

Tunneling solutions

- Shafts/portals/stations
- Adits/connectors/cross passages
- Alignment modification/improvement
- Settlement mitigation/instrumentation
- Rehabilitation/emergency response



SHAFTS/PORTALS/ STATIONS

Keller leads the way in groundwater control and earth retention for underground construction. We offer the widest range of techniques of any geotechnical contractor. Among these, structural diaphragm walls, ground freezing, secant piles, cutter soil mixing, jet grouting, steel sheeting, and beam & lagging systems are the most used.

We have the in-house capability to design and install diaphragm walls using either hydromill or clamshells and have completed more than 250 clamshell projects. We've performed most North American diaphragm wall work since 1969, which translates to hundreds of successful projects. We currently field the largest fleet of hydromills and supporting equipment in North America.

Similar to hydromill panel excavation, cutter soil mixing (CSM) uses a twin cutter wheel tool to soil mix panels. Our ground freezing expertise has progressively grown since the 1970s and has become widely accepted, particularly in difficult or disturbed ground conditions and where 100 percent assurance is required. Keller brought jet grouting to North America, where we remain the most experienced and accomplished grouting contractor. Grouted bottom seals or dewatering/pressure relief methods are just a few tools that Keller can use for groundwater control for deep stations and shafts. In addition, we have worked on every US subway system since 1970, using a range of techniques, and our versatility and experience speak for themselves.



Binocular diaphragm wall shafts.



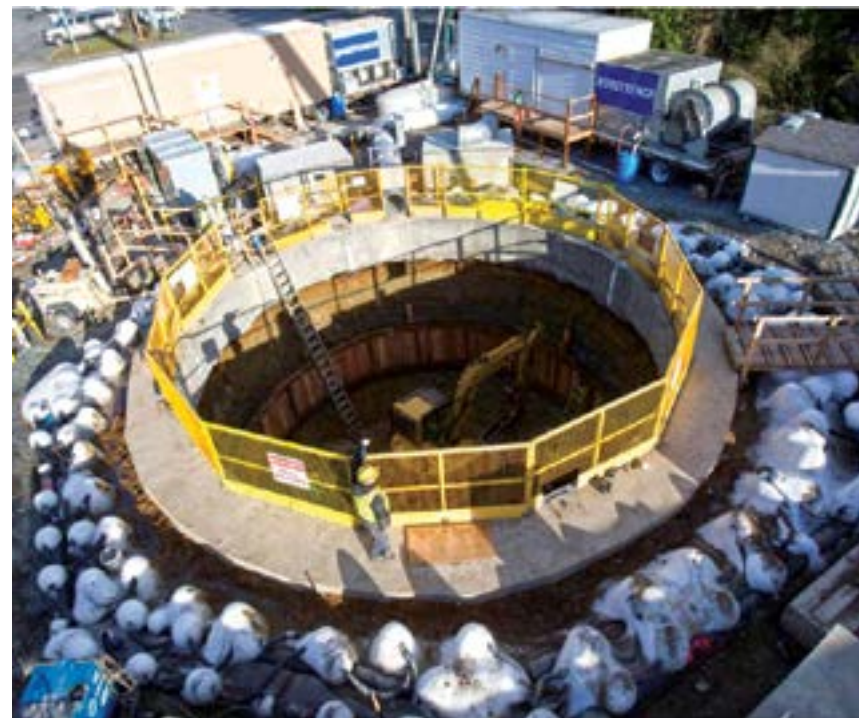
Keller has the largest fleet of hydromills in North America.



High-pressure jet grouting.



Jet grouting can be used for the lateral support of excavation as well as a bottom seal.



Ground freezing for groundwater control and support of excavation.



Secant piles for deep shaft support of excavation.



Cutter Soil Mixing (CSM).

ADITS/CONNECTORS/ CROSS PASSAGES

Tunneling projects are more than just shafts/stations and tunnels. They are made up of complex networks of underground structures featuring short adits, connectors, and cross passages that are often constructed through less than ideal subsurface conditions in a restricted space without the protection of a shield or TBM. No other mining operation is as vulnerable to unstable ground as these hand-mined elements. Keller has a complete range of in-house design/build techniques to select the optimum solution for the soil and groundwater conditions.

Some of these solutions can be accomplished from either the surface or within the tunnel itself. Ground freezing is a prime example. This technique conforms well to pre-existing structures, is effective in the widest range of soil conditions, and can accommodate obstructions better than any other technique. Also, the frozen soil mass is essentially watertight.

Permeation grouting can similarly be performed from the surface or from within a tunnel. Jet grouting also conforms well to pre-existing structures, offers a high degree of seepage control, is possible in a wide range of soil conditions, and can be performed inside structures where the drilling is near vertical. Soil mixing is typically a surface-only technique and has been highly effective in some soils that do not lend themselves well to permeation or jetting. Since underground work is often constructed below the water table, some form of dewatering is typically required during construction. Keller has been the nation's leading dewatering and groundwater control practitioner for underground construction since the early 1920s.



Cross passages are inherently difficult to access. Ground freezing and permeation grouting are readily adaptable for implementation from within the tunnel.



A horizontal frozen arch for groundwater control and structural support of a large SEM tunnel.



Keller has extensive experience with drilling inside of tunnels for the installation of grout pipes, freeze pipes, canopy pipes, instrumentation, and lances.



Connector tunnels and adits can be effectively improved, full face, at considerable depth below the water table with jet grouting, ground freezing, and permeation grouting.



Liquid nitrogen is very cost-effective for ground improvement of small connector tunnels.

ALIGNMENT MODIFICATION/ IMPROVEMENT

Improvement of a TBM alignment typically consists of launch and retrieval blocks, safe havens, mixed ground treatment, or grouting of rock. For TBM mining through mixed face conditions at the soil/rock interface, ground freezing has proven to be an effective option for providing homogeneous conditions. Ground freezing is also advantageous for tunneling "safe-havens," particularly at greater depth and through difficult ground, though jet grouting may be used at shallower depths or better ground. Jet grouting or creating a diaphragm wall "bathtub" are preferred options for break-ins/break-outs.

Improvement of an SEM (Sequential Excavation Method) tunnel alignment typically consists of permeation grouting of clean granular soils for improved stand-up time, dewatering, or installation of canopy pipes or spiles. For SEM tunnels and hand-mined connectors in water-bearing ground, dewatering is imperative since SEM tunneling is very vulnerable to instability or lack of stand-up time typical in wet ground. Deep well dewatering from the surface is preferred though horizontal vacuum lances can be used within the tunnel if surface dewatering is not viable.

Permeation grouting was a well-established method of stabilizing clean granular soils above the tunnel crown for open-face digger shield mining before the advent of earth pressure balance machines in the early 1990s. However, it still has relevance for hand-mined tunnels to minimize the risk of subsidence during excavation. With all of these options available through Keller and implemented by experienced crews, you can be sure your project is in the best hands.



Jet grouting of a tunnel break-in block.



A suite of grout mixes was used to grout highly variable karst rock to perform drill and blast tunneling without water inflow.



A microtunnel launch stabilized with permeation grouting.



Rock curtain grouting methods used to improve the rock where retrieval occurred with a very thin pillar.



Ground freezing (shown) and jet grouting are used for the construction of safe havens.



Ground freezing used to provide rock-like conditions through a mixed face TBM tunnel reach.



Permeation grouting can be performed with a variety of grout materials and mixes based on ground conditions and requirements.



SETTLEMENT MITIGATION/ INSTRUMENTATION

With its breadth of technical capabilities, Keller can take advantage of several approaches to counteract actual or anticipated ground relaxation due to tunneling operations near sensitive structures. To prevent settlement, geotechnical measures such as micropiles can be used to support sensitive structures.

Where direct access to third-party structures is limited, or the ground relaxation should be addressed closer to the source, ground improvement methods include jet grouting, permeation grouting, and soil mixing. Rigid earth retention methods include diaphragm walls, soldier pile tremie concrete (SPTC) walls, or secant piles.

Compensation grouting can be performed concurrently with mining with the precise injection of grout between the tunnel and the structures subject to settlement. Drilling and installing grout pipes can be from the surface, a tunnel, or a subsurface gallery. Horizontal directional drilling (HDD) may also be used to install compensation grout pipes or real-time inclinometer strings that conform to the crown of the tunnel.

Keller can provide a wide range of instrumentation to inform and guide these mitigation measures and provide continuous monitoring of structures along the tunnel alignment, including subsurface utilities, basement walls, roadway surfaces, foundation slabs, columns, and load-bearing walls. Measurements are collected automatically, processed, checked against alarm thresholds, and posted on dedicated project websites. The project team can view data, graphs, alerts, and reports via their web browsers. Keller is uniquely qualified to combine settlement mitigation with sophisticated instrumentation so that the work is performed seamlessly.



Keller is particularly experienced with monitoring on large projects which require multiple AMTSs, linked together for a strong optical monitoring network.



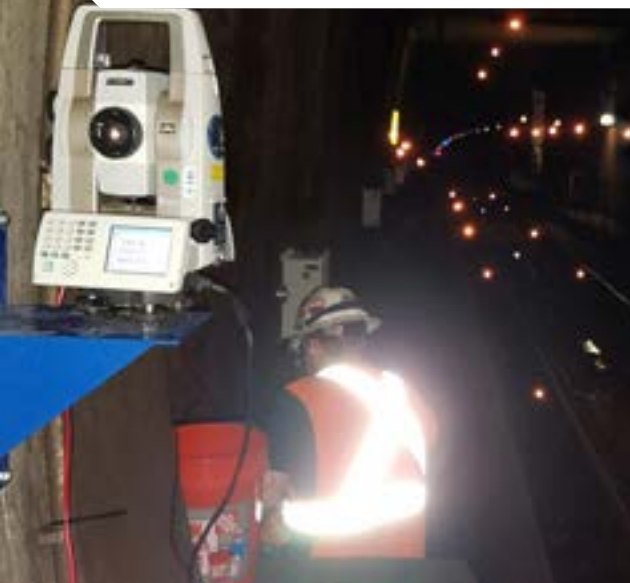
Access shaft for the installation and grouting of compensation grout pipes.



Monitoring of strain gauges on lattice girders to verify load distribution on SEM tunnel lining.



Permeation grouting between a building and future shaft to mitigate settlement of the building from shaft excavation.



Keller has the experience and training to provide instrumentation and monitoring within active tunnels.



Grout injection through horizontal directionally drilled compensation grout pipes that follow the curvature of the tunnel.



REHABILITATION/ EMERGENCY RESPONSE

When the unexpected happens during tunneling operations, a resolution must be initiated quickly to mitigate further disturbance, keep the project on track, and minimize costly schedule delays. Often, such events involve groundwater inflow and ground loss. Since there is no time for a thorough geotechnical investigation and detailed diagnosis, the condition assessment must be rolled into the immediate response and corrective action. Therefore, it is critical that the geotechnical contractor hired for the work is well-versed in understanding the likely causes, the likely impacts to the surrounding ground and structures, the best remedial approach, and has the personnel, tools, and resources to mobilize and accomplish the task quickly. In this respect, Keller stands alone. We have seen – and remediated – everything from stuck TBMs, to unanticipated mixed-face conditions, to deep access shafts that failed all previous contractors' attempts at groundwater control.

Our tunnel remediation repertoire is as varied as the issues we've corrected and requires the same insights that come with experience. Seepage and long-term ground loss are typical concerns with tunnel rehabilitation. Seepage is difficult to control under flowing water conditions, and the accompanying ground loss can be difficult to trace, but we have the greatest overall experience under such challenging conditions. No matter the most appropriate emergency or remedial response measure, Keller has the expertise and experience to get the job done swiftly and effectively.



Jet grouting used to address seepage through a deep secant pile wall.



Grouting can be performed inside tunnels for seepage control, contact grouting of a segmental liner, or treatment of ground irregularities.

WHY CHOOSE KELLER?

Keller is the world's leading specialty contractor, operating across 40+ countries and five continents. This means we have ready access to the latest technological and equipment advances. Yet while we enjoy unparalleled global reach, we also ensure local focus through our network of North American offices.

We've been successfully resolving tunneling issues for decades. We have more "tools in the toolbox" than any other geotechnical contractor, and the in-house engineering capability to design/build the optimum solutions tailored to project objectives and subsurface conditions. And we bring to every job the equipment and experienced site personnel to execute those solutions safely and effectively.

No matter where in the country your tunneling project is, and no matter how complex the challenge, Keller is around the corner and poised to work with you to develop the best solution.



Compaction grouting is often the quickest way to compensate for ground loss and counteract settlements that occur with tunneling.



Grouting methods used for seepage control of in-service tunnels.

5 continents



40+ countries



9k people



6k projects/year





Keller's team of engineers, project managers, and construction experts are available to provide the optimal solution to your geotechnical challenge.

Contact us today
800-456-6548
keller-na.com

Global strength and local focus