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STRUCTURAL REHABILITATION OF WATER MAINS

THE AQUA-PIPE® PROCESS

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1. INTRODUCTION

The importance of safe drinking water to public health is undisputed. However, as we enter the 21st Century, water utilities are faced with aging buried infrastructures. Underground pipes delivering safe drinking water have exceeded their design life. The various pipes installed during different periods in history have different life expectancies, and thousands of miles of potable water pipes that were buried 50 or more years ago will need to be replaced within the next 30 years. In the last 30 years, CIPP (Cured-in-Place-Pipe) technologies have become a standard in rebuilding buried gravity pipeline systems.

Municipalities and Water Districts are turning to innovative technologies provided by the trenchless rehabilitation industry to help solve the economic burden related to the renewal of drinking water infrastructure.

For the last decade, AQUA-PIPE® has been the leading option for the rehabilitation of water mains. The million dollar savings for tax payers/water utility users as well as the capacity for AQUA-PIPE® to reinstate service connections from within the pipeline are what distinguish AQUA-PIPE®'s unique technology from other conventional methods.

Water utility managers can also appreciate the following benefits from the use of AQUA-PIPE®:

- Rapid installation
- Minimal excavation
- Minimal impact on traffic
- Regained structural capacity
- Capable of lining through bends
- Improvement in water pressure/flow
- Corrosion resistance
- Future pipe cuts and (dry or pressure) taps easily carried out
- No special end seals required
- Increase in life span of infrastructures
- Water and $ savings
- Reduction of Greenhouse Gas Emissions (GHG)

2. TYPICAL PROJECT STEPS

Most AQUA-PIPE® installation projects generally include the following steps:

1. Locating the pipe
2. Installation of temporary water supply
3. Excavation of access pits
4. Cleaning of existing pipe
5. Insertion and curing of liner
6. Opening of service connections and inspection

This document is meant to briefly describe the various steps of water main rehabilitation using AQUA-PIPE®.

2.1 Locating the Pipe

Unlike sewer mains, water mains are not visible from the surface via manholes. Locating the pipe to precisely determine the position of hydrants, valves and intersections (T connections), service connections as well as elbows and services (occasionally not identified in the plans and often unknown to the water utility) is necessary.

It is also important to be aware of any other utilities (gas, telecom, etc.) that may be found in the path of the water main to prevent damaging such utilities or infrastructures during the excavation of the access pits.

The location of the water main will dictate the actual location of each access pit on the job site.

Figure 1: Locating pipe and utilities

2.2 Temporary Water Supply

The temporary water supply (bypass) is installed on the surface and ensures uninterrupted water service to the residents during the project..

The houses are connected to the bypass system using a hose connected to the outdoor spigot or meter box. If required, plumbing may have to be modified to allow feeding the house with drinking water from the garden spigot.

As the host pipe must be isolated from the surrounding houses, cut-off valves from the house are shut and the main stop is turned closed. If required, the main stops will have to be repaired or replaced in order to close them.

The temporary water supply work may be installed by the utility owner and not be included in the scope of work.

Figure 2: Temporary water supply

2.3 Access Pit Excavations

The water mains are accessed through standard excavated and shored access pits.

Access pits are used as entry and exit points for the liner during insertion as indicated in Figure 3. The liner is pulled inside the existing pipe with the use of a winch located above the exit pit.

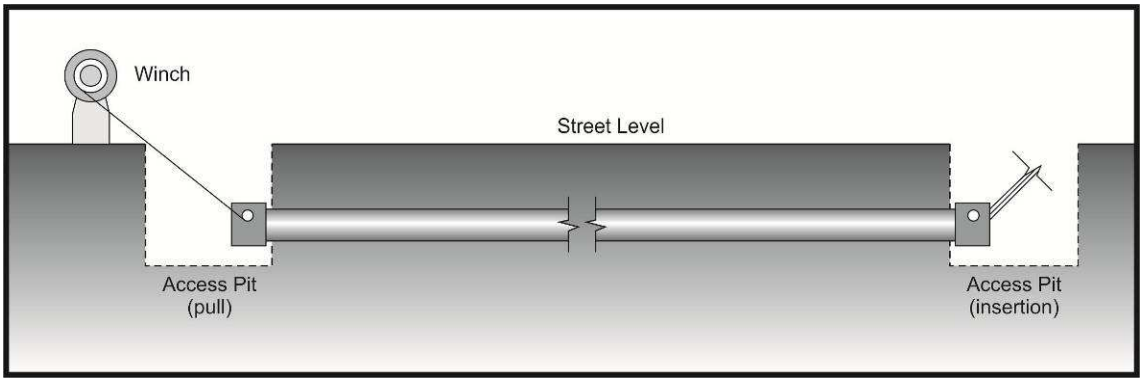

Figure 3: Access pits

The location of access pits will be selected to minimize excavation. Typically, the pits will be placed at water main intersections (tees, crosses, valves, hydrants, etc.) or the pits will be spaced to maximize the length of the sections to be rehabilitated, up to 1000 feet, whichever occurs first.

The pits are fitted with a trench box to ensure a safe work environment and proper signage is required for optimal traffic control. As this is a trenchless technique, streets are kept opened to traffic during the project.

As can be seen in the following figures, a typical access pit requires an excavation of 9 ft x 6 ft and a depth of 12 inches below the pipe.

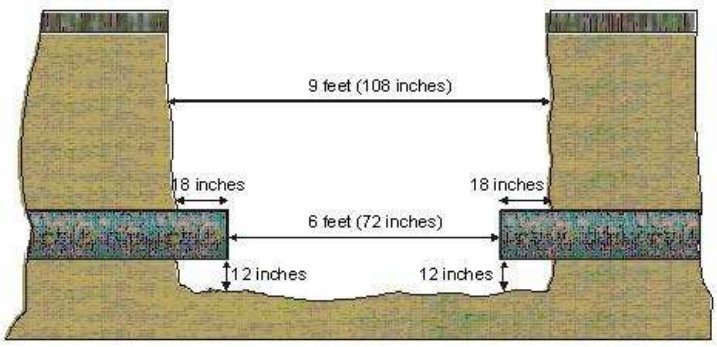

Figure 4: Access pit – side view

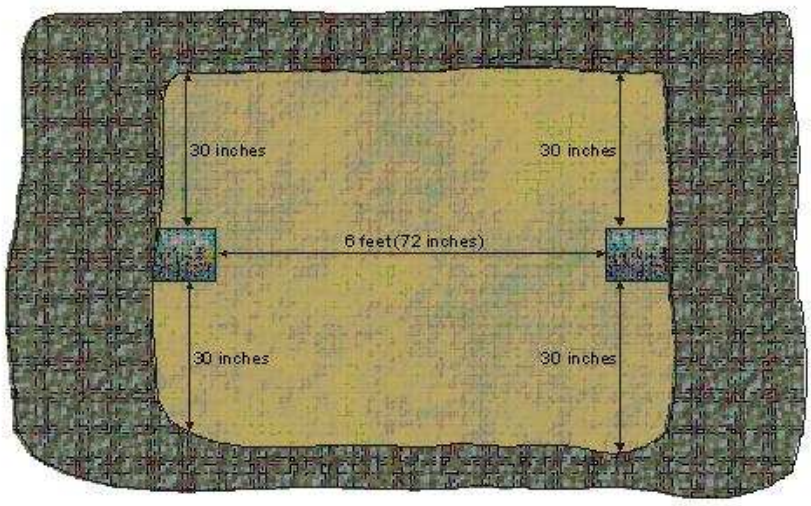

Figure 5: Access pit – top view

Figure 6: Trench box and fencing

Figure 7: Little or no impact on traffic

2.4 Pipe Cleaning

The cleaning of the pipe is a critical step in the rehabilitation of a water main with AQUA-PIPE®. The rust and scale is removed to allow the new composite liner to adhere to the host pipe and restore the flow capacity of the pipe.

After cleaning, the pipe is inspected with a closed circuit television camera (CCTV) to verify that the rust and deposits have been adequately removed.

Cleaning is accomplished using a variety of cleaning tools. Existing stainless steel water main repair clamps do not affect the rehabilitation process since all work is carried out from inside the existing pipe.

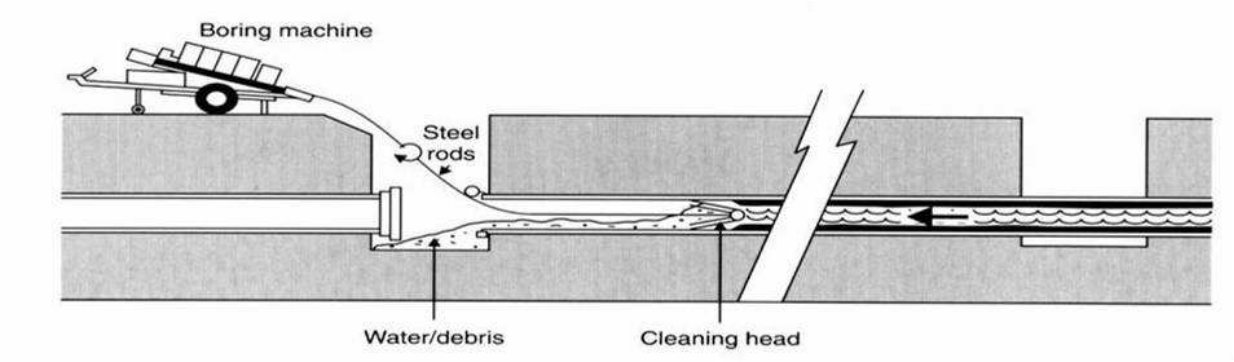

Figure 8: Pipe cleaning

Figure 9: Water main before cleaning

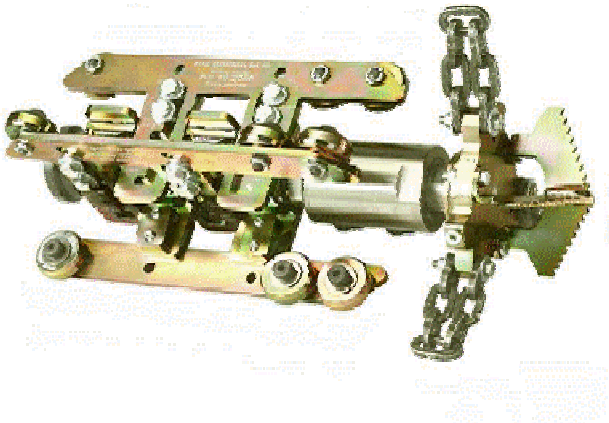

Figure 10: Cleaning head

2.5 Inspection and Plugging

Rehabilitation of a water main with AQUA-PIPE® starts with the camera inspection and the insertion of plugs inside the service connections.

The plugs are inserted in the service connections to prevent the migration of epoxy resin into the service line and potentially blocking the corporation stop.

As the service connections are plugged, a video inspection of the line is carried out. Each service connection is located and compiled in a log to be used at the end of the rehabilitation process when these same service connections have to be opened (see Section 2.8).

Finally, the video inspection allows the technicians to check for any major pipe leaks / leaking service connections and provides the client with a preconstruction video. Major pipe leaks must first be sealed off using Link-Pipe structural repair systems.

Figure 11: Control panel for CCTV inspection

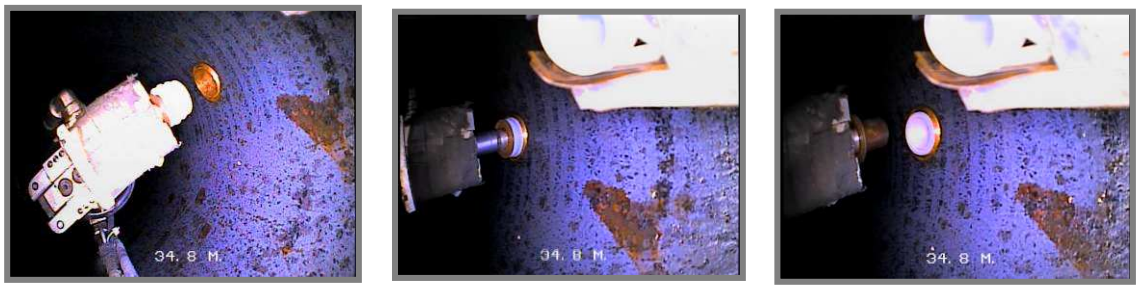

Figure 12: Plugging service connections

2.6 Impregnation, Insertion and Curing

Lining involves three main activities: impregnation of the liner; insertion into the host pipe and curing the liner inside the host pipe.

AQUA-PIPE® is made of two circular woven (seamless) polyester jackets with a watertight polymeric membrane fused to the inner jacket.

The idea is to have an absorbent fibrous matrix (polyester) that will allow the epoxy to penetrate the material and harden in place. The combined effect of polyester with a hardened epoxy makes the composite liner. The mechanical properties of the resulting composite liner will exceed the requirements of ASTM F1216.

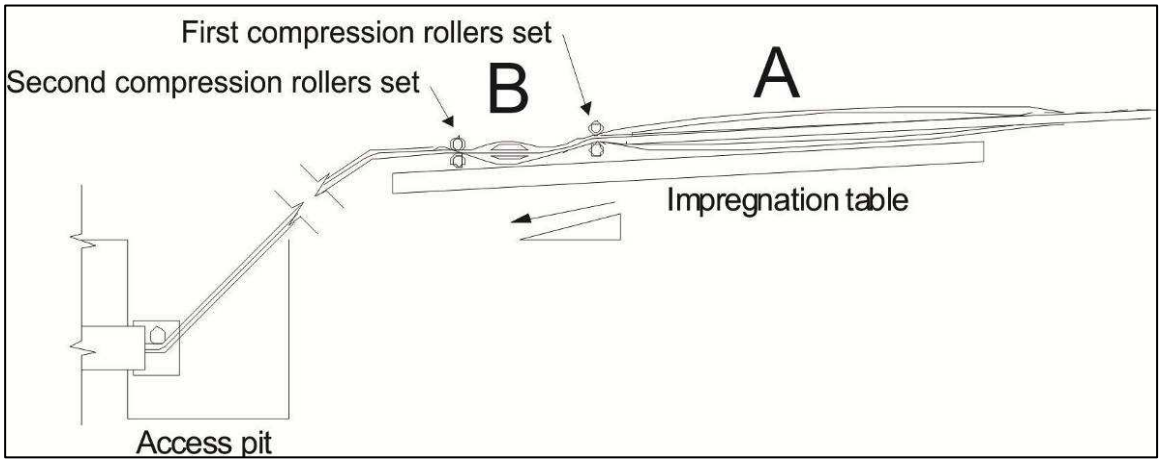

Figure 13: Arrangement of impregnation table

The impregnation of the material (or wet out) is achieved on-site in a refrigerated environment. The low temperature delays the reaction of the mixture that ensures the adhesion. The AQUA-PIPE® liner is impregnated with a two part epoxy system. Figure 14 shows the table arrangement for the impregnation process.

Figure 14: Impregnation of the liner

The AQUA-PIPE® liner is pulled inside the host pipe with the help of a winch at the receiving access pit. Pulling can be performed in small spaces. The impregnation and pulling actions are carried out simultaneously (see Figures 15 and 16).

Figure 15: Insertion of the liner

Figure 16: Insertion of the liner

Once pulled into place, the liner rests flat inside the host pipe and needs to be formed or inflated (see Figure 17). The liner is pushed against the inside walls of the host pipe with the help of a swab (pig) and water pressure.

In the process, any trapped air located between the liner and the pipe is evacuated and all voids and cracks are filled with epoxy. These actions allow the liner to fit tightly against the inside walls of the existing pipe and provide a watertight environment after the liner has cured.

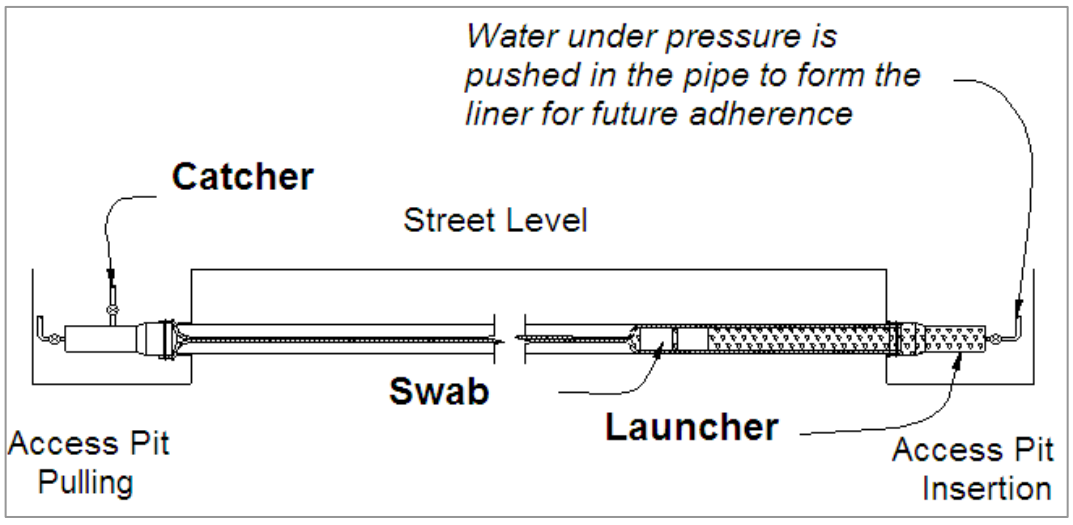

Figure 17: Pulling and forming process

Curing involves heating the impregnated liner to accelerate the reaction between the components of the polymeric resin. The reaction will cause the polymeric resin to reticulate and harden to confer mechanical rigidity to the liner. Heat is supplied and transported by water.

At the end of these three steps (total time of approximately 16 hours), the liner has become a solid structural pipe, inside the host pipe.

Figure 18: Curing with hot water

Figure 19: Pipe rehabilitated with AQUA-PIPE®

2.7 Hydrostatic Pressure Test

If required by the owner, the water main will be subjected to a hydrostatic pressure test before the reinstatement of the service connections. The pressure test and the allowable leakage will be carried out as indicated in Section 8.3 of the ASTM F1743 standard.

2.8 Opening of the Service Connections

The AQUA-PIPE® trenchless technology allows for the services to be robotically reinstated from the inside of the renewed pipe. A remote controlled robot is used to open the service connections.

The remote controlled robot is water tolerant and small enough to fit in a 100mm diameter pipe and still allow for the freedom of movement necessary to reach and open the service connection (see Figure 20).

Equipment to reinstate service connections is combined with video viewing and recording equipment for final inspection of the lined water main.

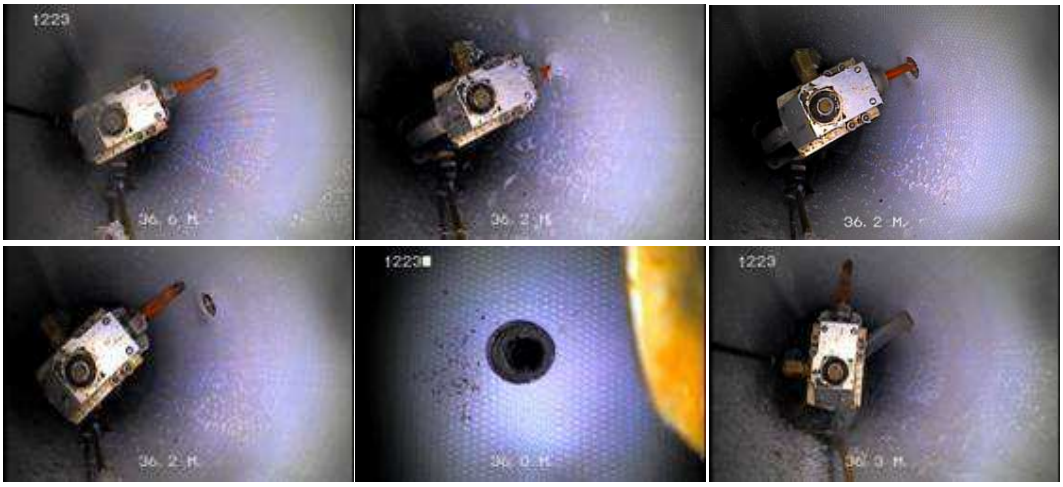

Figure 20: Opening of the service connections

The reinstatement of the service connections does not affect water tightness. In fact, water tightness is maintained by the epoxy which fills all voids around the threads of the service connection (see Figure 21).

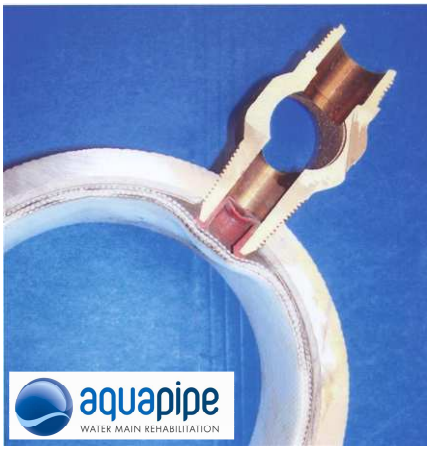

Figure 21: Water tightness at the service connection

2.9 Fitting Installation and Civil Works

Following the reinstatement of all service connections, the required fittings and accessories are installed in the access pits and the rehabilitated pipe is rinsed, disinfected and returned to service. Figure 22 shows a typical re-connection in an access pit. Regular pipe and fittings readily available in the market place and as specified by the utility are used for these connections to the rehabilitated pipe.

Figure 22: Typical reconnection in an insertion pit

Most utility owners will take advantage of the rehabilitation work and replace the old valves and hydrants. In addition, valves and hydrants may be installed or abandoned because of changes in codes and regulations. The replacement and addition of new valves and hydrants are carried out through local excavations which, when possible, are used as access pits.

Furthermore, restoration of the roadway infrastructure is done after the rehabilitation in order to leave the environment as it was before the work began. Restoration involves pavement, curbs, sidewalks and any other infrastructure that was removed to access the water main.

2.10 Future Maintenance, Tapping and Connections

The new lining will not require maintenance once it has been installed into the old pipe. The corrosion free lining will not allow deposits to attach or form on the inside wall of the pipe.

The new lining can be easily dry or pressure tapped. The only precaution would be to make sure that the utility workers use a saddle or tapping sleeve and a sharp shell cutter, and make sure that they have cut through the walls of both the existing pipe and the liner.

If a cut must be performed on a section of rehabilitated pipe, the same procedure as regular pipe can be used. The pipe should be cut with a circular saw equipped with a sharp diamond blade, removed and replaced with a new section of pipe and fittings along with a coupling. No special end seals are required at the pipe extremities. Written procedures are available for these operations and are submitted as part of the work report for an AQUA-PIPE® project.

Figure 23: Typical pressure tap equipment

Figure 24: Typical pipe cut