KELLER

Building a better world

Enabling low-impact, low carbon construction

What sustainability means to us

At Keller, we are committed to better understand our contribution to sustainable development and work collaboratively with our customers and stakeholders to reduce potential impacts.

We define what sustainability means to Keller using four Ps:

People

We operate in a way that respects people and their health, safety and environment, always striving for zero harm. Our motivating and inclusive culture helps everyone thrive, and makes us a good employer that people are proud to work for.

Projects

We continually innovate to support low carbon, low impact construction, actively transforming our product portfolio to help our customers use fewer resources, reduce their carbon emissions and have less environmental impact.

Planet

We are helping to build a sustainable future by using less resources and reducing waste across our operations, whilst playing a positive role in our local communities and wider society.

Profit

We are making sustainability core to our business to differentiate us from our competitors and help achieve long-term profitability and growth.

Our sustainability commitments

The United Nations Sustainable Development Goals (SDGs) seek to address the world's biggest challenges and provide a universal language for sustainability. They also provide a helpful framework to understand how different projects and activities we do in Keller contribute.

We believe we can have the greatest impact on the following eight goals that are most closely aligned to our core business:

Our leadership role

Every day, people around the world live, work and play on ground prepared by Keller, the world's largest geotechncial specialist contractor.

The best solutions

Used alone or in combination, our techniques solve a wide range of challenges across the entire construction sector – from industrial, commercial and housing projects to infrastructure construction for dams, tunnels, transportation and water treatment, as well as projects to address environmental challenges.

Global strength and local focus are what makes us unique. Our knowledge of local markets and ground conditions means we're ideally placed to understand and respond to a particular local engineering challenge. Our global knowledge base then allows us to tap into a wealth of experience, and the brightest minds in the industry, to find the optimum solution. A significant portion of work is won based on design and build tenders with innovative design solutions.

With 10,000 employees and operations across six continents, we have the people, expertise, experience and financial stability to respond quickly, get the job done and see it through safely.

By connecting global resources and local knowledge, we can tackle some of the largest and most demanding projects around the world but the everyday work we do is just as important and, in total, we tackle an unrivalled 7,000 projects every year.

Proven track record on health and safety

We believe no one should be harmed as a result of any work we do and our ultimate goal is zero harm. We have a proven track record of one of the lowest accident frequency rates in our industry, and the commitment of leaders and employees to 'Think safe, work safe, go home safe' has earned us awards and recognition from industry bodies as well as our clients.

Building learning across the geotechnical community

We are proud of the leadership role we take in the geotechnical industry on developing and sharing knowledge, and advancing industry-wide approaches.

Many of our team play key roles in professional associations and industry activities around the world, contributing to industry-wide specifications, guidelines and codes.

Our local companies share knowledge with employees, peers, customers and suppliers on an ongoing basis via a mix of technical papers, seminars and field visits. Working in this way not only advances our industry, but also creates great opportunities for our people to be recognised and rewarded individually for their contributions.

Educational partnerships

Staff from companies throughout the group maintain close contact with partner universities to share best practice and provide examples of their leading-edge engineering.

Keller has also teamed up with the University of Surrey, UK, on a research project to identify and drive sustainability best practice throughout all our operations.

Solutions for a low-carbon, low impact built environment

The construction sector, and the geotechnical sector within it, is well positioned to benefit from a growing population, climate resilience projects and from the expansion of cities and infrastructure.

But it will be constrained by new limits on carbon, resource use and waste production, and will be expected to create local jobs and social value.

The smartest companies won't wait to be pushed by regulation. They will get ahead of the curve and design solutions that meet customer needs, at lower cost, with lower carbon emissions, and that minimise any negative impact, or have a net positive impact, on the environment.

At Keller, we have the experience, skill and creativity to rise to this challenge.

We offer:

Soil remediation and prevention of contamination
see page 6

New materials and design solutions to reduce carbon
see page 10

Equipment to reduce spoil and materials
see page 14

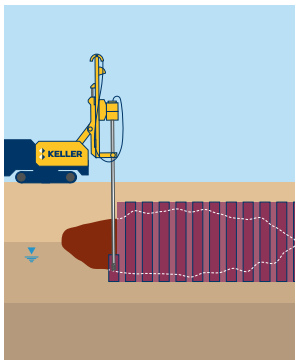
Soil remediation and prevention of contamination

At Keller, we offer cost-effective and environmentally-beneficial soil remediation solutions to reduce contaminants to levels which are suitable for use without environmental risks or danger to health.

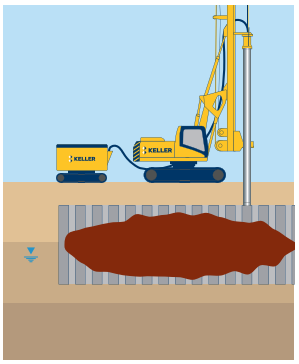
Different techniques can be applied depending on the site characteristics, including the type and amount of contaminant, groundwater conditions, chemical parameters and sensitivity of structures around the treatment zone.

Challenges we can help solve

- Soil contamination in urban areas and former industrial sites where manufacturing, industrial dumping, and waste disposal may have occurred.
- Soil contamination below the surface due to leaks from buried tanks, pipes, or landfill.
- Contamination that is seeping through the soil into groundwater or being carried to nearby land and waterways in rainwater.



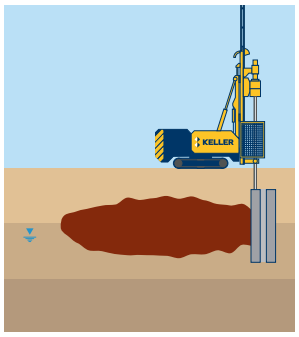
On-site treatment



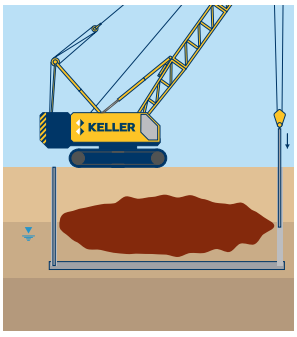
Stabilisation

Benefits

- **Multiple solutions for different contaminants including heavy metals, mineral oils, PAH (Polycyclic Aromated Hydrocarbons) and chlorinated hydrocarbons**
- **Minimal impact on people and existing structures**
- **Compliance with environmental regulations**
- **Efficient with minimal waste**



Removal



Containment

Approaches

Approach	How it works	Techniques we can do this with
On-site treatment	This in-situ chemical oxidation (ISCO) converts contaminated soils into non-hazardous soils by introducing remediating agents. It is particularly useful for remediating contaminants in difficult to access areas, for example, beneath buildings. We can use a number of different techniques to introduce different remediating agents into the soil. In an innovative extension of the Jet grouting / Soilcrete® process, Halocrete involves adding a chemical reactant to the jet grouting slurry mix, strengthening the ground with soil-cement columns while, at the same time, degrading the contaminant in situ.	• Grouting and chemical grouting • Deep soil mixing/Mass mixing • Jet grouting / Soilcrete® • Compensation grouting / Soilfrac®
Removal	This involves digging up and removal of contaminated soil from a site for above-ground treatment or disposal. When the contamination is too deep or too close to existing structures, we use bored piles to enable excavation without the need for horizontal support.	• Excavation and replacement
Removal	Elimination of contaminants is also possible by washing the soil with a liquid wash solution. Fine grained soils, such as silts and clays, are washed away along with contaminants, which are prone to bind to the fine soils. This separates the contaminants from the cleaned coarse grained soils, such as sands and gravels, which can be safely re-used. As the washed out soil still contains contaminants, it then has to be disposed of.	• Soil washing
Stabilisation	Binders are mixed with the in-situ soil to transform it into a new, solid, non-leachable material, effectively locking contaminants in place. This technique can also be used to improve the geotechnical competency of the ground, increasing resistance and lowering permeability to make it more suitable to build on.	• Grouting and chemical grouting • Deep soil mixing/Mass mixing • Soilcrete® / Jet grouting • Soilfrac® / Compensation grouting
Contain-ment	This involves the creation of an impermeable barrier to contain contaminants, eliminating the need for its costly removal and disposal.	• Grouting and chemical grouting • Deep soil mixing/ Mass mixing • Cut-off wall • Slurry wall, with optional synthetic membrane

Combining jet grouting and decontamination

ST25 Putzerei Plachy, Rittergasse, Graz, Austria

When Keller was asked to provide a geotechnical solution for the construction pit of a new residential block on a contaminated site in Austria, it proposed an innovative technique that combines jet grouting, or Soilcrete, with an oxidising agent to simultaneously provide support and remediate the soil.

For several decades Rittergasse in Graz was home to the ST25 Putzerei Plachy – a former clothes dyeing and later dry-cleaning and laundrette business. Over many years, the cleaning agent tetrachloroethylene seeped into the ground, leading to heavy subsoil contamination.

When the property was demolished with the plan to build residential premises, Keller was brought in to provide support for the construction pit.

Originally the plan was to use bored piling and then dispose of and treat the excavated material off-site. However, the site was too small for a bored piling rig. Some contaminated areas were also under the street and nearby buildings where no excavation was possible and other treatment difficult.

To solve the problem, Keller proposed HaloCrete®. This involves adding a chemical reactant to the jet grouting slurry mix, strengthening the ground with cement columns while, at the same time, degrading the contaminant in situ.

Example projects

Cleaning up contaminated soil

MKW Vogelweiderstraße, Wels, Austria

When hazardous mineral oil hydrocarbons were found on the site of a former storage tank, Keller was asked to remediate the ground.

Keller was contracted for the project in Wels after the local authority discovered pollution caused by years of oil spills seeping into the soil and groundwater. The site had to be excavated, however, there was serious concern by the planner that this would destabilise a nearby railway line. As geotechnical experts, Keller was asked to help.

As struts to support a construction pit and the railway track would have hindered the excavation, the project team decided to use cased bored piling instead. The use of bored pile equipment was a much more cost-effective solution than creating a conventional excavation pit. Plus it enabled Keller to support the track and prevent any movement.

Casings were driven into the ground and the polluted soils excavated. The soil was then inspected by a chemical engineer and either left on site for processing and re-use, or taken away. Finally, the holes were filled with fresh, unpolluted gravel from other areas of the site and nearby quarries.

New materials and design solutions to reduce carbon

At Keller, we can offer a number of lower carbon products to help clients reduce the carbon footprint of their projects. We also offer measurement and offsetting.

Challenges we can help solve

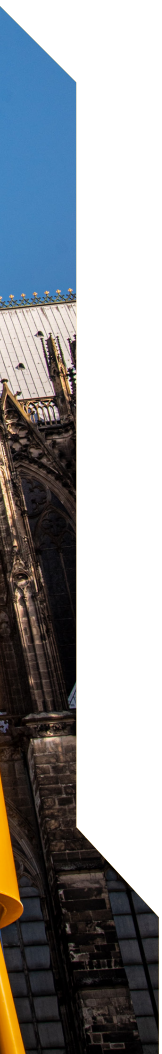
- A need to reduce the carbon footprint of a project.
- Provision of information to understand the true, whole life cycle carbon differences between solutions and inform a final choice.
- A need to offset carbon emissions to balance the carbon footprint of a project.

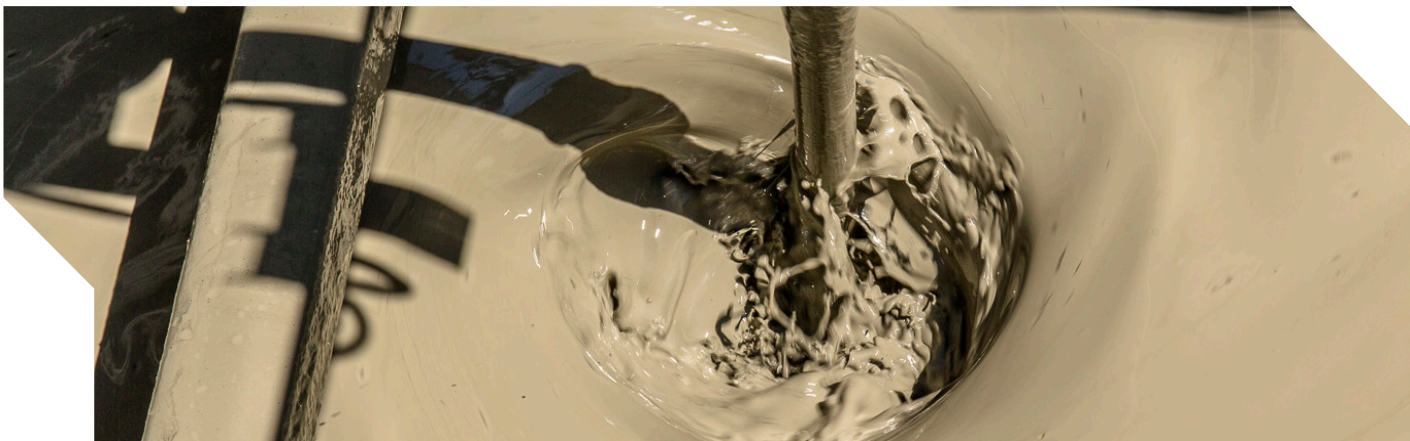
Benefits

- **An improved carbon footprint**
- **In some cases lower costs, for example where replacement materials are cheaper**
- **A contribution towards BREEAM and LEED scores on material use**

Approaches

Approach	How it works	Techniques we can do this with
Alternative less carbon-intensive solutions	Alternative ground improvement methods, such as vibro stone columns in place of traditional piling, can save 30% - 60% of the cost and up to 95% of the embodied carbon of deep foundations. This is due to the use of stone aggregate in place of concrete and steel, and typically more efficient installation.	• Vibro stone columns
Use of recycled materials	We can use recycled materials in our solutions, including glass sand in place of gravel, and GGBS (Ground Granular Blast Furnace Slag) and PFA (Pulverised Fly Ash) in place of cement. These are waste products of the steel and coal industries respectively which, as well as saving carbon, reduce waste and contribute towards the circular economy. We can also use recycled concrete.	• Vibro stone columns • All cement-based piling solutions
Carbon measurement	We measure the embodied carbon in our products through our carbon calculator, enabling customers to make informed decisions in their choice of product. We use the EFFC-DFI carbon calculator that is standardised with geotechnical contractors across Europe.	• All techniques
Carbon offsetting	Using a standardised European carbon calculator, we can calculate full scope 1, 2 and 3 emissions for a specific project. We then offer to purchase certified carbon offsets through Climate Care to make the project net zero carbon.	• All techniques





An innovative alternative to traditional piling

2020 | Lorong Halus, Singapore

For almost 30 years, Lorong Halus in Singapore was home to the island's largest landfill, built on the site of a former sewage works.

After the landfill closed in 1999, the area has been gradually transformed into an attractive, ecologically diverse coastal wetland. And with these positive changes has come the need for greater infrastructure.

The local government has invested heavily in a major roadworks programme, but with difficult ground conditions caused by years of buried waste, the government's consultants in charge of the project turned to Keller for help.

After analysing the soil conditions, we explored the possibility of using deep soil mixing, vibro stone columns or vibro concrete columns. Vibro concrete columns were best in terms of performance and speed, whilst also using less cement than deep soil mixing to achieve the necessary strengths. They also offered an economical alternative to traditional piling methods and produced very little spoil.

The Keller crew started on site at the end of January 2020 and proved the benefits of the technique by completing works three weeks ahead of schedule. In total, the team installed 373 columns, with 650mm diameters, to depths of 20m, across an area of 2,194m^2.

Example projects

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Equipment to reduce spoil and materials

Some ground improvement techniques, like piling and grouting, create spoil which, as it has to be removed from site, adds to cost. Keller offers innovative solutions to help its clients reduce and/or reuse spoil.

Challenges we can help solve

- A need to reduce spoil for disposal for environmental reasons, especially when disposal costs are high.
- A need to reduce the CO2 footprint of a project through recycling cement slurry.
- A need to reduce water consumption through recycling.

Benefits

- Potential to reuse processed fluid and cement or other material
- If processed water is reused, less water consumption
- Equipment with a small footprint can be used on urban and inner-city sites
- Less spoil and a significant reduction in waste disposal
- Lower costs

Approaches

Approach	How it works	Techniques we can do this with
Use of equipment to better manage spoil	The equipment that we use to manage spoil varies depending on project size, soil conditions and the available space on site. All treatment systems use a shale shaker to remove large solids. You can then add an automatic chamber press, decanter centrifuge or dewatering plant to remove finer solids. This reduces the sand content of the slurry, with the potential to save money in two ways. By lower disposal costs through the reduction in spoil volume. And by lower material costs by re-using the cement or other material in the recycled slurry.	• You can use this type of equipment any time it would be useful to separate solids and water. • For example, in jet grouting to reduce and recycle jet grouting backflow. • Shale shakers are often used for vibro compaction which uses water as part of the process. You can pump the mud that comes out of the bore hole onto the shale shaker, separate and re-use the water. • For deep geothermal drilling using bentonite, you can pump the mud out, separate the solids and the water and then reuse it with more bentonite added. • In some projects, the spoil from jet grouting can be used to perform another technique on site like deep soil mixing.

Filter chamber presses and centrifuge

2018 - 2020 | Follo Line, Norway

This large infrastructure project connecting Norway's capital, Oslo, with the suburban town of Ski included a 20km-long twin tube tunnel; the longest railway tunnel in The Nordics.

Keller implemented numerous ground engineering techniques including soil stabilisation by jet grouting and deep soil mixing, ground anchors, micropiles and injection works.

We used two chamber filter presses and a centrifuge to treat the backflow and remove fine particles from the drilling and jet grouting work.

Around 100m³ of processed water were available for reuse each day for drilling and mixing grout. This then saved 100m³ of waste disposal, as well as lowering freshwater consumption, costs and the environmental impact.

The solids produced by the plant were also sufficiently dewatered to be directly loaded and disposed of.

Example projects

Dewatering plant

2013 | Aarau, Switzerland

As part of flood protection for a hydropower station in Aarau, Switzerland, Keller was contracted to install a 30 metre deep jet grouting wall working with a mixture of cement and limestone. Using a dewatering plant consisting of shale shakers and cyclones, we were able to recycle all of the spoil and reuse 70%, leaving just 30% to be disposed of. We also reduced binder consumption by 27%. Overall, this generated significant savings for the client.

Shale shaker

2019 | Wiener Neustadt, Austria

Keller installed a large jet grouted bottom seal as part of this station project in Wiener Neustadt, close to Vienna. After removing large solids from the spoil, using a shale shaker we were able to reuse the slurry for drilling, and guarantee a 30% saving on disposal of water.

Example projects

Dewatering plant

2018 | Salzburg, Austria

For the installation of a flood protection wall along the River Urslau, Salzburg, Keller was contracted to perform jet grouting columns. Working in coarse-grained sandy gravel, a dewatering plant was the perfect technology to reduce spoil and cement. We were able to recycle the spoil, reducing disposal by 50% and cement consumption by 17%. This achieved savings of €45.000 on this €600,000 project.

Keller Group Plc

Geotechnical specialist contractor
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