



## Bay Area Rapid Transit Authority Warm Springs Extension

San Francisco, California

Keller's innovative solution to perform the jet grouting using several multi axis (Bi-Jet) machines enabled the construction of the project to be completed in less time requiring fewer machines as well as being less costly than anticipated.



## The project

The San Francisco Bay Area Rapid Transit (BART) Authority planned the construction of an additional subway station to extend the existing subway line further south, from Oakland into the city of Fremont, to alleviate the ever-growing traffic. The station was located on an alignment that crosses underneath the eastern portion of Lake Elizabeth. The BART engineers designed the subway station tunnel structure to be constructed using the “cut and cover” method, meaning that the excavation is cut deep enough to allow the new tunnel structure to be built and then covered up with soil after completion.

## The challenge

This project required support of excavation on both sides for over half a mile, as well as a jet grouted base seal for the bottom. Tremie concrete seals are the usual method that is used in areas of high water table and highly permeable soils. The use of jet grouting for such a large excavation was an important application of the effectiveness of the technology.

## The solution

The BART design engineers specified that a significant amount of coring and testing would be required, which is costly and time consuming for the owner. Keller offered to do a full-scale test program to prove the effectiveness of the jet grouting and eliminate much of the testing and coring. The test was successful and the project benefited as a result. The industry standard for jet grouting at the time was, and still is, to use a single drill stem to jet grout one column at a time. Keller's innovative solution to perform the jet grouting using several multi axis (Bi-Jet) machines enabled the construction of the project to be completed in less time, which required fewer machines and was less costly than anticipated. Keller's innovative engineers have now developed three- and four-axis jet grout machines that are unique to this market and setting new records at various projects around the country.

## Project facts

### Owner(s)

Bay Area Rapid Transit Authority (BART)

### Keller business unit(s)

Keller

### Main contractor(s)

Shimmick-Skanska JV

### Solutions

Ground improvement  
Support of excavation

### Markets

Infrastructure  
Transportation  
Tunnels and shafts

### Techniques

Jet grouting

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