To support a planning application for a new treatment unit, United Utilities Water plc required a site investigation of ground conditions and contamination levels in and around Wellington Dock, Liverpool. River bed conditions extending approximately 300m out into the River Mersey for a new outfall structure also needed to be determined. Geotechnics Ltd was commissioned to carry out the works as ground investigation marine specialists under the AX5 KitFramework Agreement Term Contract.

Construction works will comprise:

- Dredging out of Wellington Dock,
- Removal of dock bed silts/clays to either the River Mersey (Dependent upon a Marine Management Organisation Licence Application) or to a suitably licensed landfill,
- Backfilling of Wellington Dock with engineered fill
- Construction of a new process treatment works to reduce Chemical Oxygen Demand (COD) of waste waters prior to being discharged into the River Mersey via the new outfall structure.

United Utilities commissioned a bathymetrical and magnetometer survey to determine river bed levels and any anomalies such as UXO and obstructions that could be a risk to both the investigation and construction schemes.

That survey information was provided by Geotechnics Limited to aid the selection of a suitably large jack up platform to work in up to 20m of water tidal range and to withstand currents of up to 5m/s in the river. Specialist marine contractors, Red7 Marine were asked to mobilise Haven Seajack 1 – a modular platform measuring 18m x 18m with 27m long jack up legs to Wellington Dock in late January 2011.

Eight HGVs duly arrived and work began on erecting the giant “Meccano” set in time to ensure that the lock gates from the dock system in to the river were open at or around ‘slack water’ Carmet Tug Company supplied two tugs, ‘Audrey’ and ‘Vigour’, to tow the Seajack through the docks system and out into the River Mersey. A safety vessel, ‘Vigour’ was also supplied for both staff crew changes at near-by Pier Head and to act as a support vessel in the case of an emergency.
Potentially the most difficult aspect of the investigation was the outfall works in the river. Careful planning and timing was required to ensure that the boreholes in the deepest water were completed at neap tides. Over a period of 5 days, four 10m boreholes, positioned along the route of the proposed 300m long outfall were successfully drilled through the river bed sediments and into the underlying Sherwood Sandstone.

Haven Seajack 1 came back into the dock system on 31st January – mission accomplished and bang on programme!

Meanwhile, within Wellington Dock, Geotechnics was busy carrying out over-water works on a smaller scale using a spudded pontoon barge. Water depth here was generally less than 9m, and a total of eleven boreholes were drilled, again using a combination of cable percussion and rotary techniques to depths varying between approximately 13.40m and 24.90m below dock base level. Samples were taken at predetermined depths within the dock silts/clays for chemical analysis to determine whether materials could be removed from site to the River Mersey Estuary (subject to a Marine Management Organisation Licence Application) or whether they would have to be removed to a suitably licensed landfill.

Landside boreholes around Wellington Dock were also required. Seventeen boreholes were needed to investigate the backfilled nature of the dock walls and to determine contamination levels of both the soils and groundwater. Each borehole was drilled with a combination of cable percussion and rotary techniques to depths of between 20.40m and 29.70m below ground level. Dual monitoring installations, one deep and one shallow, were installed to monitor ground water and gas regimes over a period of three months. Eight automatic water level loggers were installed to monitor tidal variations over a period of one month.

The wealth of experience exhibited from Geotechnics Limited’s own staff teamed with approved specialist contractors resulted in a high quality and professional investigation in a demanding and potentially risky environment.

All site works were supervised by Senior Engineer, Lawrence Page and Geo-Environmental Engineer, Jon Hutchinson with project management by Paul Hayes.

Geotechnics Limited was approached by Osiris Projects to assist them in completing an offshore survey for a number of windfarm interconnector cable routes in the German Bight for TenneT Offshore GmbH, a major European electricity transmission system operator. Geotechnics was to supply geotechnical engineers aboard the MV Poseidon to carry out logging, sampling and in situ testing during vibrocore operations and Katy Fothergill, Chelan Ellis and Laurence Page rose to this challenge.

Working as part of a multi-disciplinary international team, a total of 351 exploratory hole locations along 13 cable routes within a 25,000km² area off the west coast of Germany were investigated. The sampling was carried out using the Osiris’s newly purchased GeoCorer 6000 Vibrocorer. The work was carried from the 29th August 2011 to the 1st October 2011. The vibrocore locations were drilled approximately every kilometre along the proposed routes, or at areas of interest highlighted by previous geophysical surveys. The vibrocorer was lowered by a winch from the A frame located at the stern of the ship and winched to the seabed, where the coring commenced. Once full depth of penetration or refusal was achieved the corer was brought back to the surface. Each sample was drilled using a 6m length barrel and sample recovery varied from 3m up to 6m. Back on deck, the sample liner was extracted from the barrel. On board, Geotechnics Limited geologists cut each tube into 1m segments, carried out thermal resistivity testing, preliminary logging and then sealed and labelled each tube ready for transportation to Geotechnics Limited’s office in Chester.

At the office, each 1m sub-sample tube was opened up longitudinally in two parallel lines using a power cutter on a bench which was specially constructed to hold the sample whilst undertaking this tricky task. The sample was then photographed within a lined enclosure which gave uniformity of lighting and photographing distance and logged in detail. Following this exercise specimens were selected from each sample and sent to Geotechnics Limited’s UKAS soils laboratory in Coventry for particle size distribution and other classification tests. The Specification required that test procedures complied with the German DIN Standards and hence procedures for doing so were devised, after appropriate translation, and software programming. Tests were done in the Company’s Special Testing laboratory by designated staff.

The project required flexibility by the staff to adapt to conditions off-shore and the vagaries of the weather in this moving environment! On shore, the requirement for efficient transport, logging and testing was also met and as a result Geotechnics is now well set to continue into the next phase of such work.
SUSTAINABLE SEATON
Earth Works in Our Favour

An exciting regeneration project in the town of Seaton in East Devon has taken place on the site of a former holiday park to provide the basis for both a new Tesco store, with associated parking and roads, and a future housing development.

Geotechnics Limited designed and implemented a comprehensive first phase ground investigation for the site and this was supplemented by monitoring of a trial embankment as design proposals emerged. Working as part of the team led by the Client Tesco, and involving Structural Engineers Pinnacle and Main Contractors ISG Pearce, Geotechnics developed a strategy which involved the design, supervision and monitoring of an earthworks operation based on treatment by surcharging of the soft Alluvium which underlies the site. This obviated the need for piled foundations for the structure, allowing the use of a raft foundation to support the structure and floors, and a comprehensive treatment of both the car park area and associated roads. The housing development is to take place later.

In order to comply with flood risk assessments, the importation of 300,000m³ of fill material was required to bring the site up to some 2m above the pre-existing levels. Bringing the material in by sea has avoided 30,000 lorry movements on local roads and meant that the work could be done in a relatively short period for such a large scale operation. Monitoring of settlement of the development area during the placement period was carried out using both Rod and Plate and Horizontal Profile Gauges to provide the means of control and allow assessment of the effects of the surcharge. When deemed appropriate, surcharge loads were moved to other parts of the site and the store and ancillary works constructed. Monitoring of vertical movement is to continue for some time. Testing of the fill material was undertaken in an on site laboratory, and included particle size distribution, density, and moisture content tests. In situ CBR evaluations and Plate Bearing Tests were also undertaken.

The project illustrates that phased investigation and team working can have major cost and environmental benefits. The approach adopted complements the challenge of sustainability for the scheme as a whole, which includes the use of timber trusses and columns for the store as well as innovative slab design. The geotechnical work was managed by Anne Simpson of the company’s South West office in Exeter, together with Principal Engineer Tim Thornburn and site staff Ben Tucker, Chelan Ellis and Caroline Oldfield.

The historic Daniels Mill to the South of Bridgnorth in Shropshire was hit by the twin disasters of flooding and landslip during extreme rainfall in the area in the summer of 2007. These problems were intimately associated with those of the adjacent and also historic Severn Valley Railway which passes to the west of the site on a viaduct over the valley of the stream which serves the mill.

The landslip impacted on one of the outbuildings and stabilisation works were required to address both the slope behind the building and the slopes and buttress associated with the viaduct.

Remediation needed to recognise the historic environment, access constraints, sustainability issues and the maintenance of stability of the viaduct throughout the construction. Reinforced Soil was seen as providing the optimum solution and required careful construction on a very confined site to part of which the public had access. It was important to develop construction procedures which minimised the reduction of support to the slopes above the failure and to the historic railway embankment.

As their name suggests WM Longreach were able to make use of their specialist plant to reach places other techniques can’t and to trim excavations using articulating excavator heads. This minimised disruption to the client who remained in occupation throughout. The conceptual solution was devised by Geotechnics but detailed design and supervision was undertaken by Paul Thurlwell of PaSCoE. As is often the case the key to the success of this project was close cooperation between members of the team, their skill and flexibility.
Geotechnics was delighted to be involved in the conference programme in June when Len Threadgold, Chairman of Geotechnics Limited, was invited to speak about the effect of Eurocode 7 in the Site Investigation industry from the point of view of a practitioner.

The purpose of Eurocodes is to standardise practice in the industry throughout Europe, and in many ways it is seen as embodying what is already considered to be good practice, with the consequence that designs should be based on more reliable data and hence be better and more efficient. However it needs to be recognised that the EC7 document is more prescriptive than BS5930 (1999).

The ground has resulted from a range of geological influences over geological time and has most recently been subject to Man’s activities – the so called Anthropocene. All data from investigations need to be viewed in context and with caution by experienced staff. Research has shown that, typically, tests are done on about a millionth of the soil affected by construction. There is a danger that simple adherence to components in the code may imply a precision in prediction which cannot be justified in this context.

Much interpretation of test data has come from empirical correlations between test results and behaviour of the actual foundations and hence re-calibration will be necessary in the context of the new codes and it may be years before the benefits are fully realised. For example on granular soils the Standard Penetration Test or SPT has been used in much published work but such work has not had the benefit of identifiable efficiency values for the equipment. The fact of calibration allows for this in the future and has already highlighted the importance of using well maintained equipment and improved test procedures.

In relation to cohesive soils there has been much debate on the use of only Class 1 samples in determining shear strength and compressibility. Such sampling has proved to be very difficult if not impossible within the context of conventional site investigations of glacial tills in Scotland for example. This also applies to other soils. Perhaps Eurocode 7-Geotechnical design Part 2, paragraph 3.4.3 provides the key to this where it recognises that mechanical disturbance and release of stress causes disturbance and that some soils are more sensitive than others. Each problem requires a different degree of accuracy and hence the experienced engineer needs to decide on the degree of disturbance that can be accepted.

Perhaps the way forward is to structure investigations in a series of phases as the code suggests rather than to undertake the investigation in a single hit. In this way the first phase can allow less sophisticated sampling to provide data on the general ground conditions and allow selection of the most appropriate technique for obtaining Class 1 samples of the soils that are critical to the geotechnical design in the second or third phases. Either way the costs of investigation are likely to increase, either as a result of damage to the much less robust and much more expensive sampling tubes and cutting shoes, or the need for additional time and mobilisation.

Even with increased costs, however, the value of Site Investigation as part of any project remains high. Research done many years ago indicated that the average cost of an investigation was on average approximately 0.21% of project costs. It therefore needs to be recognised that procurement strategies to minimise the costs of investigations have a minimal effect on project costs but are likely to result in disproportionate increases in risk. It might be argued that this can perhaps be compensated for by over-design but without adequate knowledge this cannot be quantified and is hardly the sustainable, intelligent, efficient design which we would all aspire to.

Procurement and design strategies for Site Investigations therefore need to be re-considered and this is particularly so in the context of the new code. Particular account needs to be taken of the value of the experience of those structuring, undertaking and interpreting investigations.

Monitoring of the behaviour of actual foundations and earthworks can have major cost and confidence benefits that can be fed back into investigation practice and provide a much better ability to predict foundation performance in the future. The industry owes a debt of gratitude to those who have done so in the past and this should be a guide to future actions.

Site Investigation needs to have a much higher priority and profile in the construction industry if it is to attain its true potential for savings, efficiency and safety of the competed project. EC7 and its philosophy could be a key element in this.
Geotechnics Limited has recently completed a ground investigation at Wimbleball Dam in North Somerset. The dam, which is some 50m in height, was constructed between 1974 and 1978 using mass concrete buttress foundations benched into the underlying bedrock, and has a storage capacity of around 21,500M litres.

The geology around the dam comprises the Upper Devonian Pickwell Down Beds which are formed of sandstones, siltstones, mudstones and slates. In places these beds are faulted and fractured, which necessitated the formation of a grout curtain at the time of the dam construction to form a seal around the dam shoulders.

A new grout curtain is now proposed for the southern end of the dam to address suspected leakage through the fractured rocks. In order to optimise the possible design solutions, Halcrow Group approached Geotechnics to devise a digitally controlled hydrostatic test to determine the permeability and pressure head data at a range of test depths up to 50m. Given the rock variability, it was important that the equipment was able to assess a wide range of potential rock mass permeabilities, with flows in the range 1 litre/min up to 20 litres/second, thereby requiring flow control and pressure measurement systems to suit. Halcrow also had a requirement to improve data quality and digital data storage to a level greater than that currently expected by British Standards, to ensure accurate determination of the permeability values.

Geotechnics took the required Specification for the tests and designed and constructed digitally controlled Borehole Packer Equipment with data storage capacity. At the surface a digital flow meter is clamped to the valve control assembly which allows the flow rate to be monitored and adjusted by either a larger diameter valve control assembly or, at very low rates of flow, the use of a smaller diameter bypass valve arrangement. The flow rate is calculated by measuring the transit time of acoustic pulses sent between transducers mounted on the control valve assembly. The transit time downstream is less than the transit time upstream and the difference between the two is proportional to the velocity of the flowing liquid.

Pressure transducers/thermistors, placed above and below the Packer, were connected to a laptop computer at the surface, where real time pressure and flow rates were presented on screen continually throughout the test. In addition the ability to measure the water temperature above and below the packer provided additional data on the integrity of the seal made by the packer and the flow through the fracture zones.

On this particular contract, the packer tests were carried out in rotary cored boreholes, with test sections of up to 5m long. Injection pressures were set at hydrostatic pressure plus 1 bar for high flow situations, and up to a maximum of 10 bars for low flow situations. The tests are commenced at the set pressure, with flow rate being adjusted until a constant pressure over 5 mins is achieved, or for a period of up to 30 minutes. Calculation of permeability results used both the Jacob and Loham (1952) 'straight line method' and BS5930.

Having developed this equipment it is now available for use on other sites which demand the same high standards.
Following late summer storms at Bewdley in Worcestershire the gardens rising above a house on Cleobury Road had an unwelcome moving experience, pushing retaining walls towards the house and affecting the power supplies and sewer pipes which passed through the garden. The home owner instigated temporary scaffolding support and Geotechnics was called in to advise the insurers’ agent on the likely cause and solutions to the problem.

The scale of the landslide was not large but the problem of access both to investigate the site and carry out remedial works was huge. This was compounded by the house being located on an extremely busy main road. Initial works involved the temporary re-routing of the sewer and power supply to limit the consequences of the failure from a health and safety perspective. Access problems limited the Site Investigation to window sampling, laboratory testing, surveying and mapping of surface features, including emerging groundwater. The failure was analysed by Habib Ur Rehman and outline remedial works involving drainage, reinforced soil and proprietary facing blocks devised by Len Threadgold. These were presented in a report to the Client’s insurers’ agent.

On receipt of instructions for detailed design, following approval of the concepts and design strategies, Geotechnics commissioned Paul Thurlwell of P and S Consulting Engineers (PaSCoE) to prepare a design and drawings for construction. Following acceptance of the design, the remedial works were put out to tender with the work being awarded to WM Longreach (WML) in June 2011. They devised means of doing the work using their specialist plant and careful programming of the earthworks. The process involved the formation of a working platform and ramp up from the road, the use of a mini excavator to excavate the way in to the site and the carefully timed collection of waste and delivery of materials. The design required the excavation of a large part of the garden and the failed slope, with temporary anchors being used to hold the sides to the access route into the site and the rear scarp of the excavation to provide safety for workers and stability to the land above during construction.

Work commenced on site at the end of July 2011 with the removal of garden buildings. Careful site monitoring was undertaken during construction and excavation clearly showed the extent of the main shear surface of the slip and identified seepage locations. This allowed adjustments to give further confidence that the works would provide the necessary reinforcement and drainage in the long term whilst making savings. Adaptations to the reinforced soil wall were necessary to suit variations in ground conditions adjacent to the main slip, however, and this led to costs for the designed works being very close to the original estimate.

The success of the project on site was due to good working practices, the skill of the site staff, notably Dave Ryan of WML and Paul Thurlwell of Pascoe, and close liaison with Trevor Hardie of Geotechnics. Photographs show the situation before, during and after completion of the works. The Client, Mr and Mrs Edgerton, was delighted with the outcome, with the garden rather than themselves being left in tiers.

Geotechnics Limited has again demonstrated continuous improvement in the key areas of safety, quality and environmental performance under the latest UVDB Achilles Verify audit held in March 2011. It scored higher than last year with results of 96.4% for Health and Safety, 95.1% for Quality and 96.4% for Environment.

UVDB Verify is the UK Utility Industry’s scheme to assess and verify supplier capability and is now recognised as the standard for supplier pre-qualification within this sector. It is understood that Geotechnics’ scores are all 10-15% above average values for suppliers registered under the scheme, clearly demonstrating that the Company’s culture of commitment to raising standards, not only in this sector but also in its service to Clients at large. The Company also sees approachability, flexibility, continuity and value as important concomitants to its technical capability in broadening its client base.
The Port of Liverpool has always had to develop and reinvent itself to meet the changing needs of the world economy. One significant export is scrap and recycled metal, so when Peel Ports wanted to deepen the berths in the Alexandra Dock to accommodate larger vessels, the condition of the walls and base of the dock needed to be assessed.

Geotechnics Limited was appointed to carry out investigation works comprising four over-water boreholes to measure the depth of silt and sediment which would need to be removed from the bed and to prove the depth and condition of the underlying sandstone strata. Cable percussion boring and rotary drilling work was carried out from a spudded pontoon barge using a standard Pilcon Wayfarer boring rig and a Mobile Drill B24 rotary rig.

The condition of the dock walls, their depth and foundations were critical to the scheme designer R G Parkins and Partners Limited. Quayside level is +12.2m Chart Datum, the base of the wall was expected to be at about -3m Chart Datum, and the proposed dredged level is -2.9m Chart Datum, so there were serious concerns that the walls would lose frontal lateral support.

The investigation called for rotary core holes to be drilled from coping stone level, through the Victorian mass concrete wall and into the foundation materials. Geotechnics Limited used a Comacchio 205 track mounted rig, working as close as one metre from the waters’ edge and chose a T6/116 water flush, coreline set, drill barrel, and Series NF drill bits supplied by JKS Boyles UK Ltd. The wall structure proved to be variable but intact and the drilling equipment successfully cored granite coping stones, mass concrete and sandstone blocks.

Laboratory testing is underway and design options and costings are being finalised.

Re-Berth at The Port of Liverpool

As part of Warwick University’s innovative Tunnelling and Underground Space MSc course students were given a conducted tour of Geotechnics’ facilities, stores and UKAS accredited laboratory in Coventry. This was complemented by lectures on procurement of Geotechnical and Site Investigation services delivered by John Booth, the Company’s Joint Managing Director, and on the process and techniques of Site Investigation delivered by Len Threadgold, Company Chairman.

This was followed by an exercise in core logging conducted by David Bracegirdle and Habib Ur Rehman where the students produced their own logs of a sandstone sequence and compared them with those produced by Geotechnics’ own Geologists. Discontinuity logging proved a particular talking point as it recognised the dilemma in differentiating between naturally occurring and drilling-induced discontinuities, and whether this was interpretation, opinion or fact. Such experience will add to the understanding and interpretation of Borehole Records when presented in reports used to formulate designs and control construction in the students’ future careers.

We were delighted to hear from the Course Manager, Benoit Jones and course Director, Tony Price that the feedback from the students was excellent with a very positive reception of what was conveyed and learnt. Geotechnics looks forward to continued involvement with the course in what must be one of the growing areas of construction as cities seek to maximise use of underground space for transport, water supply, sewage disposal and accommodation.

Please visit this website for further course information http://go.warwick.ac.uk/tunnelling
A Vital Chapter – a new Dawn

After over 28 years with the Company Una Jenks, the Company’s Joint Managing Director, based at our head office in Coventry has regrettably decided that the time has come to retire.

Una spent the first 13 years of her working life in the motor trade where she met and married her husband Mac. They both spent 2 years working in the construction industry in Abu Dhabi, UAE, returning to the UK for the birth of their son Edward.

Una was in on the formation of Geotechnics Limited in 1983 and started the long and happy process of helping to develop and establish Geotechnics as it is today. She was appointed Company Secretary in November 1987, Director in September 1989 and Joint Managing Director in December 2007. She managed all accounts and administration functions throughout this period as she quickly moved to premises in the Foleshill Road in Coventry where its laboratory was also established. Subsequently, growth meant a further move to its current Head Office on Torrington Avenue in Coventry. During this time, additional offices were established in Exeter and Chester to meet the ever growing order book for these areas.

Una has helped to create the bedrock on which the development of the Company has been founded and has played a vital part in its success, often through difficult times. We wish her and Mac a long, healthy and happy well-earned retirement (although we do have her address and telephone number for future reference!!).

We are pleased to welcome Dawn Wadsworth, who joined the company in October as its Finance and Administration Manager, based in the Coventry office. Dawn has worked within the Construction Industry for much of her career and hence is aware of its characteristics. After a three month transition period with Una she has also been learning the peculiarities of the Geotechnical and Ground Engineering industries and has quickly demonstrated an ability to adapt to this new environment. We look forward to her working and developing with us.

If you require more information about any of the articles included in this latest issue of Geotopics or any other matter, or wish to continue to receive your next issue of Geotopics electronically, please email Pam, at pknight@geotechnics.co.uk or give her a call on 01244 671117; she will be delighted to help.

National Grid’s contractor, Land & Marine Project Engineering Ltd asked Geotechnics Limited to undertake a geotechnical investigation at an existing pylon site located near Penrhyndeudraeth to the north of Harlech in North Wales.

The works scheduled comprised a cable percussion borehole to be drilled to approximately 18.00m together with some window sampling and dynamic probing. However, the work site was located in the inter-tidal area of the Afon Dwyryd Estuary, approximately 700m from the nearest road. Access was further restricted by environmentally sensitive grass land and drainage channels between the coast and the pylon base preventing the use of any vehicles to cross it.

Lifting the equipment by air was proposed but restrictions on helicopter availability and lifting capacity coupled with a suitable tidal window reduced the options of rig type. The helicopter to be used had a maximum lift capacity of 1100kg ruling out many conventional rigs. However, a Pilcon Wayfarer 1500 rig, which could be broken down to fit into a 20’ container was selected. Ease of leg and mast removal and re-assembly, together with a maximum single combined unit weight (engine, winch drum and axle) of 1040kg, just fell within the lifting criteria.

Pre-weighed stillages of drilling and window sampling equipment were assembled to speed up the lifting and recovery process, with all equipment moved in eight lifts each way. The works were completed over a period of 3 days showing that such things are possible with the right team, commitment and equipment.

Metrolink suppliers Award Evening

This year Geotechnics Limited has had continued involvement in Greater Manchester’s Metrolink expansion project which will create several new lines by 2016. This should see great improvement in the transport infrastructure for Manchester by considerably reducing car journeys on the local roads.

Geotechnics won the contract to investigate the first phase of work at the main tram maintenance depot in the Trafford area of the city in 2008 and was subsequently approached by MPact-Thales (MPT) – the Thales, Laing O’Rourke & Volker Rail consortium – on behalf of TIGM to undertake further site investigations. Geotechnics Ltd has continued to carry out further ground investigation work across the scheme this year.

With the investigation work successfully completed, Geotechnics Limited was invited by MPT to attend an awards dinner held at the Museum of Science and Industry, Manchester in recognition of their contribution to the success of the project as a whole. The evening was attended by Geotechnics’ Senior Engineer Lawrence Page and Engineer Katie Fothergill.

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