TRENCH CONTROL

Piling and Ground Support Equipment

Engineering and Design

Capability and Experience Statement

Engineering and Design at Trench Control

At Trench Control we have a proud tradition of ground engineering and temporary works design. For 35 years we have been an owner-managed and design-led organisation specialising in safe and cost-effective ground support and temporary works solutions.

Led by experienced chartered engineers with international experience for contractors and consultants encompassing Ireland, the UK and the Middle East, our design department services our contracting arm and has a strong list of clients for whom we undertake design services.

We specialise as a Contractor's Designer in the Civil and Geotechnical Engineering sectors and our specialist skills include:

- Geotechnical consulting
- Design and numerical modelling
- Independent checking
- Alternative design solutions and "optioneering"
- Temporary works

We run a suite of geotechnical and CAD software but it is our experience and judgement which we rely on primarily to provide our clients with engineered and practical solutions. Our culture is based around the following key tenets:

- We strive for clearly presented, buildable solutions
- We strive for a high level of customer satisfaction
- We advocate early involvement with our clients to establish practical and safe solutions
- We advocate innovative and "outside the box" thinking in design development
- Our team is accessible, reliable and responsive
- We are committed to collaborative working relationships

The testimonials at the back of this statement give an indication of the type and quality of service we provide for our Clients. Our aim in the coming years is to build on our current relationships and forge new relationships, both in Ireland and the UK, in what is a sector of the industry to which we are very committed to.

Altnagelvin Hospital, Londonderry

At a glance

Client: McLaughlin & Harvey

Services: Temporary works design

Altnagelvin Hospital's new £50+million Radiotherapy Unit, which is due to open in 2016, will increase Radiotherapy capacity in Northern Ireland. The Radiotherapy Unit at Altnagelvin is envisaged, not as a single building, but as interconnected clinical areas which are designed along the continuum of the "garden" that incorporates both the external existing landscape and the internal path of the patient's journey.

Working for McLaughlin & Harvey, Trench Control designed and installed a bespoke temporary works solution to support a section of existing tunnel connecting the existing maternity unit to the rest of the hospital. The tunnel remained live while a section of new tunnel servicing the radiotherapy unit was constructed underneath. The support involved insertion of needles to the soffit of the existing tunnel and the primary support beams were supported on secant piles which also formed the temporary shoring forming the new section of tunnel.

Smithfield Square, Hornsey, London N8

At a glance

Client: Keltbray Piling

Services: Contiguous pile wall and bearing pile design

Keltbray Piling were nominated by St. James Group to undertake the design and construction of a section of contiguous pile retaining wall and bearing piles of the proposed development of Hornsey Depot in Hornsey, London N8. The consulting engineers for the project are Powell, Tolner & Associates. The retaining wall and pile design was undertaken by Trench Control Ltd. on behalf of Keltbray Piling.

In broad terms, the project involves Demolition of existing structures and buildings and redevelopment of the site to provide a mixed-use development on Hornsey High Street; two live/work units fronting onto Cross Lane; together with private amenity space and new public realm, including publicly accessible routes through the site; an energy centre; 178 car parking spaces for the residential use (within a basement and undercroft); cycle parking; refuse storage; recycling centre in the foodstore car park; access; and other infrastructure work. The contiguous pile wall forms a load bearing retaining wall (as part of Block A) to properties on the NE boundary properties.

Cathedral Road Pumping Station, Cavan Town

At a glance

Client: P&S Civil Works

Services: Temporary works design for ground support

P&S Civil Works Ltd. appointed Trench Control Ltd. (TCL) to design ground support measures to facilitate the construction of the Cathedral Road Pumping Station for the Cavan Sewage Scheme project. The overall project has been designed by the EMCA. P&S Civil Works Ltd. are the Main Contractor with Trench Control being appointed Temporary Works Designer for the ground support measures only.

The proposed pumping station is approximately 13.1m x 8.3m on plan at the ground surface with the deeper section of the tank at 8.3m x 8.3m on plan. In order to construct the deeper section of the tank, it is proposed to construct a cofferdam of 10.3m x 10.3m on plan to allow for 1m of working room all around. The maximum excavation depth is approximately 9.1m from existing ground level. Design work included routine site inspection to verify the stability of the rock mass exposures and development of contingency rock mass support measures.

Flintshire Bridge Converter Station, Wales

At a glance

Client: John Sisk & Son

Services: Temporary works design, supply and installation of ground support system

John Sisk & Son appointed Trench Control to design and install ground support measures to facilitate the construction of three service tanks for the proposed Western Link Interconnector Project.

The works comprised three excavations for a Dump Tank and two Oil Interceptors. The Dump Tank was the larger element with excavation dimensions of 20.65m x 11.05m with an excavated depth of 5.735m. The Oil Interceptors excavations were 8.65m x 3.85m and 9.85m x 3.85m on plan dimension and 3.365m and 3.77m deep respectively. The excavations were supported using sheet piles. The Dump Tank were braced using hydraulic frames and the Oil Interceptors were not propped.

Commenting on the works, Sisk's design manager Brian Dillon said the following: *"We've worked with Trench Control on the Flintshire Bridge Converter Station Project and we've found them to be very knowledgeable both in the planning and the execution of their works"*

Leixlip Water Treatment Plant

At a glance

Client: Siac

Services: Temporary works design, supply and installation of ground support system

The new stand-alone €30 million water treatment facility will provide water treatment capacity of an additional 80 million litres of water per day for consumers in the Greater Dublin supply area, bringing overall production at Leixlip to 215 million litres per day. The Leixlip Plant is the second largest water treatment plant in the country and supplies approximately 30% of the Dublin Region's drinking water requirements, supplying North Dublin City and County as well as parts of South County Dublin and Kildare.

Working for Siac, Trench Control designed and installed a large cofferdam in order to facilitate the construction of an aeration tank and other structures as part of the plant upgrade. The temporary works included sheet piling and internal bracing for a total excavation depth approaching 6.5m. The internal bracing comprised proprietary elements of cross struts and flying shores to mitigate lateral sheet pile movement. Driven piles where used to support the 37m span cross struts at midspan.

Ballyrickard Wastewater Treatment Plant (Project Omega)

At a glance

Client: Laing O'Rourke

Services: Temporary works design, supply and installation of ground support system

Project Omega is one of the UK's largest Public Private Partnership (PPP) schemes providing a fifth of Northern Ireland's wastewater treatment capacity. It also handles the entirety of its sludge disposal. The scheme is intended to form a sustainable wastewater strategy to meet the Province's needs for the next 25 years.

The project included upgrading six existing wastewater plants - at Ballynacor, Bullays Hill, Seagoe, Armagh, Richhill and Ballyrickard – refurbishing a number of sludge facilities and constructing three pumping stations and associated transfer pipelines. The project cost was £122m – strong competition throughout the tendering process and the high degree of innovation encouraged by the PPP performance criteria having yielded savings of more than 17% of the original £154m capital estimate.

Working for Laing O'Rourke, Trench Control designed and installed a large cofferdam as part of the upgrade of Ballyrickard Wastewater Treatment Plant. The cofferdam included 10m long sheets standing in cantilever (unpropped) and a scheme of ground anchors as the anti-floatation mechanism.

Kilkenny Central Access Scheme

At a glance

Client: John Cradock Ltd.

Services: Geotechnical and dewatering analyses

For the River Nore crossing on the Central Access scheme, it is proposed to construct a concrete bridge which spans two mid-stream piers between east and west abutments. The pier piles and pilecap are founded at a level well below existing bed level and so a temporary works scheme is required in order to facilitate construction of the bridge piers.

Trench Control carried out the geotechnical numerical analysis of the proposed mid-stream cofferdams which involved sheet piling and high level propping support. Trench Control additionally undertook a dewatering feasibility study examining likely groundwater control volumes and potential mitigation works such as wet excavation and grout blankets.

Commenting on the project, Alan Wright, director at John Cradock Ltd. said: "*John Cradock Ltd. have worked with Trench Control Ltd. on the Kilkenny Central Access Scheme and found them to be most proactive in providing a comprehensive temporary works design and subsequent installation which adopted the Client's complex requirements".*

Clonakilty Drainage Scheme (Carberry-Muskerry Wastewater Treatment Plant)

At a glance

Client: EPS Pumping and Treatment Systems

Services: Temporary works design, supply and installation of ground support system

The Carbery/Muskerry Wastewater Treatment Plants DBO (design, build and operate) and O&M (operate and maintain) Contract for €6million is primarily a contract to carry out upgrade works to the existing wastewater treatment plant in Clonakilty, providing a treatment capacity of 20,500PE (population equivalent). It also includes the construction of a storm water retention tank and upgrade works to the existing Pumping Station at Long Quay.

Working for EPS, Trench Control designed and installed an octagonal cofferdam to suit the profile of a very constrained site in order to facilitate the construction of a storm holding tank approximately 24m in diameter. The temporary works included sheet piling and internal bracing for a total excavation depth approaching 4m. The internal bracing worked primarily in hoop compression to eliminate any internal raking or flying shores providing a clear working space for the construction of the tank. Groundwater control was a critical issue at the site because of the permeable gravels prevalent across the site and so installation accuracy of the sheet piles was crucial the success of the project.

Freshford Wastewater Treatment Plant Upgrade

At a glance

Client: Source Civil

Services: Temporary works design, supply and installation of ground support system

Part of a €3.6million scheme incorporating Freshford, Johnstown and Goresbridge, Response Group (parent of Source Civil) were appointed by Kilkenny Co. Co. as the main contractor to design, build and operate new wastewater infrastructure for the villages of Freshford, Johnstown and Goresbridge. The treatment plants will be designed to treat 1300, 800 and 600 PE respectively.

Working for Source Civil, Trench Control designed and installed a scheme of temporary works comprising sheet piles and hydraulic propping elements to facilitate the construction of a pumping station at the Freshford site. Groundwater control was a critical issue at the site because of the permeable gravels prevalent across the site and so installation accuracy of the sheet piles was crucial the success of the project.

Swords Wastewater Treatment Plant Phase 2 Expansion

At a glance

Client: Siac / Aecom

Services: Temporary works design, supply and installation of ground support system

Since completion of the Phase 1 expansion works in 2003, growth in the Swords catchment has outstripped the treatment works' current capacity, causing it to operate above its maximum design of 90,000 population equivalent. The Phase 2 expansion and upgrading the treatment plant aims to reduce the level of pollutants discharging to the receiving water (the inner Broadmeadow estuary) and to allow capacity for the growing population and projected commercial development of the greater Swords area.

Working for Siac / Aecom, Trench Control designed and installed ground support systems for large storm holding and retention tanks and a number of smaller ancillary tanks and structures. In addition, Trench Control provided other temporary works and geotechnical design services for the project. The ground support systems provided included sheet piles for 4m to 5m retained height in cantilever (unpropped) as well as sheet piles and trench sheets to with hydraulic propping elements for other structures.

M9 Kilcullen Services Upgrade, Pier Foundation Temporary Works

At a glance

Client: Clonmel Enterprises

Services: Temporary works design, supply and installation of ground support system

The new M9 Services began work in 2013 and involved significant earthworks and a new motorway crossing. The bridge superstructure comprises bankseat abutments and piers. Owing to a significant depth of soft ground the pier foundations were founded at depth below the existing motorway level. The soft material was required to be removed to find a suitable formation for the piers and so temporary ground support was required to form the excavation.

Working for Clonmel enterprises, Trench Control designed and installed ground support measures for the pier foundation construction adjacent to the live motorway. The works comprised sheet piles and bracing to support the existing embankment and carriageway. The excavation had plan dimensions of 8m x 5m and the overall depth of the excavation was approximately 3.5m to the formation of the pier foundation.

North Leixlip Sewage Works

At a glance

Client: Terra Solutions

Services: Temporary works design, supply of ground support system

The Lower Liffey Valley Sewerage Scheme Wastewater Treatment Plant Upgrade aims to upgrade the existing Leixlip WWTP from 80,000 population equivalent to its ultimate capacity of 150,000. The WwTP expansion is required to accommodate predicted future increases in wastewater flows up to a population equivalent of 150,000 PE from an expanding domestic, industrial and commercial population. The proposed WwTP expansion will provide secondary and tertiary treatment with nutrient removal. The WwTP will discharge final effluent to the River Liffey at Leixlip.

Working for Terra Solutions, Trench Control provided a series of temporary works designs and supply of ground support equipment for multiple excavations required as part of the works. The works included launch and reception pits for tunnelling works beneath the Royal Canal and a series of smaller pits for the construction of ancillary chambers.

Youghal Main Drainage Scheme

At a glance

Client: Wills Bros.

Services: Temporary works design, supply and installation of ground support system

Youghal is situated on the Blackwater Estuary, which is environmentally sensitive and an area of significant recreational activity. The town has a population of 6,990 (2011 Census) but this can increase to 14,000 in the summer months with an influx of tourists and daytrippers. However, the town currently has no wastewater treatment plant and all wastewater currently discharges directly to the Blackwater Estuary with no treatment. The Main Drainage Scheme will end the practice of discharge of untreated sewage directly to the Blackwater Estuary, and will bring Youghal's wastewater drainage and treatment systems in line with best international practice and will help improve water quality in the Estuary.

Working for Wills Bros., Trench Control designed and installed a scheme of temporary works comprising sheet piling and proprietary hydraulic propping elements to facilitate the construction of one of the primary pumping stations for the scheme. The design accommodated the difficult ground conditions which were encountered including loose reclaimed sands with high and tidal groundwater. The excavation depth was in the order of 6m.

Osberstown Wastewater Treatment Plant Upgrade

At a glance

Client: Bam Contractors

Services: Temporary works design, supply of ground support system

County Kildare's population has increased dramatically since 2006 and Kildare is now the 4th most populous county in the Republic. Consequently, an application to the DoEHLG was been submitted by Kildare County Council for a Stage III upgrade to the Osberstown facility to 130,000 population equivalent (from 80,000 p.e.). The new works will facilitate predicted future increases in wastewater flows from an expanding domestic, industrial and commercial population. In addition, the state of the art wastewater treatment plant will treat the wastewater to the highest standards, ensuring that the local environment is greatly enhanced.

Working for Bam, Trench Control designed the ground support systems for a series of structures including new inlet works, outlet works, effluent sampling and distribution chambers and tunnel launch and reception shafts for a pipejacked crossing of the adjacent M7 motorway. Retained heights varied from 7m to 10m for the majority of the structures. The temporary works included sheet piles and proprietary hydraulic propping elements.

Barrow-in-Furness Wastewater Treatment Plant Upgrade

At a glance

Client: Farrans

Services: Temporary works design, supply and installation of ground support system

The current outfall arrangement involves final effluent being pumped from a tidal pump house at the west of the works via a 1200mm diameter glass reinforced plastic (GRP) pipe which passes beneath a sea defence bund. From this point the outfall continues as a cast iron pipe to the outfall headwall. The proposed replacement outfall runs generally parallel to the sea defence wall for a distance of approximately 1400m from where it heads adjacent to Walney Channel. The foreshore is classified as a Special Area of Conservation, Special Protection Area, a Site of Special Scientific Interest and a RAMSAR (Wading birds).

Working for Farrans, Trench Control designed and installed the temporary works for the main pumping station for the new outfall works. Additionally, Trench Control designed and installed a pipe track for connection to existing structures. The design accommodated the difficult ground conditions which were encountered including loose reclaimed sands with high and tidal groundwater. The maximum retained height was in the order of 5m.

Mutton Island Wastewater Treatment Plant Upgrade

At a glance

Client: Siac

Services: Temporary works design, supply and installation of ground support system

The rapid growth of Galway city and environs now means that the existing Mutton Island Wastewater Treatment Plant is nearing design capacity and with growth projected to continue, there is a requirement to increase its capacity to cater for both residential and industrial expansion within the catchment area. The Mutton Island Wastewater Treatment Plant, completed in 2003, was designed to cater for 91,600 population equivalent. The upgrade works involve a design and build upgrade to the plant to increase capacity to 170,000 population equivalent.

Working for Siac, Trench Control designed and installed a series of temporary works schemes for a number of structures for the project including two pumping stations and flow meter and discharge chambers. The temporary works typically involved sheet piles and bespoke propping scheme owing to the constraints associated with the retrofitting of existing structures in the existing facility.

Clonakilty Wastewater Treatment Plant Upgrade (Carberry-Muskerry Wastewater Treatment Plant)

At a glance

Client: EPS Pumping and Treatment Systems

Services: Temporary works design, supply and installation of ground support system

The Carbery/Muskerry Wastewater Treatment Plants DBO (design, build and operate) and O&M (operate and maintain) Contract for €6million is primarily a contract to carry out upgrade works to the existing wastewater treatment plant in Clonakilty, providing a treatment capacity of 20,500PE (population equivalent).

Working for EPS, Trench Control designed and installed cantilever (unpropped) sheet piles for a 5m approximate retained height for the new Nereda tank. The primary difficulty on the project was the groundwater control given the tidal groundwater regime and underlying permeable gravels. Trench Control provided advice and proposed and installed a dewatering well layout which allowed the cofferdam to be dewatered effectively and allowing construction of the tank to a tight construction programme.

Testimonials

"We've worked with Trench Control on the Flintshire Bridge Converter Station Project and we've found them to be very knowledgeable both in the planning and the execution of their works" **– Brian Dillon, Design Manager with John Sisk & Son**

"We've worked with Trench Control on the Cathedral Road Pumping Station as part of the Cavan Sewerage Scheme. They provided the Temporary Works Design for the excavation of the Pumping Station structure. We found TCL very helpful throughout the process, and they offered an innovative and practical approach to the design of the temporary works. I would have no hesitation in working with TCL on future projects, based on the experience which we have had to date" **– Declan O'Dea, Contracts Manager, P&S Civil Works Ltd.**

"…EPS employed Trench Control as a specialist subcontractor to design and install sheet pile cofferdams for large stormwater storage and treatment tanks below ground level as part of the Carberry Muskerry Grouped Wastewater Treatment Plant DBO project. This was an extremely challenging project but Trench Control successfully completed the works in a safe, timely and professional manner. I would highly recommend Trench Control…" **– Cathal Hurley, Project Manager, EPS Pumping and Treatment Systems Ltd.**

"John Cradock Ltd. have worked with Trench Control Ltd. on the Kilkenny Central Access Scheme and found them to be most proactive in providing a comprehensive temporary works design and subsequent installation which adopted the Client's complex requirements" **– Alan Wright, Director, John Cradock Ltd.**

"We've worked with Trench Control on the Luas BXD utilities framework and we've found them to be very professional and approachable at all times. Our experience working with their team is that they are always able to find solutions to our issues without delay, often at short notice, and this is of great benefit to us in this fast paced environment. It is great to know that we can pick up the phone and rely on their expertise at any time" **– Darragh O'Gorman, Site Engineer for Luas Cross City Project, GMC Utilities Group Ltd.**

"Trench Control provided all the design drawings, calculations and temporary works design certification for all our shafts in the Osberstown WWTP site. We found them to be very professional and easy to work with. Trench Control also supplied all the frames, hanging chains, power packs etc, which we found to be in excellent condition allowing the works to be completed in a safe and timely manner" **– Shane Boland, Project Engineer for the Osberstown Wastewater Treatment Plant Upgrade, Bam Civil Ltd.**

"Trench Control have worked with us on the Freshford/Johnstown & Goresbridge Wastewater Treatment Works DBO Contract and we have found them to be very professional and efficient in their work" **– Allen Dolan, Project Manager for the Freshford/Johnstown & Goresbridge Wastewater Treatment Works DBO Contract, Source Civil Ltd.**

"Having worked with Trench Control on multiple schemes of varying sizes in the past, most recently the Barrow-in-Furness Outfall Relocation Project, I have found them to be efficient from the concept stage throughout the design process and carrying out installation to a high standard on site, whilst acting in a professional manner at all times and would have no problem using them on future projects" **– Neil Magee, Project Manager, Farrans Construction**

Key Personnel

David Magee
B.A., B.A.I. CEng MIEI
Managing Director / Owner

Profession:
Civil / Geotechnical Engineer

Education:
Bachelor of Arts (Trinity College) Civil Engineering

Professional Status:
Chartered Member, Institution of Engineers Ireland

David early career saw him work as a civil engineer in the private and public sectors progressing to senior roles at both the Office of Public Works and Dublin City Corporation. David went on to set up the National Excavation Company which specialised in deep excavations, pipelines and rock excavation using explosives.

Since 1984, David has been owner and managing director of Trench Control and has fostered the company's engineering tradition and design-led ethos based on his own background as a civil engineer. David's keen interest in health & safety has seen his set up a successful safety training company which he established in 1989.

David's current work involves design management and high-level strategic development of the company. He currently sits as company chairman but remains involves in all technical matters.

Recent Project Experience:

Fermoy Flood Relief
18 month piling contract encompassing complex arrangement of temporary and permanent works for the Fermoy Flood relief Scheme.

Aberech Wales
Design / management of installation 320m of 4.5m long vinyl piles for a water cut-off barrier.

St. James Hospital, Dublin
Design / management of secant pile wall for two-storey basement.

Waterford Flood Relief
Design and management of supply and installation of 2200m^2 of a permanent sheet pile wall.

River Dodder Flood Relief
Design and management of supply and installation of 1200m^2 of a permanent sheet pile wall.

Leixlip WWTP
Design and management of supply and installation a 45x35m cofferdam with sheet piles and hydraulic frames

Anthony O'Brien

BEng (Hons) CEng MIEI MICE
Senior Geotechnical Engineer

Profession:
Civil / Geotechnical Engineer

Education:
Bachelor of Engineering (Honours) in Civil Engineering

Professional Status:
Chartered Member, Institution of Engineers Ireland
Chartered Member, Institution of Civil Engineers
Member, British Geotechnical Association

Since graduating in 2008 with first class honours in Civil Engineering, Anthony has been involved in an array of schemes, working for both contractors and consultants which has seen him build up substantial experience in the design and construction of technically challenging geotechnical projects in Ireland, the United Kingdom, Eastern Europe, Kazakhstan and the Middle East.

His work involves tender and contract design of ground investigations, deep foundations and deep basements, retaining walls, temporary works and earthworks including soft ground engineering. This involves management of the technical aspects of projects.

Anthony has recently been involved in larger infrastructure projects involving multi-facetted design elements and in finite element analysis for detailed effects on ground movements and effects on adjacent structures. He has also worked on projects in seismically active areas in Eastern Europe and the Middle East.

Publications:
"The Role of Geotechnical Temporary Works on Infrastructure Construction in Ireland" published in Geotechnics on Irish Roads, 2000-2010: A Decade of Achievement (Geotechnical Society of Ireland) October 11, 2012.

Selected Project Experience:

<u>Deep Foundations</u>

MSD Biologics, Carlow, Ireland
Analysis, design and management of large CFA piling scheme which comprised approximately 750 no. 450mm and 600mm CFA piles to carry a variety of compression, tension and lateral loading.

Seaspace, Priory Quarter, Hastings, UK
Analysis, design and management of alternative scheme of c. 100 no. 450mm and 600mm diameter bearing piles in very difficult ground conditions in Hastings Town centre.

Mattex Silo Foundations, Jubail Industrial City, Kingdom of Saudi Arabia
Tender development and contract design of innovative piled ring beam for large silo structures in seismically active area. Included preparation of geotechnical design, preparation of piling specification and preparation of construction drawings including management of structural design and production and checking of structural detail and reinforcement drawings.

Bakri Fuel Oil Plant, King Fahd Industrial Port, Yanbu, Kingdom of Saudi Arabia
Development of piled slab foundation solution for large fuel oil storage tanks. Activities included design development of foundation solutions, preparation of piling specification, development of slab structural analysis and design and analysis of instrumented pile load test for design verification. Included management of structural design and production and checking of structural detail and reinforcement drawings.

Cambridge College, Cambridge, UK
Analysis, design and management of c.1100 300mm and 350mm diameter CFA piles to facilitate development of residential/retail development in Cambridge. .

Travelodge, Chichester, UK
Analysis, design and management of alternative scheme of approximately 50 no. 300mm diameter bearing piles in Chichester, West Sussex. .

Travelodge, Ealing, London, UK
Analysis, design and management of alternative scheme of approximately 100 no. 350mm diameter bearing piles in London.

Christian Street, Central London, UK
Analysis, design and management of alternative scheme of approximately 500 no. 300mm, 350mm and 450mm diameter bearing piles in central London.

New Street Demolition, Birmingham, UK
Preparation of Category II check and associated certificates for temporary works piles facilitating demolition temporary works.

Abu Dhabi Plaza, Astana, Kazakhstan
Comprehensive review of all existing site investigations and provide an interpretative report. Define the piling methodology and provide a design for the bearing piles. Provide a pile specification including recommendations for pile testing. Review of pile test results. As a result of the considerable height of the development the bearing piles were required to resist compressive loads of up 28MN, requiring piles of up to 1.5m in diameter with 60N/mm^2 concrete. A number of instrumented preliminary pile test were performed using O-Cell technology to allow direct assessment of the shaft capacities in the different types of bedrock found beneath the site.

Deep Basements & Temporary Works

South King Street, Dublin, Ireland
Design and detailing of reinforced capping beam for large diameter rotary-bored secant wall with a retained height of approximately 12m adjacent to Gaiety Theatre, Dublin. Involved in site supervision and QA control activities for the substructure work.

Lamberton Hotel, Dublin, Ireland
Involved in tender design of innovative anti-floatation pile scheme to accommodate complex loading regime and complex ground conditions for a large hotel development in Dublin.

Olympic Stadium Cofferdam, London, UK
Analysis, design and management of sheet pile cofferdam and associated propping scheme for provision of drainage connection in complex East London ground conditions. Maximum excavation depth was 4m.

Oxford Molecular Pathology Institute, Oxford, UK
Analysis, design and management of secant wall for double basement at Oxford University's new OMPI facility. Design work also included design and structural detailing of tower crane base and piles adjacent to the excavation. Maximum excavation depth was 4.5m.

No. 40 Queen's Grove, London, UK
Analysis, design and management of contiguous piled wall (600mm diameter piles) and 600mm diameter bearing piles for single-storey basement construction in restricted residential area of central London. Scheme involved tension piles to resist uplift and heave pressures and vertical loading to be carried on the basement wall. Design of temporary propping scheme including reinforced concrete capping beam, structural steel braces, raking struts and concrete thrust blocks. Included detailed ground movement assessment submission to Party Wall Engineers. Maximum excavation depth approached 5m.

Holiday Inn, Commercial Road, London, UK
Analysis, design and management of propped and cantilevered contiguous piled wall (450mm diameter piles) and 600mm diameter bearing piles for single-storey basement construction in restricted residential area of central London. Scheme involved tension piles to resist uplift and heave pressures and vertical loading to be carried on the basement wall. Maximum excavation depth was in the order of 4-5m.

Parkway, Newbury, West Berkshire, UK
Analysis, design and management of alternative scheme of temporary works for basement retaining wall of large retail / commercial development using support from existing piles and observational techniques allowing the Main Contractor to save 3-4 weeks on construction programme. Maximum excavation depth in the order of 8m.

Witanhurst House, Highgate, London, UK
Analysis, design and management of secant wall construction for 9m deep excavation adjacent to Grade II listed structure constructed using top-down methods in complex ground conditions in north London. Project also included analysis, design and management of plunge column piles and other load bearing piles.

Jeddah Stormwater Drainage Project, KSA
Analysis and design of three large cofferdams to facilitate construction of the outfall structures for a major drainage scheme in Jeddah, Kingdom of Saudi Arabia. The cofferdams were constructed using sheet piles and a single propping frame which comprised a UC waling beam and large CHS props with typical spans of 15-20m. Maximum excavation depth reached 6m.

Abu Dhabi Plaza, Astana, Kazakhstan
Due diligence review of c.20m deep excavation supported with anchored diaphragm wall panels. Design work included detailed site inspection, structural appraisal and provision of advice on remedial options for damaged and redundant panels. The review also encompassed existing pile foundations and piled raft.

<u>Tunnels / Metros</u>

Demolition and refurbishment of Blackfriars Station, London, UK
Analysis, design and management of temporary kingpost wall and propping to facilitate demolition and reconstruction works as part of London Underground's (LUL) refurbishment of Blackfriars

Station, London. Work included Form C submissions to LUL and finite element analysis to establish ground movement and likely effects on Circle/District line tracks.

Strategic Tunnel Enhancement Project (STEP), Abu Dhabi, UAE
Preparation of the geotechnical interpretation, shaft design and construction impact assessment for the Strategic Tunnel Enhancement Programme (STEP) which comprises 40km of wastewater tunnel in Abu Dhabi, UAE. This involves design and procurement of the ground investigation, subsequent interpretation of the data and preparation of high-end numerical modelling using PLAXIS 2D. Preparation of concept and detailed design of temporary works and temporary support measures for circular rock excavations forming launch and reception shafts for pipe-jacking / TBMs.

QGEWC Electricity Micro-tunnels, Lusail Expressway, Lusail, Qatar
Preparation of high-end numerical modelling use for assessment of tunnel-induced movements underneath the Lusail Expressway. The tunnels are to be used as utilities tunnels to facilitate further expansion of the new city of Lusail, north of Doha Also, preparation of concept and detailed design of secant pile circular launch and reception shafts for TBMs.

Port and Infrastructure

Alexander Quay, Dublin Port, Ireland
Involved in preliminary and concept design of improvement works to Alexander Quay in Dublin Port which included derivation of solution to accommodate additional 2m of dredging in front of existing caisson. Involved in scheme design for combi-wall quay structure and tie back anchor system.

Aqaba New Port Facility, Jordan
Preparation of a review of seismic design of the project and establishment of design peak ground accelerations utilising the probabilistic seismic hazard assessment and code-based provisions. Preparation of liquefaction assessment. Preparation of concept quay wall design methodologies for quay wall analysis and deadman tie-back analysis. Design and specification of additional ground investigations for seismic considerations.

Gas Storage Facility Extension, Cork, Ireland
Design, procurement and subsequent management of site investigation for large extension to existing gas storage facility in Cork. Preparation of the geotechnical interpretation and design recommendations.

N4 / N52 Junction, Mullingar, Ireland
Preparation of Category III check of embankment and reinforced earth construction for upgrade of the N4/N52 Junction at Mullingar, Co. Meath which will modify the existing at-grade junction to a grade-separated junction

A32 Cherrymount Link Road, Enniskillen, UK
Preparation of the successful tender design of the geotechnical aspects of 2km link road over very soft ground including, consolidation calculations and settlement predictions, stability analyses and design of piled slab section of road. Contract design of these elements for main contractor in accordance with Eurocodes. This included preparation and submission of technical Approval In Principle documents for highway structures to the Technical Approval Authority, management and supervision of additional ground investigation works, preparation and submission of the Geotechnical Design Report and supervision and quality control responsibilities for the construction phase.

Kosovo Route 7, Section 8 and Prishtine Orbital, Kosovo
Preparation of ground investigation specification and contract documents for Phase 1 (preliminary) and Phase 2 (Detailed Design) works. Preparation of ground investigation schedules and drawings and management of ground engineering model using AGS / Keyhole / Holebase software progressing to scheme design.

Milot-Morine Motorway PPP, Albania
Site inspections associated with site role as the geotechnical advisor to assist in introducing private sector participation in the operation and maintenance of the Milot-Morine Highway in Albania. The project will involve limited expansion and/or upgrading of the existing highway and its effective operation and maintenance, including improving the protection and stabilization of cuttings and embankments in order to improve safety and to gradually reduce operation and maintenance costs.

Flood Defence Schemes

River Dargle Flood Defence Scheme, Wicklow, Ireland
Review of hydrogeology. Design of anchored sheet pile wall structures for river widening scheme as part of Contractor's design team. Also worked on a Contractor's tender review team, considering multiple options for river widening works.

Mallow Flood Defence Scheme, Cork, Ireland
Review of piled retaining wall and earth embankment food defence measures. Design of piled wall solutions as part of the Client Representative's design team. Review of piling problems associated with Karstic bedrock.

Bandon Flood Defence Scheme, Cork, Ireland
Lead designer on the geotechnical aspects of this flood defence scheme. Design work included reinforced concrete retaining walls, flood defence embankments, rip-rap revetments and bespoke secant pile cut-off walls.