Margam Substation Extension – Piling Method Appraisal Document

Covering the installation of Displacement Auger Piles (DAP), Continuous Flight Auger Rigid Inclusion Piles (CFA)

P02

Executive Summary

This document has been produced to outline the methodology of the proposed techniques for the foundations for the new substations at the Margam substation extension site. The proposed methodology for the piled foundations consists of;

- CFA Rigid Inclusions
- DAP Displacement Piles

Contents

The chosen piling methodology & appraisal of options.

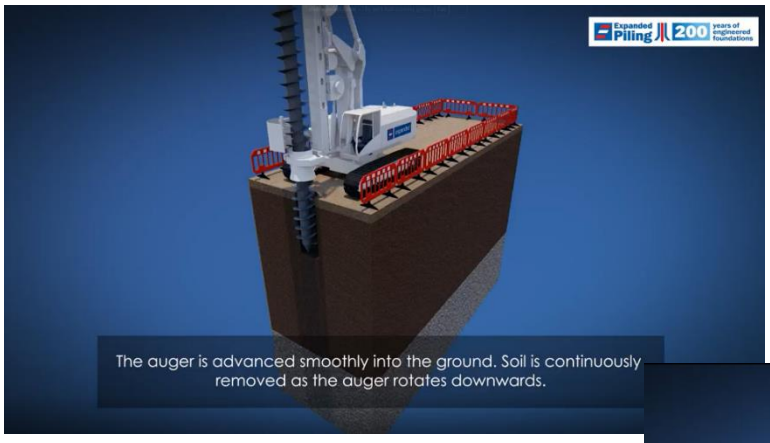
For the proposed works at the Margam substation extension project, both a continuous flight auger (CFA) and displacement auger piling (DAP) solution has been selected by Expanded. The DAP construction methodology displaces the ground during boring resulting in short-term increases in horizontal stresses in the ground. These horizonal stresses can lead to short-term heave of adjacent existing ground levels. There is potential for these increased soils stresses to impact existing foundations. As a result, we have allowed for the mitigation of using the CFA piling methodology along the site boundary adjacent to the existing sub-station. This will minimise this potential impact.

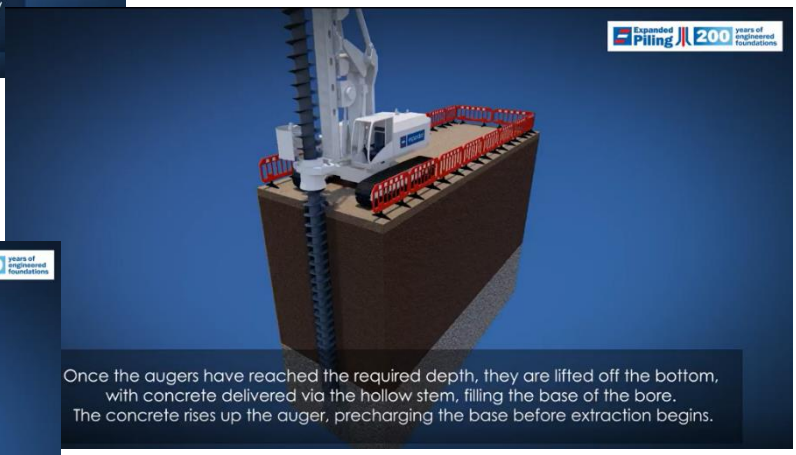
There is a flood wall proposed to the substation boundary, should this require piled foundations the above solutions will be implemented, any design require alternative methods such as sheet piling, a separate risk assessment will be carried out.

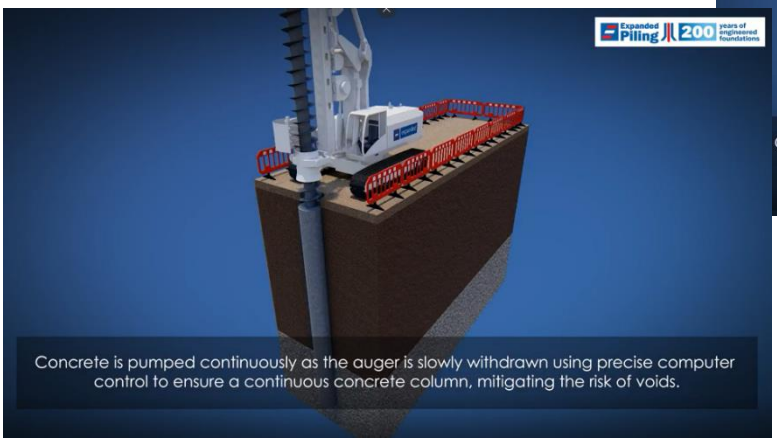
A short summary of each technique is outlined below.

Continuous Flight Auger (CFA)

Continuous Flight Auger (CFA) piling, also known as auger cast piling, involves drilling a hollow stem auger into the ground to the desired depth. Concrete is then pumped through the hollow stem as the auger is slowly withdrawn, creating a continuous pile without leaving an open hole. Reinforcement can be inserted into the fresh concrete if needed. This method is advantageous for its low noise and vibration levels, making it suitable for urban areas.

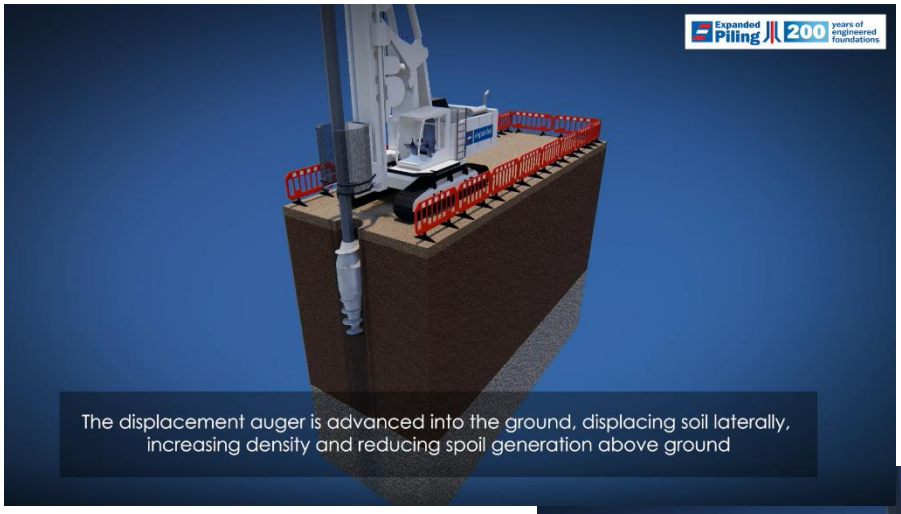


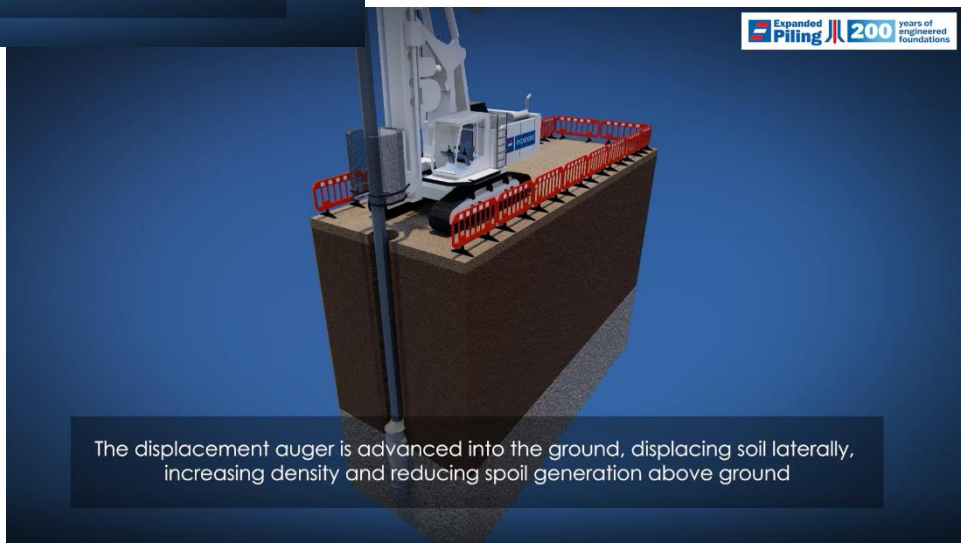


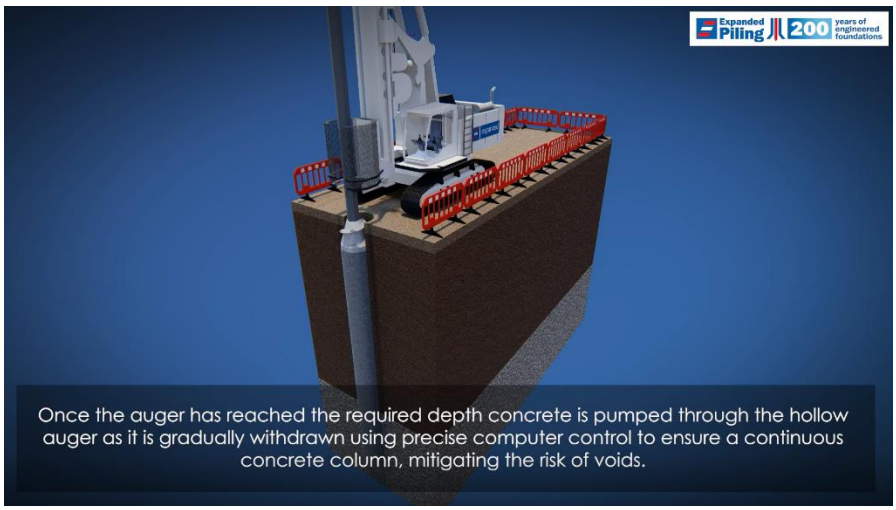


Displacement Auger Piling (DAP)

Displacement Auger Piling, also known as Drill Displacement Piling (DDP), uses a displacement tool to compact soil laterally as it drills, minimizing soil removal. This method increases the pile's load-bearing capacity due to the compacted soil around it. Like CFA, the auger is drilled into the ground to the required depth, or to refusal. Concrete is then pumped through the hollow stem, as the auger is withdrawn, and reinforcement can be added if required following removal of the auger. This technique is beneficial for sites with soft, loose or contaminated soils due to the reduced spoil generation.







Advantages of CFA, DAP

CFA piled solution

Advantages;

- Low Noise and Vibration: Ideal for urban areas and sensitive environments.
- Flexibility: Can be used in various soil conditions, including soft peat.
- Speed: Relatively quick installation process.
- Loads: Can provide high load bearing capacity, with depths and diameters up to 36m / 1.2m respectively

Disadvantages;

- Soil Variability: Unpredictable soil conditions, such as obstructions can affect the installation process.
- Concrete Quality: Ensuring a good flow of concrete is crucial due to this being pumped through a closed system.
- Equipment Maintenance: Requires regular maintenance of plant and equipment to prevent breakdowns and down time.
- Cost: Can be more expensive due to the need for specialized equipment and materials.
- Spoil Generation: Spoil is removed from the bore and replaced with concrete, hence not ideal for hazardous material muck away

DAP piled solution

Advantages:

- Increased Load-Bearing Capacity: Compacts soil laterally, enhancing the pile's load-bearing capacity.
- Minimal Spoil Generation: Reduces the amount of soil that needs to be removed – minimises impacts to Peat on site.
- Suitability for Soft Soils: Effective in soft or loose soils like peat.
- Low Vibration: Similar to CFA, it produces low levels of vibration.

Disadvantages:

- Complexity: Requires precise monitoring during installation for refusals.
- Equipment Costs: High initial investment in specialised equipment, and extra care needs to be taken to not damage drilling equipment through excessive drilling on refusals.
- Soil Displacement: Can cause displacement of nearby structures if not carefully managed.
- Limitations on Load Bearing Capacity: Due to how the bore is progressed and drilling to refusal, the depths of the piles will be limited, hence this can limit the geotechnical capacity of the pile.

Risks Assessment

Risks and Mitigation Measures

Displacement of Existing Foundations

Risks:

- Disturbance to existing substation and overhead line foundations
- Impact to the operation of the existing substation

Mitigation Measures:

- Assessment of Soil Conditions: Site Investigation to be reviewed thoroughly to identify potential risk
- CFA piling methodology to be implemented where risks associated with displacement of the ground remain (for example alongside the existing substation)
- Monitoring of surrounding structures during piling

Working in Sensitive Ecology (Peat Layers at Margam)

Risks:

- Ecological Damage: Disturbing peat layers can release stored carbon, contributing to greenhouse gas emissions.
- Soil Erosion: Peat is highly susceptible to erosion, which can lead to habitat loss and water quality issues.
- Biodiversity Loss: Construction activities can disrupt local flora and fauna.

Mitigation Measures:

- Minimize Disturbance: Use low-impact construction techniques to reduce soil disturbance such as Displacement Auger Piling.
- Erosion Control: Implement erosion control measures, such as silt fences and vegetation buffers.
- Rehabilitation: Restore disturbed areas by replanting native vegetation and stabilizing soil.
- Monitoring: Regularly monitor the site for signs of ecological impact and adjust practices as needed.
- Permits and Regulations: Ensure compliance with environmental regulations and obtain necessary permits.

Noise

Risks:

- Hearing Loss: Prolonged exposure to high noise levels can cause permanent hearing damage.
- Health Issues: Noise pollution can lead to stress, high blood pressure, and sleep disturbances.
- Community Impact: Construction noise can disrupt nearby residents and wildlife.

Mitigation Measures:

- Noise Assessments: Conduct noise assessments to identify sources and levels of noise.
- Selection of piling technique, such as CFA of DAP reduces potential noise impacts from driven piles
- Engineering Controls: Use quieter machinery and install noise barriers around the plant if required, and/or around the site perimeter.
- Personal Protective Equipment (PPE): Provide ear protection for workers exposed to high noise levels.
- Community Engagement: Inform nearby residents about construction schedules and noise mitigation measures.

Short conclusion and outcome of risk assessment

Using a combination of Continuous Flight Auger (CFA) and Displacement Auger Piling (DAP) techniques at Margam Substation Extension offers several advantages over other piling methods like driven piling and rotary bored piling.

At Margam Substation Extension it is known that there are shallow peat layers, DAP will be implemented over much of the site to reduce the disturbance to the Peat.

Where risks remain with displacing ground alongside the existing structures, CFA piling will need to be implemented. The management of any peat arisings during the construction operation will be addressed by the Peat Management Plan.

Based on the available Ground Investigation information we are not expecting ground contamination, therefore both CFA and DAP are appropriate.

CFA and DAP will provide the smallest amount of Noise & Vibration compared to other techniques such as Rotary Bored Piling, or Driven Piling. As noted in the risk assessment section of this document there will still need to be monitoring implemented for vibration and movement of existing structures, as well as noise monitoring where directed in the construction noise assessment .

CFA and DAP methodology are one of the quickest techniques for pile construction, compared to other methods such as rotary bored piling, and will be one of the most beneficial techniques for the project programme.

Appendices

CFA / Displacement Noise & Vibration

Historical Vibration data

Project	Peak Particle Velocity (PPV)	Distance away	Activity
Manchester Airport	0.950mm/s	9.8m	CFA drilling
Manchester Airport	1.725mm/s	3.0m	CFA drilling
Manchester Airport	0.875mm/s	2.0m	Rig tracking
Beckton STW	4.39mm/s	5.0m	Rig Tracking
Beckton STW	1.00mm/s	5.0m	CFA drilling
Shepperton Studios	0.50mm/s	10.0m	DAP drilling
Shepperton Studios	1.85mm/s	10.0m	Rig Tracking

Historical Noise Data

Project	Average Sound Level (dB)	Distance away	Activity
Shepperton Studios	75.1dB	10.0m	DAP drilling
Shepperton Studios	70.9dB	20.0m	DAP drilling
Shepperton Studios	73.0dB	20.0m	Concrete Pumping
Shepperton Studios	68.6dB	60.0m	DAP drilling

Note N&V data may be different due to the environmental surroundings and plant selection etc. It is proposed that new data will be captured and reviewed at the start of the project.

Sustainability Info

Environmental Sustainability

The current challenge facing our industry is to reduce our impact on the environment and to ensure projects are sustainable.

Sustainability to us is about maximising our environmental, economic and socio-economic performance, in the interests of the business, our stakeholders and our planet.

To this at Expanded Piling we are focused on achieving the goal of the Piling & Foundation Industry of being net zero carbon by 2050.

In supporting this goal, Expanded Piling are active with the FPS (Federation of Piling Specialists) Environmental Sustainability Working Group. This group has recently been formed and has an agenda aimed at challenging our accepted methods of working to reduce our impact on the environment.

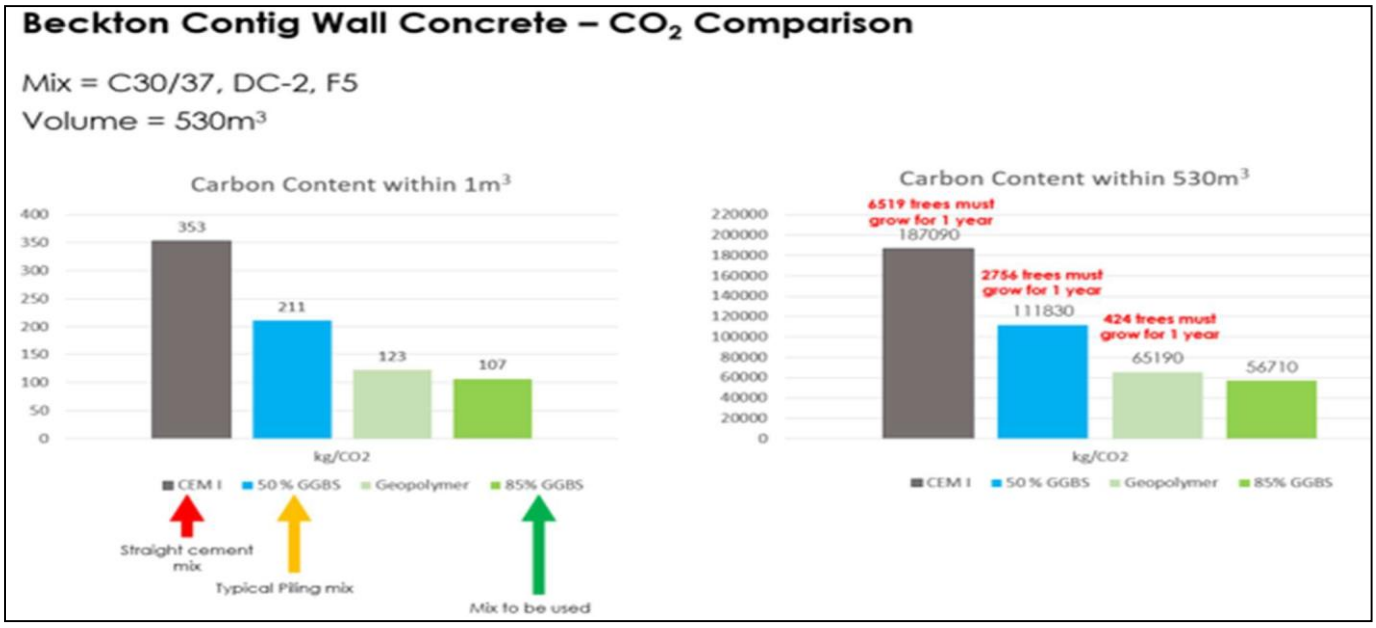
Concrete

Currently we construct piles with the use of up to 95% GGBS which complies to BRE IR17-05 for durability and replaces up to 95% of the traditional cement content. This concrete mix design can be used in both permanent and temporary piles as the durability complies with not only the British standards for concrete but the building design requirements.

In temporary work conditions we will be using a cement free content concrete and can offer this to projects where the durability of the pile is not a design requirement.

Our focus for the future is to develop the use geopolymer concretes which contain 0% cement. As with all 0% cement there is further work to be carried out to ensure it satisfies all design standards for use in permanent works. Currently 0% cement concretes can be used in temporary work conditions as technically the mix design does not satisfy all accredited standards for use in permanent work conditions and comes with some open life difficulties.

The below graphs represents some data we collected from a recent contract and the amount of carbon our concrete mixes were able to remove compared to traditional options:



Steel reinforcement

The supply chain is in the process of moving towards using Electric Arc Furnaces over traditional blast furnaces. The advantage of arc furnaces is that they use scrap metal rather than iron ore as the main fuel. They use a lot less energy than blast furnaces and can be quickly stopped and restarted.

Alternative Fuel

Following a successful trial within our equipment facility earlier in 2021, we now operate all projects with Green D+ HVO fuel. HVO fuel stands for Hydrotreated Vegetable Oil and Green D+ HVO is an enhanced second-generation biofuel, with up to 90% lower lifecycle CO2e emissions This fuel type in early 2022 was adopted across all plant items within the Laing O'Rourke group.

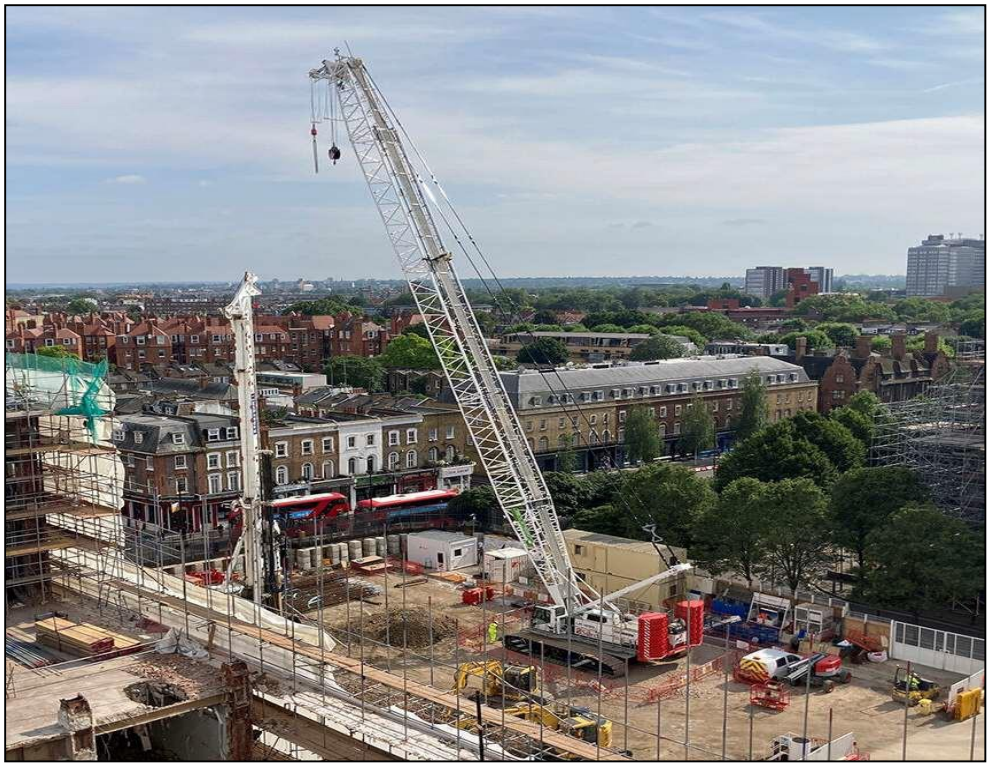
As an example of the savings, we are making across our business, on one contract we had 31,000 litres delivered to site which equated to a saving of 94 tonnes of CO2 (100T verses 6T – based on the government's greenhouse gas conversion factors).

Electric Plant items

In partnership with Select Plant Hire & Explore, Expanded Piling have access to operate ancillary plant items powered via electric powered motors.

As well as the ancillary plant items, Select Plant Hire have a strategy plan to purchase and operate electric powered attendant cranes. These crawler cranes are a key asset to the piling operations as often we require these items to undertake lifting throughout the installation of piles.

On our current Olympia project we have been operating a 250Te Liebherr Electric crawler crane from Select Plant Hire. This was the UK's first electric crane and emits zero carbon emissions. Being electric, the crane also produces a reduced noise emission compared to a diesel-powered unit. Over a 16wk period this electric crane saved 8000 Litres of fuel, which is equivalent to removing 215 cars off the road each week.



Noise emissions

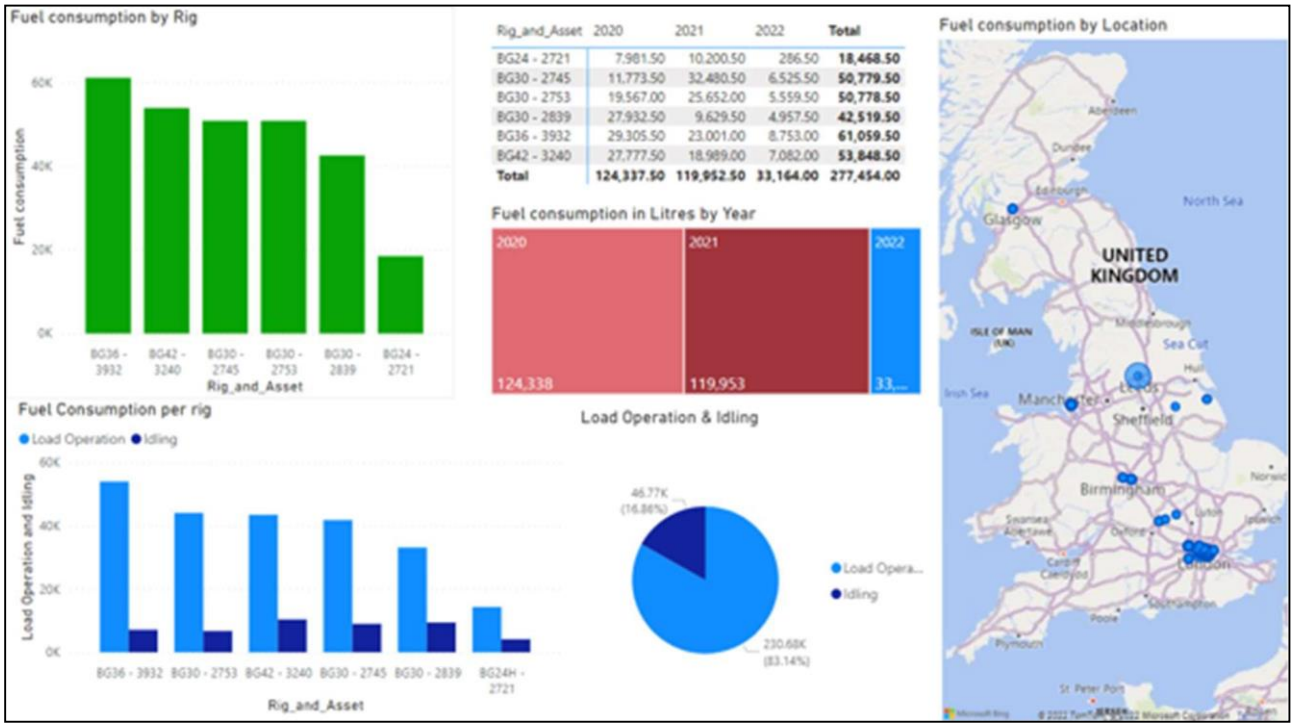
Construction by its nature is a noisy industry. At Expanded all our rotary Kelly bars are 'silenced' which means they have dampening component to them to reduce the noise emitted during the construction of rotary bored piles.

Idling

We have been working hard to eliminate engine idling on our project sites. When a piece of equipment is idling, not only is it unproductive, but it also produces unnecessary emissions, contributing to degraded local air quality.

Our equipment when idling uses approximately 12 litres of fuel per hour or 5,500 litre per year per piling rig. By avoiding idling, we can save 79 trees per rig per year. Focus on idling not only reduces our carbon emissions, but increases the life span of the machine itself, thus increasing the sustainable benefits.

The below is an image of our idling dashboard used to monitoring our fleet across the UK:



Social Sustainability

Our biggest asset as a business is our people and making sure we attract and retain the right talent is a key aspect of sustainability to us. Research has shown that successful businesses have a diverse and inclusion workforce, who all feel valued and engaged. In 2021 we implemented a hybrid working arrangement, to promote flexibility and allow individuals to work remotely. This not only reduces the time and emissions produced travelling but empowers individuals to manage their own workload and balance home commitments with work.

Coupled with this working arrangement is our focus on attracting the right talent into our business. We recruit people based on their attributes and the skills they offer. This recruitment process is supported by Laing O'Rourke's commitment to a 50/50 gender staff split by 2033 and all who are involved in the recruitment process having undergone 'Inclusive recruitment' training designed to eliminate any bias.

Where Next?

At Expanded we strive for continuous improvement in how we go to work through innovative and will challenge ourselves to find new sustainable solutions to remain the piling contractor of choice for all.

Photographs

CFA Piling

DAP Piling