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Creating a Pilot Tube Guided Boring Project from Scratch: The Subcolector San Marcos Project, Mexico City

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1. ABSTRACT

In mid-October 2013, construction was finalized on the installation of 2,944 ft. (897m) of new 36-in. (914mm) ID storm and sanitary pipelines using pilot tube guided boring methods in Mexico City. The Subcolector San Marcos project, owned by La Comisión del Agua del Estado de México (CAEM), represents the first trenchless installation with this technique in Mexico. The Subcolector San Marcos project embodies the successful and accurate completion of the alignments, but more importantly, the culmination of several years of partnerships to educate, design, and procure equipment and pipe among many entities, proving the value and viability of this method over open-cut installation. The Subcolector San Marcos has spawned a series of forthcoming phases to increase the capacity and quality of its sanitation and storm water infrastructure that is currently serving 88,000 inhabitants.

Subcontractor, Tordo Technologies SA, crews installed the total 2,944-ft. (897m) in eight drives, ranging from 186 to 441-ft. (57-134m) in length, from nine minimal depth and diameter shafts in the urban Plaza de Aragon, Ciudad Nezahualcóyotl municipality of Mexico City. Construction, including shaft creation and crew training, was completed in 13-weeks. The soil stratum, comprised of soft clay, was conducive to this method allowing for above average production and accurate tolerances. The project was designed by CAEM and part of an investment of 120m pesos, for two main and several sub-collectors.

This paper presents an account of how each party contributed to this project.

2. INTRODUCTION

The Subcolector San Marcos project comprised of the installation of 2,944-ft. (897m) of new 36-in. (914mm) ID storm and sanitary pipelines using pilot tube guided boring methods in Mexico City. While this region has been installing pipe lines in diameters above 48-in. OD via trenchless methods since for many years, small diameter trenchless installations under 48-in. OD were not done. In a region prime for the necessity of this technology, a faction of determined individuals comprised of equipment representatives, manufacturers, and governmental officials set out to propagate the introduction of such means to the area. Their success was marked by the first trenchless installation by pilot tube guided boring in Mexico.

3. MEXICO'S WATER INFRASTRUCTURE PROGRAM

Mexico experiences many seasonal flooding events due to its situation between two major bodies of water. Inadequate and sometimes, nonexistent storm infrastructure has commonly lead to disastrous circumstances for residents.

"Mexico is prone to several weather events including hurricanes on both Pacific and Caribbean coasts. Hurricanes contribute to recharge surface and groundwater reservoirs with increases water supply for cities, irrigation and electricity generation. Hurricanes pose also a threat to service delivery, infrastructure and ultimately to ecosystems and human life. This situation is aggravated by deforestation upstream as well as human settlements located in flood prone areas." (Water Resources Management in Mexico, 2013)

The Conaqua Comisión Nacional del Agua (CONAGUA) is the federal level institution responsible for water management. La Comisión del Agua del Estado de México (CAEM) is responsible for water management at the state level.

The guiding plan for water management at the federal level is called the National Water Program 2007-2012, part of the National Development Plan 2007-2012. The National Water Program outlines the crux of Mexico's water and infrastructure problem as:

"…in general, 67% of the rain we receive occurs in just four months of the year, namely from June to September, and this makes it hard to take advantage of it properly, thus making it necessary to build major infrastructure for collecting and storing it.

It is important for us to always bear in mind that two-thirds of the land in Mexico is arid or semi-arid, which necessitates the efficient use of water in all our activities, ranging from irrigation to industry to our homes.

The above situation becomes particularly relevant if we consider that Mexico's population has quadrupled in the past 55 years, going from 25 million inhabitants in 1950 to 103 million in the year 2005. There is a marked concentration of the population in urban zones, where the number of inhabitants rose from 11 million to 79 million in the above-mentioned period.

At the national level, the greatest population and economic growth has taken place in areas with less water availability. Therefore, in the central and northern regions of the country, we find 31% of national water availability, with 77% of the population, a situation in sharp contrast with 12 the southeastern part of Mexico, where we find 69% of our water availability and only 23% of the country's inhabitants. One reference parameter used throughout the world with regard to water is per capita availability. In just 56 years, Mexico went from an availability of 18,035 cubic meters per inhabitant per year to only 4,416, which places it in a delicate situation.

Moreover, we should mention that given our country's geographical location, it is periodically subject to hurricanes and droughts that cause serious damage in large portions of our territory, and it is expected they will be even more frequent and intense due to the effects associated with climate change." (National Water Program, 2008)

Residents of Ciudad Nezahualcóyotl are frequently exposed to flooding conditions. A post-project video, released by the Gobierno Del Estado De Mexico, focused on testimonials by Nezahualcóyotl residents who were subjected to these conditions. Flooding has caused major property damage along with governmental expenses associated with health and safety issues for these residents.

4. BACKGROUND

Mexico City has a rich pipe jacking history. US based pipe jacking and tunneling equipment manufacturer, Akkerman introduced their mechanized pipe jacking system to Mexico in 1994. Since this time, over 100km of various diameter pipes have been installed with Akkerman equipment.

In the early 90s, Akkerman was approached by Antonio Torres, a local paving contractor based out of Tijuana. Torres was familiar with the inherent value of pipe jacking over the open-cut method and followed it through trade publications. Torres noticed the difficulties and patterns of disturbance that the Mexico City International Airport Authority was having with the open- cut method of pipe installation while working on projects. After many calls and connections, Torres was able to get in touch with the right people to initiate the opportunity for a demonstration in Chalco Nuevo (Mexico City) with an Akkerman 114-in. (2.89m) OD excavator shield and pipe jacking system.

Following this successful demonstration, the pipe jacking market became more robust. This was evidenced by the emergence of several contractors adopting this method as part of their service offerings which resulted in many meters of pipe jacked pipe in the area.

In 2006, Alinea Group entered into an equipment representative agreement with Akkerman. The Alinea Group had been longtime advocates and educators on the benefits of trenchless solutions with strong connections at La Comisión del Agua del Estado de México (CAEM) and other governmental agencies involved in water and sewer infrastructure decision making.

Alinea Group and Akkerman officials spent many hours educating about the pilot tube guided boring method during private meetings, public presentations and industry trade shows. Initial discussions with local contractors about the possibility for pilot tube guided boring were met with some resistance, due to the lack of contracts and pipe availability. Without a saleable market for jacked pipe in this range, discussions with pipe manufacturers were also met with some indecision since projects that were bid were not requiring jacking pipe in this diameter. While Alinea Group was actively quoting contractors for pilot tube guided boring equipment, it proved to be an exercise in futility.

This cycle of frustration continued until an agreement was made in October 2011. The Alinea Group arranged to meet with a few governmental contacts at CAEM to secure a site for a pilot tube guided boring project, and Akkerman agreed to dispatch a complete small diameter guided boring system with an accompanying, appropriately-sized jacking pipe.

In the summer of 2012, Akkerman shipped the GBM system from its facilities in Minnesota, and picked up a small quantity of 15-in. (381mm) ID of NO-DIG clay pipe in on the way to a storage facility at the Alinea Group headquarters in the City of Mexico. The system remained in storage until the CAEM’s demonstration was secured some six-months later.

5. THE DEMONSTRATION

The demonstration took place in Amecameca, a rural region south of Mexico City (see Figure 1). At this time, most of the remaining pipe lines on this project had already been installed via open-cut pipe methods except for a small 50-lft. (15.2m) section, intended for the pipe installation under a road crossing.

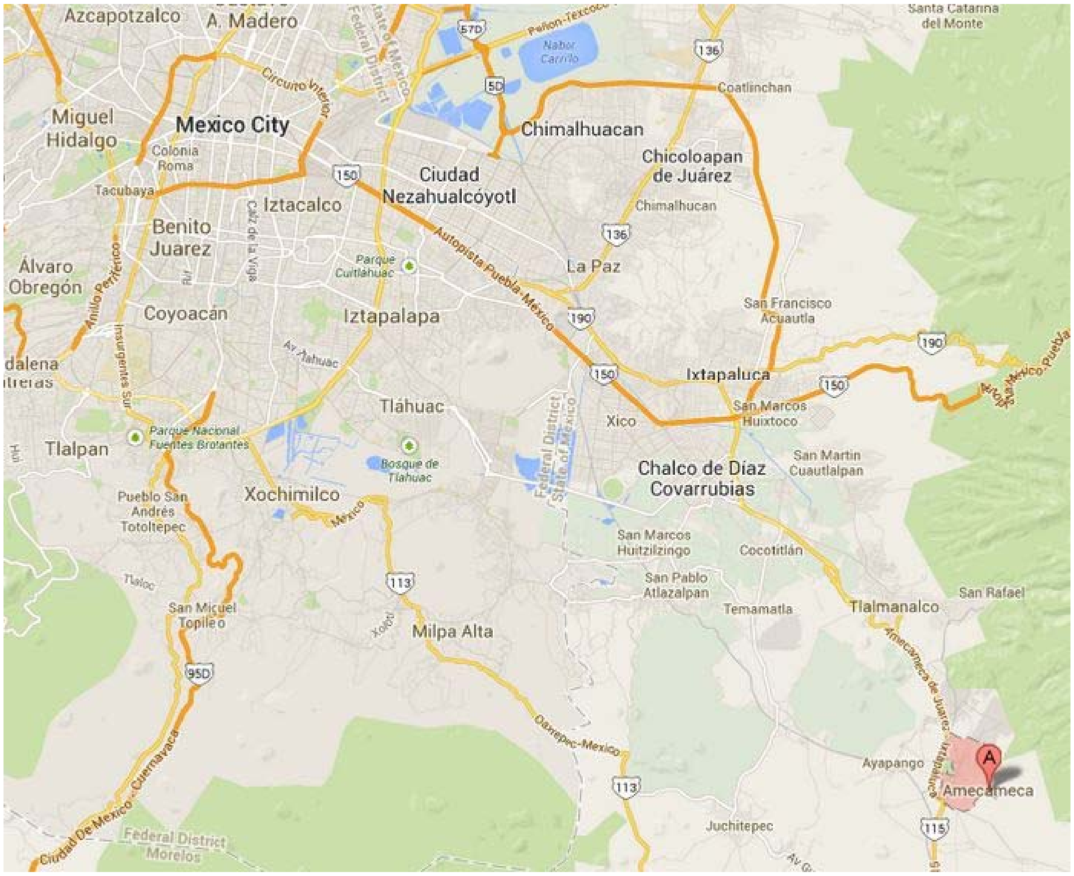

Figure 1. Location of Amecameca in relation to Mexico City.

The demonstration took place on December 5-6, 2012, with an audience of city officials, engineers, representatives from the Alinea Group, Akkerman, and local contractors (see Figure 2). The installation was performed by an Akkerman factory trained field technician using an 308A GBM jacking frame, P100A power pack, powered reaming head (PRH) assembly for upsizing to the pipe OD, pilot tubes, and 11-in. (279mm) casing and augers.

Figure 2. CAEM officials, engineers, local contractors, the equipment representatives gathered to witness the demonstration in Amecameca.

The geological profile for the demonstration was ideal to showcase the range of capability of the guided boring system. The sandy clay was easily displaceable and allowed for spot-on accuracy to achieve the gravity flow.

Following the demonstration, CAEM officials further embraced the value of trenchless pipe jacking solutions, especially from the perspective of reduced social costs. The success of this demonstration made quick advocates of the pilot tube guided boring method by all attending parties.

6. PIPE PROCUREMENT

The lack of pipe manufacturers making a jacking pipe in this diameter range was one of the biggest deterrents to getting this technology into the repertoire of contractor's pipe jacking solutions in the region.

During the Asociancíón Nacional de Empresas de Agua y Saneamiento de México (ANEAS) Expo in October 2012, the Alinea Group's exhibit space contained several pieces of the loaner GBM system, including an appropriately sized segment of clay pipe. The display piqued the interest of several pipe manufacturers at the show. The visual representation of this pipe led to the opportunity for more tangible discussions on the subject of its manufacture at a local level.

An Akkerman sales engineer met with three pipe manufacturers during the ANEAS Expo. TuboCreto of Morelos, Mexico, an established manufacturer of large diameter pipe, who expressed interest in furthering the notion of manufacturing a jacking pipe to complement the GBM equipment capabilities. These conversations manifested into TuboCreto providing the full lineal footage of 36-in. (914mm) ID RCP for the Subcolector San Marcos project.

7. THE SUBCOLECTOR SAN MARCOS PROJECT

The opportunity for the Subcolector San Marcos project was born out of the success of the demonstration and the design was tailored specifically for GBM installation. The specifications for this subcollector called for the installation of 36-in. ID (914mm) storm and sanitary sewer lines with the pilot tube guided boring method. The contract for the project had been in place for some time, but the change from open-cut to the trenchless method was a modification by the Conaqua Comisión Nacional Del Agua. The Subcolector San Marcos project was part of an investment of 120m pesos, for two main and several sub-collectors to reduce risks during flooding events.

The project is located in the municipality of Ciudad Nezahualcóyotl or Ciudad Neza, northeast of Mexico's Federal District and is the second most densely populated municipality in the State of Mexico. The Plaza De Aragon is very urbanized, and comprised of closely aligned businesses and residential facilities in tandem. This region's low elevation contributes to its devastation during rainy seasons.

Geotechnical conditions in Mexico are characterized by two categories: type 1 and type 2 soils. Type 1 soil is generally sandy clay with the presence of organic matter. Type 2 soils generally presents harder geology and some cobbles. It is not typical practice for a geotechnical baseline report to be prepared during the project design phase. Often, the soil classification is defined at the time of the shaft construction. It is also not common practice to map and record buried utilities. Design parameters factor in the appropriate gravity flow at with an added estimated depth to avoid potential utilities.

Subcontractor, Tordo Technologies SA embarked on the project with a new crew, who were poised for training by an Akkerman field technician. The entire equipment package included a 4812A GBM jacking frame, P100Q and P150Q power packs, and a powered cutter head PCH 44 upsizing tool, 16-in. (406mm) heavy duty casings and augers, jetting and lubrication pump, and other ancillary equipment.

The eight runs ranged from 186 to 441-lft. (57-134m) in length (see Table 1) from nine shafts.

Drive Number	*Shaft Location*	*Drive Length (m)*
1	L1 to L2	56.79
2	L2 to L3	113.35
3	L3 to L4	115.04
4	L4 to L5	97.08
5	L5 to L6	127.14
6	L6 to L7	134.56
7	L7 to L8	132.29
8	L8 to L9	121.35
		897.60

Table 1. Subcolector San Marcos Project bore log.

The runs ran in a northward succession along Plaza de Aragon then eastward along the Avenue Plaza San Marcos (see Figure 3). The nine shafts were constructed of steel sheet pile and designed to allow for the launch or reception of the pipe jacking system in order to offer project flexibility. Shaft locations were considered and staged for the least amount of intrusion and impact on the local residents and businesses. The project had a 0.38% average grade and the soil conditions made this accuracy easily attainable throughout the project.

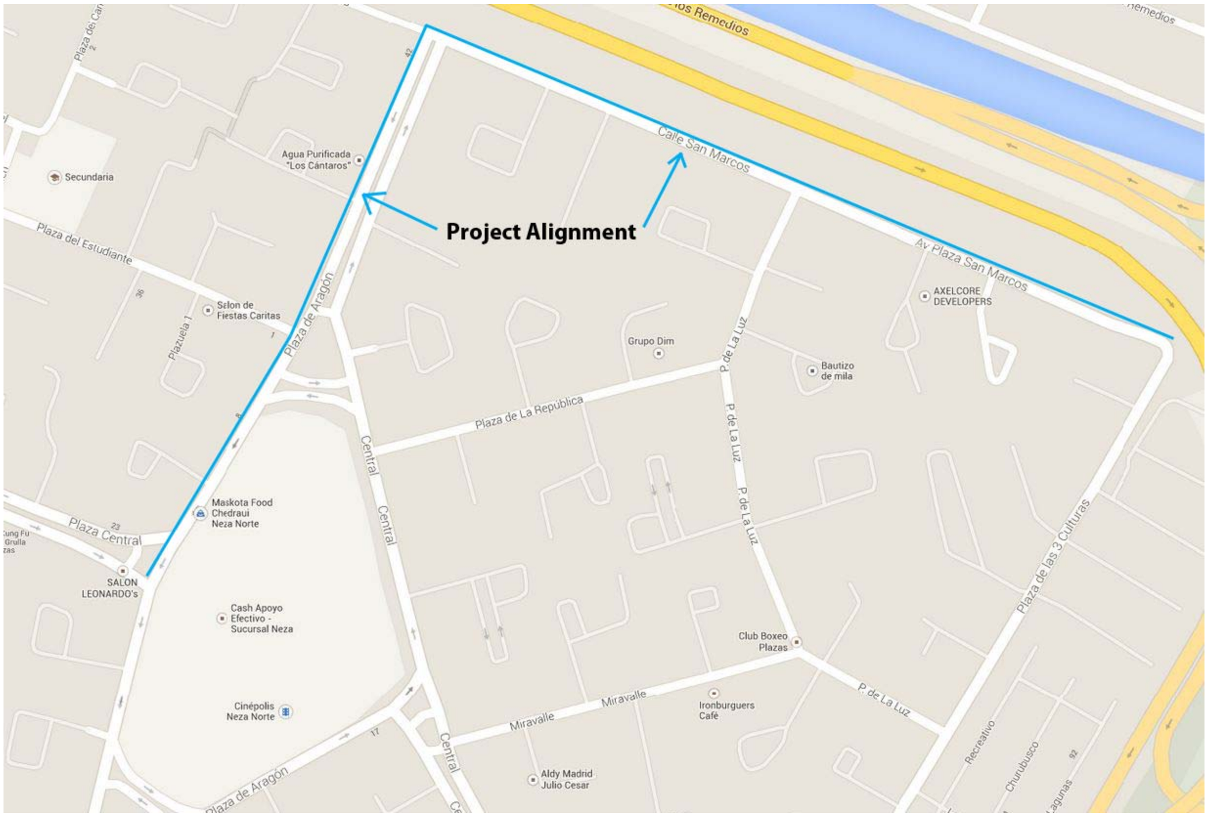

Figure 3. Subcolector San Marcos project map, illustrating the full alignment.

In the first week of June 2013, GBM operation training was given by an Akkerman field technician for the 10-man crew. The first drive was initiated from the central Plaza de Aragon, with a fairly generous staging area (see Figure 4). The first drive was also the shortest, at 186-lft. (56.79m).

Figure 4. Project staging area for the first drive.

Crews moved northward, using the previous run's reception shaft as the launch shaft for the second drive. Construction progressed north to the intersection Avenue Plaza San Marcos where the alignment turned eastward. Crews completed all eight drives by mid-October 2013.There were no significant delays or challenges encountered on the project.

A post construction video, funded by the Gobierno Del Estado De Mexico, focused on testimonials by community members speaking to the pre-alignment devastation that they were experiencing during wet weather episodes and their pleasure with the new system, post-construction.

8. CONCLUSIONS

The Subcolector San Marcos project's most significant achievement is the inroads that it made for trenchless solutions in this diameter range. Involved parties were fortunate to have the support of a government that was familiar with the method, saw its inherent value and fully embraced the investment of minimizing social impacts in their communities. The new infrastructure has positively contributed to the quality of life for Ciudad Nezahualcóyotl residents, who were vastly familiar with the adverse effects of frequent flooding in their homes and businesses. It was an archetype project and the future catalyst for increased quality in Mexico's sanitation and storm water infrastructure.

The Subcolector San Marcos also represents tangible results for innumerable hours of persistence and dedication by all contributors. The project embodies the ideal outcome for shared trust, collaboration, education, negotiations, and execution.

9. REFERENCES

CONAGUA (February 2008). National Water Program. Gobierno Federal SEMARNAT.

Wikipedia (2013). Water Resources Management in Mexico. Retrieved December 9, 2013. http://en.wikipedia.org/wiki/Water_resources_management_in_Mexico.