-up.

Continuous Pipe Installation

Continuous installation procedures are used for pipe that can be connected or fused into continuous strings. This method is the preferred method of installation for pipe bursting applications, as it minimizes the stoppage of the product line during the burst, and requires less equipment to perform the installation. The installation process usually begins with the excavation of access pits at each end of the pipeline to be replaced. On one end of the line, the machine pit is excavated into which the pipe bursting machine that pulls or directs the bursting head is located. Opposite the machine pit is the insertion pit through which the new or product pipe and bursting head are inserted into the existing or host pipe, as illustrated in Figure 1. Any services along the pipe route connected to the host pipe must be disconnected prior to the start of the burst, with access to the lateral connections achieved through service pits.

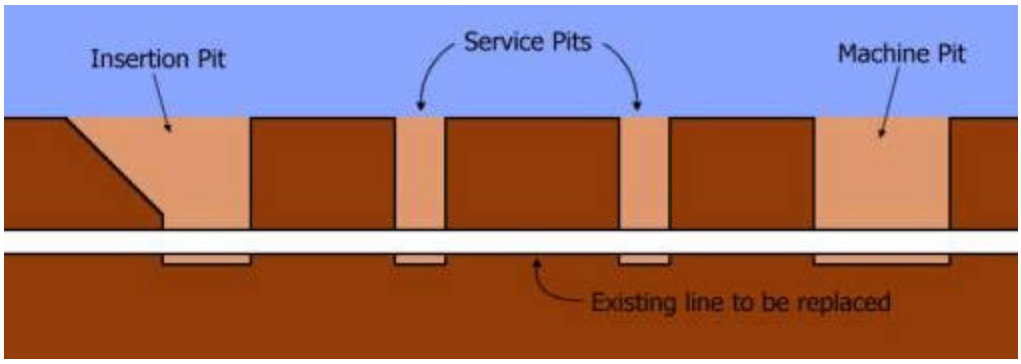

Figure 1: Continuous Installation Site Set-up

The size of the machine pit depends on the size and type of pipe bursting equipment used. Machine pits used in static pipe bursting can range in size from 4 m by 2.5 m to the size of a manhole. Some types of bursting equipment only require the insertion of a mechanical arm or leg with a pulley into a manhole to direct and pull a cable or chain. Depending on ground conditions and depth of the host pipe, shoring may be required, though sloped walls are also an option. Generally, vertical walls are used to keep the footprint of the excavation to a minimum; this assists in minimizing surface disruption and the cost of restoration.

Insertion pits are generally smaller than the machine pits. As a rule of thumb, for static bursting methods using continuous pipe, the length of the insertion pit should be 12 times the diameter of the new product pipe. Additionally, a length to account for the slope depending on the depth of the excavation at a ratio of 1.5 to 2.5 run to 1 depth should be added. The slope ratio largely depends on the bend radius of the product pipe. The width of the pit depends on the amount of space required for crews to manoeuvre around the pipe in the pit to connect the bursting head. Generally, insertion pits need only be approximately 1.2 m in width.

Service pits may be excavated with a minimal surface footprint. The size of pit depends on the depth of excavation and the manoeuvrability of the excavation equipment in the confined space of the pit. Generally, a service pit may only be 1.2 m in diameter to provide enough space for a worker to disconnect and reconnect the lateral. These pits may be shored using large diameter steel pipe sections, depending on the pit depth.

After excavation of the pits is complete, the bursting machine can be lowered and secured into the machine pit illustrated in Figure 2 Generally, the bursting machine is secured to the shoring in the pit to minimize lateral movement of the machine during pipe bursting. Additionally, the face of the excavation to which the bursting machine pushes against during the installation is reinforced with timber or steel plates to evenly distribute the bearing area.

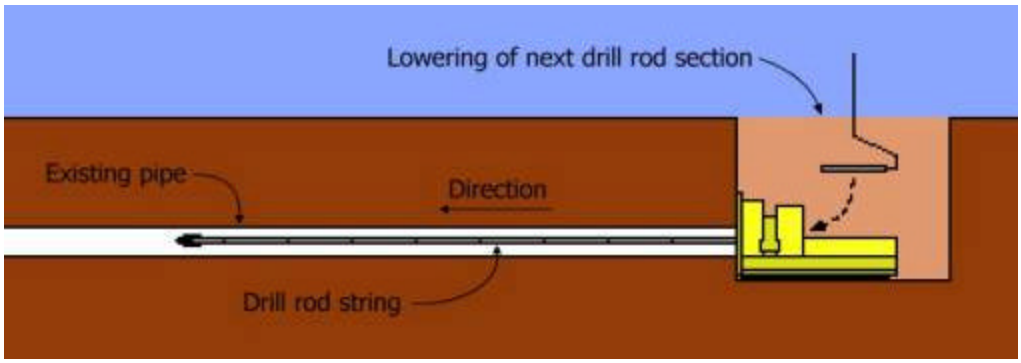

Figure 2: Continuous Installation Machine Pit Set-up

Once secure, the bursting machine pushes or "shunts" rods through the line to be replaced, to the insertion pit. These rods are specially fabricated drill pipes that are fashioned into 1.2 m long sections, with threaded connections on either end. As each section of rod is pushed into the host pipe, another section is connected until a continuous string of rods is in the host line. To assist the progression of the drill pipe string, a blunt nosed bullet head is attached to the first section of rod in the string. This head prevents the string from catching on pipe joints, as well as allows the pipe to push or bore through debris or sediment that may be in the original pipe.

As the drive rods are advanced through the host pipe, the product line is placed at the insertion pit and prepared for attachment to the drive rod string. This generally requires the connection of the bursting head or tool to the front of the product pipe string, and placing the product line in the insertion pit to connect the bursting head to the drive rods. Once the drive rod string reaches the insertion pit, the product pipe is attached as illustrated in Figure 3. Adequate measures have to be taken to insure that the product line is not damaged as it enters the insertion pit. This can be accomplished with the addition of rollers or supports under the product pipe at intervals that keep the bend radius of the pipe within the manufactures recommended limits.

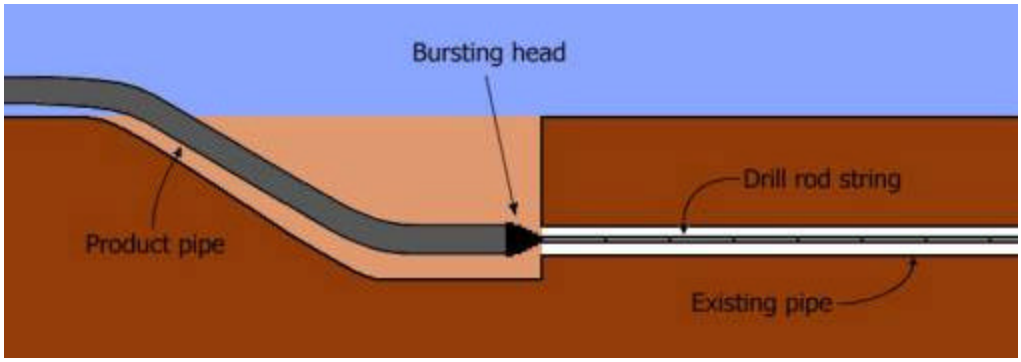

Figure 3: Continuous Installation Insertion Pit

After the bursting head is attached to the product line and drive string, bursting can commence. The bursting machine pulls the drive string and disconnects sections from the string as the burst progresses. As the bursting head advances, the host pipe is burst while the product line is simultaneously installed as shown in Figure 4.

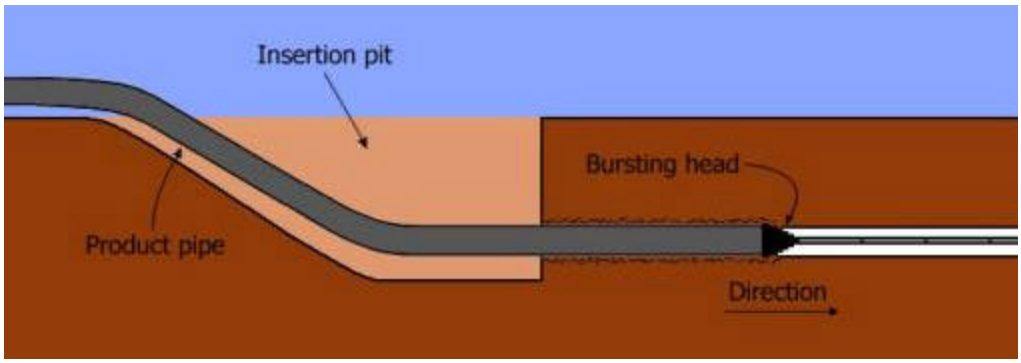

Figure 4: Continuous Installation Pipe Bursting

The head advances to the machine pit where it is disconnected from the product string. At this time, the product string is inspected for damage. If no damage is found, the new line is ready to be re-established to the existing network. Generally, the new line is given time for any residual stresses from the installation to dissipate before any service connections are made or pit restoration performed. Once the product line is determined to have relaxed, generally within a 24 hour period, lateral services are reconnected and the site restored.

Sectional Pipe Installation

If sectional pipe is used as the product pipe for the installation, a slightly different set-up is required. Again, access pits are excavated at each end of the line to be replaced, except in this case, both pits are considered machine pits as illustrated in Figure 5.

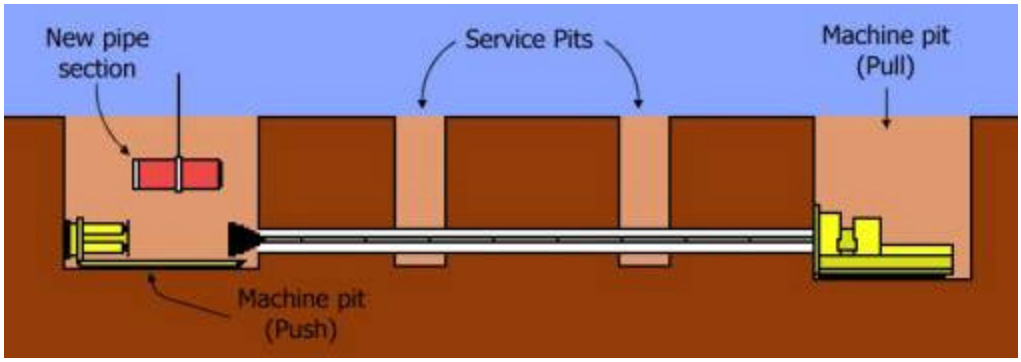

Figure 5: Push - Pull Installation Configuration

The installation of sectional pipe requires the application of a constant force to the pipe to keep the joints together during installation. This may be achieved by using a chain or cable run through the product line from the bursting head to a trailing plate on the last pipe section, or alternatively by using a push-pull set-up. In the push-pull set-up, the bursting head is pulled by one machine in the pulling pit, while in the opposite pit, the pipe section is pushed by another machine as illustrated on Figure 6.

In this set-up, a constant pressure is applied to the new pipe during installation by maintaining the push force slightly higher than the pulling force. This requires

the synchronization of the machine forces; however, allows for larger diameter installations to be achieved.

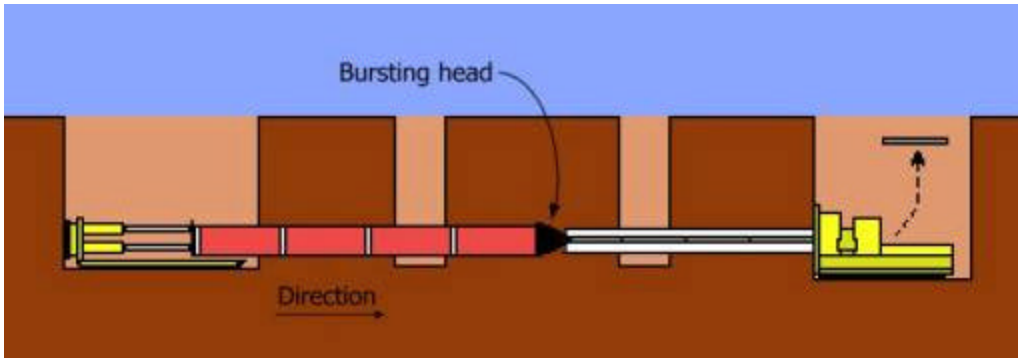

Figure 6: Push - Pull Installation Pipe Bursting

With sectional pipe installations, the push or insertions pit length will depend more on the length of one section of pipe with allowance for worker space to aid in the placement of the pipe. Width, like the length, depends more on the space required for the handling while the pipe is lowered into the pit.

Lateral Replacement

In more mature and established neighbourhoods, the replacement of buried infrastructure can cause considerable disruption. This is evident when the laterals or services to individual businesses or residences need replacement. In this situation, there may be considerable disturbance to valuable landscaping and inconveniences due to the lack of access to a property with conventional cut and cover replacement options. Pipe bursting offers a unique solution to the replacement of service laterals that allows for minimal disruption to the property under consideration.

To replace a lateral using pipe bursting, excavation is required only at the connection of the lateral with the main distribution or collection line, as illustrated in Figure 7. Additionally, access to the location where the service enters the property is required.

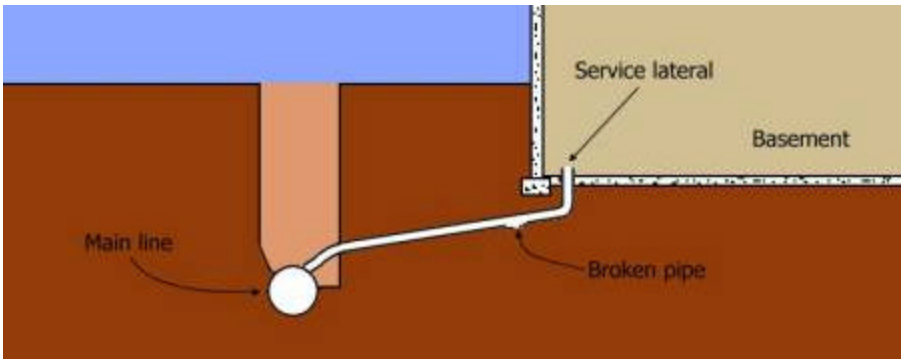

Figure 7: Lateral Replacement Configuration

To facilitate the replacement of the defective lateral, it must first be disconnected from the main line, and preparations made to improve access to the location where the lateral enters the property. In the case of a residential structure, a small area of the concrete floor around the lateral must be removed to increase the available space for the pulling of the new product line into the host. Most lateral replacements are conducted using a cable or chain pulling system as this allows the greatest flexibility for the limited space available. The product pipe is typically of continuous nature and is inserted through from the basement of the residence as illustrated in Figure 8. Since a cable or chain is used in this installation, a winch system is used to advance the bursting head through the host line.

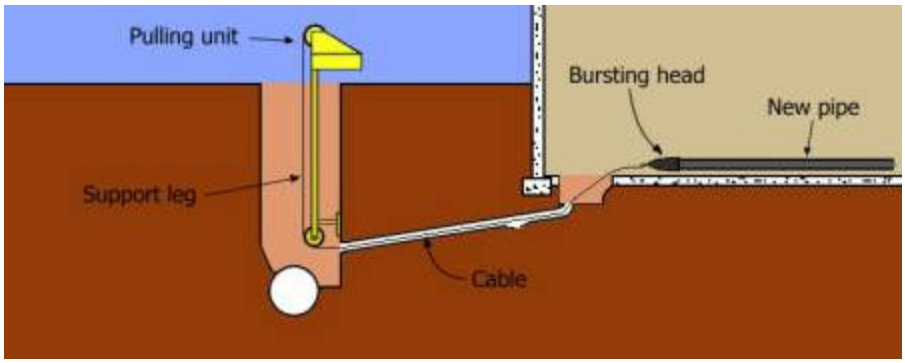

Figure 8: Lateral Replacement Set-up

In Figure 9, a pulley and mechanical leg set-up are used to direct the cable to the surface of the excavation where a winch pulls the cable to burst the pipe. After installation is complete, the line is relaxed to reduce any residual strains from installation prior to reconnection to the main line. Restoration to the site and basement can then be performed.

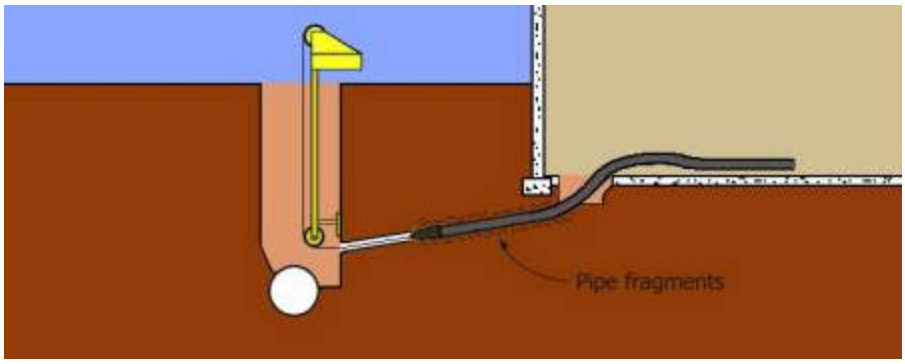

Figure 9: Lateral Replacement Pipe Bursting

In general, lateral replacements conducted in this fashion can be completed in less time and with less disruption to the owner than conventional open cut methods. This provides a practical and cost effective replacement technique for lateral replacement.