

Clients




Environmental Consultants




Ground Investigation Contractor



envirotreat[®]

Figure 1 – New Cardiff Arena



Figure 2 – Site Overview



Site Background & History

The site comprises of the car park at Cardiff County Hall and an area of adjoining public open space. Ground investigation was initially required by Cardiff City Council [CCC] to reduce ground-related risk in the design and to build the tender process. Subsequent to contract award, additional ground investigation was required by Robertson Group for detailed design. Envirotreat was appointed to both phases of the ground investigation.

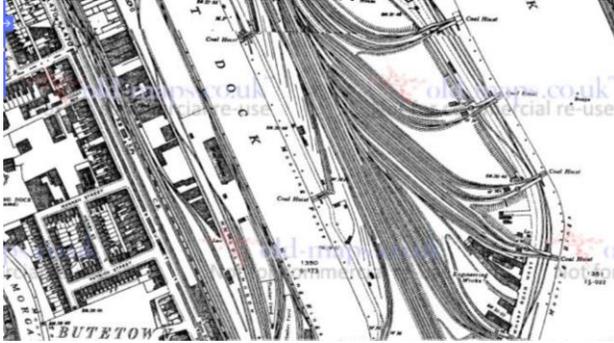
The site is referred to as Atlantic Wharf (located in Cardiff Bay) and the proposed development is the new Cardiff Arena, the associated hotel and necessary infrastructure. The proposed arena is shown in Figure 1.

The site overview is shown in Figure 2 below.

Ground conditions in this part of Cardiff Bay are known to be variable and challenging. The site is underlain by numerous infilled features, including the former Bute West Dock and timber ponds. Previous development in the area had uncovered highly variable and deep fill material generated through poorly controlled filling. The geological sequence is also complex, with very soft, organic Tidal Flat Deposits, deep cobbly granular soils overlying variable weathered Mercia Mudstone.

A desk study was provided for the site. This study identified further potential ground hazards. These included the risk from UXO (unexploded ordnance) and radiological contamination from a historic gamma and X-ray laboratory. The historical mapping of Bute Dock is shown in Figure 3 below.

Figure 3 – Historic Mapping of Bute West Dock



Project Outline

CCC had appointed Mott Macdonald to provide consultancy services. This included specifying and tendering the ground investigation. The project was tendered to four national ground investigation contractors, none of whom could meet the client's programme. Envirotreat were approached following a recommendation from the client. We were then reappointed for the second phase of GI by Robertson Group, working alongside their consultant, Arup. This appointment was made without tendering based on the successful delivery of the previous phase of work.

First Phase

Envirotreat provided a cost-effective proposal and a project programme that met the client's requirements. Upon instruction, Envirotreat mobilised subcontracted resources.

The scope of works comprised of the following:

- 7no cable percussion boreholes to target depth of 20m
- 1no trial trench to identify former dock wall
- Rotary-probed cross section of buried dock wall
- 2no trial pits and soakage tests
- Geotechnical and chemical laboratory testing
- Groundwater and ground gas monitoring.
- Factual reporting and provision of AGS data

Second Phase

Envirotreat were approached by Robertson Group and Arup on the back of successful delivery of the previous site investigation. The prime driver for the second phase was to obtain information for geotechnical piling design.

The investigations contract was awarded and works commenced immediately upon award of the main works contract. Arup specified the works to provide further site coverage and geotechnical data on the underlying Mercia Mudstone bedrock. The scope of work comprised the following:

- 8no cable percussion/ rotary follow-on boreholes to maximum depth of 35m
- 1no trial trench to identify former dock wall.
- Rotary-probed cross section of buried dock wall.
- 10no trial pits and 1no soakage test
- Geotechnical and chemical laboratory testing
- Groundwater and ground gas monitoring.
- Factual reporting and provision of AGS data

Envirotreat provided project management, site management and engineering services to deliver the project. All works were managed by our principal consultants, with support from across the company.

Archaeology investigations were also undertaken during the works. These were undertaken by Cotswold Archaeology.

Cable Percussion Drilling

Drilling commenced using 10" casing with stainless steel lead length. Environmental bentonite seals were installed at the base of the Made Ground in each location.

The boreholes were then progressed using 8" casing until either the deep granular strata or bedrock was reached. Finally, the target depth was achieved in 6" casing. By starting with 10" casing, the drillers had the option to reduce casing size again at depth (if required) to control groundwater or to penetrate dense granular soils.

The cable percussion set-up is shown in Figure 4 below.

Figure 4 – Cable Percussion Set-Up



In-situ magnetometer UXO clearance was undertaken in the Made Ground and soft cohesive soils at each location. The provision of stainless-steel lead casing meant that the casing did not have to be adjusted to ensure no interference with the magnetometer.

One of the boreholes in the first phase was drilled in the vicinity of the former gamma and X-ray laboratory. This borehole was supervised by a health physics supervisor. Arisings were screened and samples taken to confirm radiation levels.

In-situ SPT and CPT tests were completed, alternating with UT100 sampling within cohesive strata. Bulk samples together with disturbed and environmental soil samples were collected at regular intervals for geotechnical and geochemical laboratory testing.

In the first phase, where there was no rotary drilling, boreholes were either backfilled with bentonite or monitoring wells were installed. Nested wells were installed in some locations. Headworks were set in tarmac and washed down. In the second phase, rotary casing was installed before the cable casing was removed. This allowed the rotary rigs to move and set up on available positions.

A fully reinstated and washed down borehole location from Phase 1 is shown in Figure 5 below.

Figure 5 – Fully Reinstated and Washed Down Borehole Location



Rotary Rock Coring

Once suitable rock head was reached with the cable percussion rigs, rotary casing was installed ready to continue. A combination of water-air and air/water-flush drilling was used to maximise recovery of the extremely weak mudstone bedrock.

Two rotary drilling rigs were used in phases, bringing the number of concurrent drilling rigs on site to four.

SPTs were completed every 1.5m, with rock core recovered in between. Rock core was placed into boxes, logged and subsampled as required.

Trial Pitting / Trenching / Rotary Probe Boreholes

A trial trench was excavated in each phase primarily to identify the former dock wall. This was identified within each pit, with the full width and orientation recorded. The dock wall position was recorded using GPR equipment. The trial trenches were backfilled and the wall profile and thickness investigated via rotary probing. Borehole probes were sunk down the back of the wall in both locations, through the top of the wall and down the front to identify whether it was concave.

Trial pits were excavated, and soakage testing was undertaken in both phases. However, the ground was found to be generally unsuitable for soakage due to the presence of perched water at shallow depths within the Made Ground.

The outlines of the trial pits were cut out to provide a neat outline. Trial pits were then reinstated with arisings, plus additional compacted subbase materials. Hot-rolled tarmac was used to replace the pre-existing surfacing, with edges sealed with bitumen. White lines were re-painted, and the area cleaned down with a jet wash unit.

A cut-out trial pit is shown in Figure 6 below and the rotary borehole drilling set-up is shown in Figure 7 below. The trial pits were reinstated as shown in Figure 8 below.

All work areas were cleaned down using a jet wash. The area used for the site compound and the waste storage area is shown in Figure 9 below (prior to departure).

Figure 6 – Cut Out Trial Pit Awaiting Excavation



Figure 7 – Rotary Drilling Set-Up



Figure 8 – Reinstated Trial Pit



Figure 9 – Site Compound and Waste Storage Area
(Prior to Departure)



Project Outcomes

The initial ground investigation identified the thickness and composition of Made Ground materials within and outside the infilled structures and provided information on the former dock wall. Geotechnical and geoenvironmental *in-situ* and laboratory data were provided on the superficial soils. Variable weathering within the Mercia Mudstone was identified and investigated. The groundwater and ground gas regime were characterised. This information was fed into the tender process to reduce uncertainties, and consequently reduce variability in tender returns.

This ground model was built upon in the second phase. Further information broadly confirmed the conclusions drawn from the first phase on shallow soils. The testing and recovery of bedrock allowed the variation in rock strength to be assessed both laterally and vertically. This information fed directly into geotechnical design and piling assessments. The second trial trench allowed the overall position of the former dock wall to be extrapolated across the site. Accurate determination of the dock wall elevation will allow below ground structures, such as ground beams, to be designed without impinging on the dock wall.