HISTORY OF HDPE USE AT THE CITY OF PALO ALTO FOR POTABLE WATER DISTRIBUTION

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ABSTRACT

This paper will detail the steps taken during adoption of HDPE for potable water systems improvements including material justification, creation of related specifications, investigation of available piping components, qualification of contractors and the construction/inspection of related systems.

The City of Palo Alto, California, USA adopted HDPE as the primary material for water distribution in 2010. This adoption was implemented in an accelerated water main replacement program initiated in 1994. The accelerated infrastructure program lowered the level of replacement from 233 years to 77.6 years which is well within the anticipated useful life of HDPE materials (100 years minimum). This paper provides a historical account of the City's Utilities Department along with statistics of the systems composition. Several construction projects involving the exclusive use of HDPE are included.

Approximately 10 years ago, the City of Palo Alto made the decision to convert to HDPE for potable water distribution. This decision was based on the experience gained with the exclusive use of polyethylene for natural gas distribution made in the late 1980s. Several factors were considered to support this conversion. The major driving force was the leak free performance of a monolithic self-restraining system provided by fused connections. Other factors guiding this decision included the projected life of the material, minimizing corrosion failure associated with buried metallic components, ability to install piping with trenchless construction methods to minimize installed cost and customer inconvenience and the need to construct a resilient distribution system capable of remaining in service during and after seismic events. The San Andreas Fault traverses Palo Alto. In the early 1990s, utility department staff convinced Council members of the need to increase replacement levels associated with the water, gas and wastewater systems. An accelerated infrastructure replacement program was funded and additional engineering staff hired to focus on the design and construction of all three mentioned systems. In 2009, staff started the revisions of the existing standards *and construction documents for the water system and joined the Plastics Pipe Institute Municipal Advisory Board and the American Water Works 263 Polyolefin Committee (responsible for polyethylene standards) to ensure the newly created HDPE specifications represented the best practices.*

Staff utilized past experience gained during natural gas projects to implement the use of trenchless construction methods for potable water system replacement. The first HDPE project, Water Main Replacement 21/22, was constructed over the 2010/2011 fiscal year with main sizes ranging from 8 inch (200 mm) through 16 inch (400 mm) encompassing a total 31,680 linear feet (9.7 km) of mains. Construction was performed by a polyethylene qualified contractor utilizing both trenchless and open cut construction methods. Based on the success of this project, full adoption of HDPE for water, including mains and services, was made for all system extensions and improvements/replacements. HDPE is currently the primary material specified by the City for potable water distribution.

KEYWORDS

HDPE, Water, Fusion, Palo Alto

INTRODUCTION

The City of Palo Alto was incorporated in 1894 and is located approximately 35 miles south of San Francisco California.

There are more jobs than residents (approximately 60,000) in Palo Alto resulting in a net import of commuters into the City on a daily basis. Palo Alto is at the north end of Silicon Valley and has several large technology firms including: Roche, Kodak, Hewlett Packard, Xerox (PARC), Tesla Motors, Space Systems Loral, Varian, VM Ware and numerous others. Stanford University is located outside of the Palo Alto city limits located within the County of Santa Clara jurisdiction and is not served by the City with the exception of wastewater treatment. In 1951, Stanford University created a business park, within Palo Alto boundaries which is contributory to the birth of Silicon Valley. Adjacent cities include the homes of Google (Mountain View), Facebook (Menlo Park), Intel (Santa Clara), AMD (Sunnyvale), and Cisco (San Jose) forming the Silicon Valley region.

Fig. 1: Start of Hewlett Packard, David Packard garage where the Audio Oscillator was invented

UTILITIES DEPARTMENT

Palo Alto is a unique city that provides most if not all essential utilities through municipal ownership. The Utilities Department was created with the founding of the water distribution system (1896), followed by, sewer collection (1898), electrical power (1900), natural gas distribution (1917) and fiber optic communications (1996). The creation of a recycled water system is currently in planning stages.

WATER DISTRIBUTION SYSTEM

In 1938, the San Francisco Public Utilities Commission's Hetch Hetchy system, originating in Yosemite National Park, became the primary source of water for Palo Alto customers due to the higher quality when compared to existing ground water sources. Palo Alto has maintained ground water sources, in a standby mode, in the event of a disruption of the primary source or other catastrophe. The water system serves approximately 20,000 customers. The majority of the customers are served in a single pressure zone (90%+). The service territory includes sea level to the coast range elevation changes of 2,500 feet (760m) and is divided among 9 separate pressure zones. The system also includes seven reservoirs that maintain delivery pressures through the system with an average delivery pressure of 65 psi (4.5 bar). The 233 mile (375 km) water distribution system contains main diameters range from 4 inch (110 mm) to 18 inch (640 mm). Several materials are present in the distribution system including Cast Iron (CI), Ductile Iron (DI), Asbestos Concrete (AC), Polyvinyl Chloride (PVC), High Density Polyethylene (HDPE), Prestressed Concrete Cylinder (PCCP) and Steel. The breakdown of these materials is shown in Figure 2.

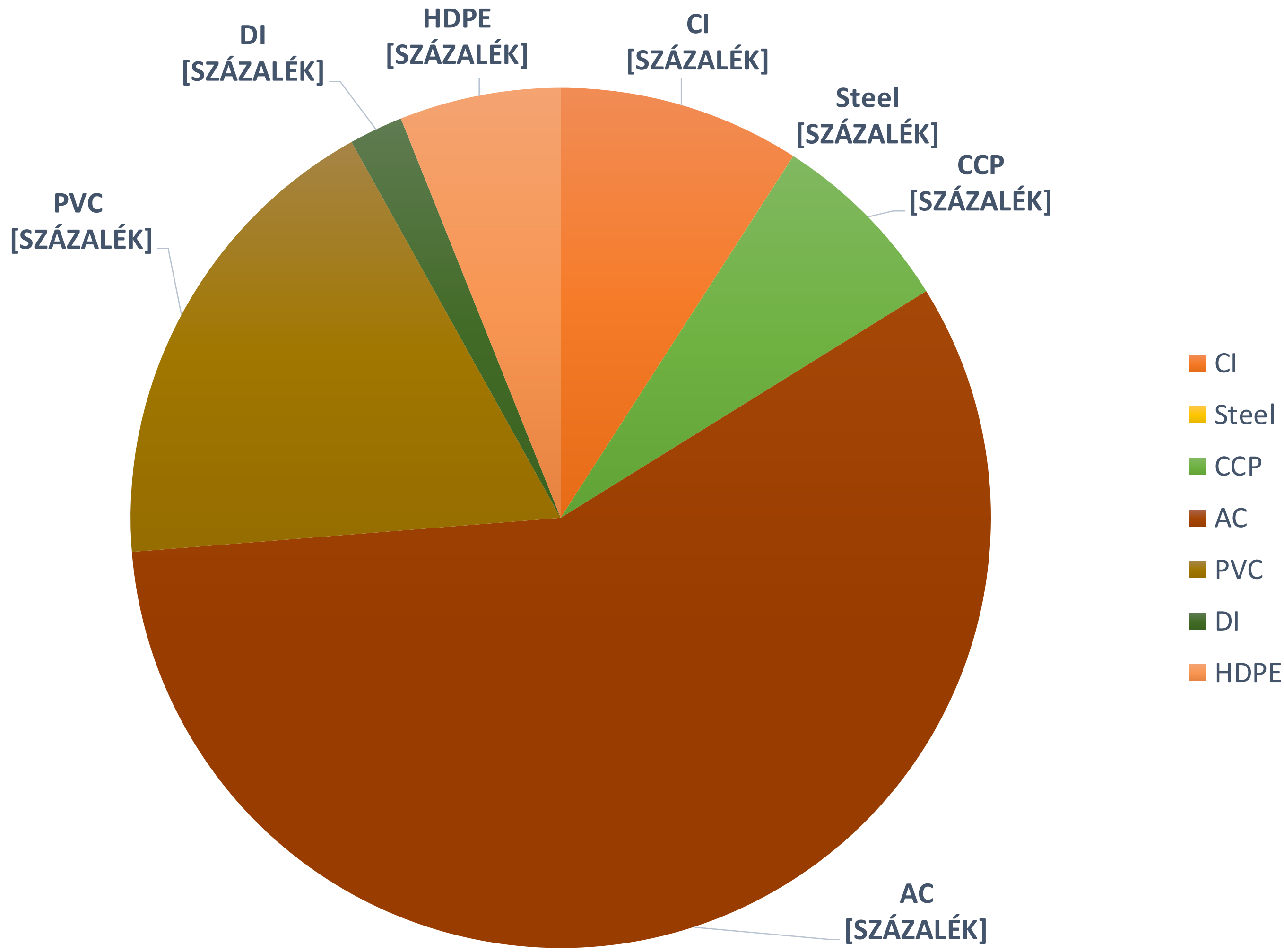

Fig. 2: 2020 Breakdown of Piping Materials by Percentage Present in Palo Alto Water System

CAPITAL IMPROVEMENT PROGRAM

In 1991, Utilities Department staff convinced council that increased investment was required to ensure reliability, reduce maintenance and leakage resulting in a tripling of annual replacement rates starting in 1994. This resulted in a targeted replacement increase of 3 miles (4.8 km) per year versus the previous level of 1 mile (1.6 km) per year. With the exception of one HDPE project, most of the pipe installed from 1994 to 2010 was PVC with a small amount of Ductile Iron. The system was converted to HDPE in 2010 with limited use of DI for shallow bury or high pressure applications.

WHY SWITCH TO HDPE

- Projected useful service life of material
- Leak free performance associated with fused connections

- Documented seismic performance (San Andreus Fault crosses Palo Alto)
- Self-restraining characteristics (minimization of thrust blocks)
- Elimination/minimization of metallic corrosion
- History of performance with polyethylene in Natural Gas System
- Familiarity with fusion, required tooling, installation methods, installer fusion qualification
- Need to reduce installed cost, social costs and environmental costs by utilizing trenchless construction methods

WATER MAIN REPLACEMENT PROJECT 21/22

Two annual projects were combined in 2010 resulting in the replacement of approximately 6 miles (9.7 km) of mains ranging from 8 inch (200 mm)(minimum main diameter) to 16 inch (400 mm) diameters using SDR 11. Work included the reconnection of approximately 1,000 copper service lines. The construction contract included provisions for half of quantity of each listed diameter to be installed by trenchless construction (horizontal directional drilling). Historically the water utility had not used trenchless methods. Trenchless construction minimizes the replacement of pavement which can be up to one half of the installed cost. On a typical 600 foot (0.18 km) long city block, the amount of impacted pavement was reduced by 5/6's to approximately 100 linear feet (0.03 km). Typical trench widths are 3 feet (0.9 km). The required excavations included service tap points, fire hydrant connections and valves at each end of the block. Additional excavations were also required to find/prospect existing underground utilities to avoid damage/conflicts during directional drilling installation.

WATER MAIN REPLACEMENT PROJECT 23/24

Two annual projects were also combined in 2012 with a reduced scope (lengths/diameters/number of services). This project specified all work to be performed with trenchless construction methods with allowances for open cut. One major aspect of this project was the specification of solid wall blue pipe. HDPE pipe marketed in the North America is typically black in color and may have colored strip indicating the type utility (blue stripe potable water, yellow stripe gas, green stripe wastewater, red stripe electric, etc.) Staff worked with a resin supplier and a pipe manufacturer to provide blue solid wall pipe for this project with the belief that a solid wall pipe is much easier to identify during a response and knew that colored exterior pipe was available in Europe. This project differed from previous efforts by requiring the replacement, instead of reconnection, or service lines with HDPE resulting in a fused system from main to meter with the material transition to metallic fittings at the meter (see Figure 3). Minimum 2inch (50 mm) services lines were installed due to residential fire sprinkler requirements. Typical placement of the meter is behind the road curb outside of the public right of way on private property. By replacing the service lines during main replacement, future maintenance in the street right of way should be limited to third party damage which should be avoidable if accurate construction records are used to locate the facilities prior to subsequent underground construction.

Fig.3: Fused Meter Manifold with Transition to Brass at Meter Inlet

ADDITIONAL HDPE WATER PROJECTS

The first installation of HDPE for potable water occurred in 1994. This “trial” project was based on available resin compounds (HDPE 3408). Fusion was limited to butt methods fabricating the 6 inch (150 mm) main with mechanical metallic saddle service connections. SDR 9.0 pipe was specified. Mechanical service tees with spring loaded gaskets were utilized for all service connections and existing cooper service lines were reconnected at the main.

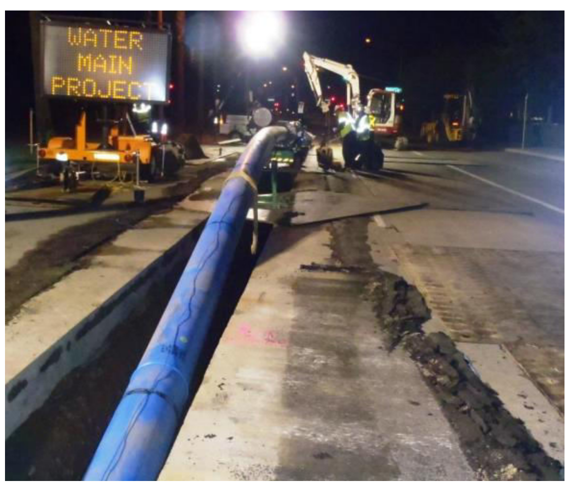

Fig. 4: Stanford Hospital 14 Inch (355 mm) Water Main

The Stanford Hospital complex was reconstructed in the period from 2010 to 2016 which required modification of the water distribution system resulting in the installation of 14 inch (355 mm) “loop” of solid wall blue HDPE pipe to provide the required flow rates (Figure 4).

FUTURE PROJECTS

Recent economic activity in the San Francisco Bay Area has led to a shortage of qualified contractors to perform underground construction. As a result of this shortage, Palo Alto has experienced increasing construction related costs. To accommodate this cost increase, future planned main replacement projects will be staggered to every other year. Note: this was planned before the spread of corona virus which has severely impacted tax revenue thereby forcing all government entities to cut spending and will result in a further lowering of replacement quantities.

With the success in Palo Alto, dozens of utilities in the US and Canada adopted HDPE as the preferred water piping system material and adopted trenchless construction methods.

CONCLUSIONS

Successful adoption of HDPE materials for potable water distribution requires diligence on the part of the owner to ensure that installers are qualified to perform fusion related activities. With the lack of unified fusion certification system in North America, owners must assume the role of self-certifier for field fabricated HDPE systems very similar to the natural gas industry in North America. Specifications must be exactly tailored to HDPE installations identifying available materials, fittings, appurtenances with detailed fabrication, operational standards and backup repair methods. Onsite inspection can monitor and identify problematic installations and mitigate premature failure if caught before new systems are put into service. With the above mentioned diligence, water operators in Palo Alto and the US and Canada can and do experience the benefits associated with HDPE.

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