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The history of the development of procedures for the rapid assessment of environmental conditions to aid the urban regeneration process at London Docklands

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Abstract

A process of urban regeneration of the former industrial dock area of east London by the London Docklands Development Corporation (LDDC) recognised the importance of geotechnical and geoenvironmental information. A systematic programme of data collection was implemented and stored in a series of bespoke computer database systems and cartographic registers. These allowed retrieval and manipulation of the data to provide rapid site assessments. The understanding of the natural setting of the area was enhanced as a consequence of the collation exercise. The data stored included geotechnical and environmental information on soil and groundwater. The hydrogeological regime was modelled by computer to determine the consequences of development on groundwater movement. In addition, a cartographic register of historic land use was developed. This gave instant detail on the potential for contamination of a site and became a fundamental tool in the UK planning process of the area. The information from the separate systems was finally combined into a geographic information system. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

The London Docklands Development Corporation (LDDC) was set up in 1981 to undertake a systematic regeneration of the run-down area of east London. This was dominated by the former docks complex that paralleled the River Thames east of the city of London to Woolwich and included land occupied by a number of associated industries. The area began to fall into decline during the 1950s and 1960s as the continued operation of the docks became impractical and they went through a series of closures.

A similar decline was also taking place in other industrial areas in the UK leaving a sense of dereliction in many inner cities. A period of social unrest occurred in the 1970s that was largely driven by the lack of opportunity in these areas. In 1981 a substantial riot in Toxteth in Liverpool spurred the Government to take positive action. Although many of the rundown areas had been subject to plans for improvement these had not been implemented. The Government took the view that it was necessary to encourage development interest from the private sector in order to ensure that speedy action was taken to provide a successful solution.

The extent of the degeneration of the docklands area of east London (Fig. 1) at the time of the formation of the LDDC was well reflected in land values.

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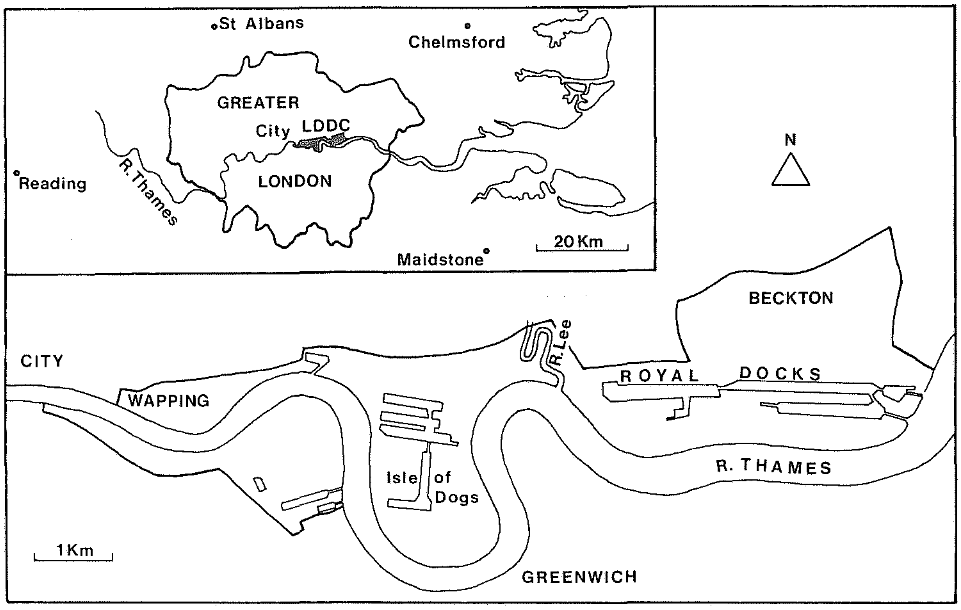

Fig. 1. Plan and location of the docklands area of east London.

The general view was that ground conditions would warrant a disproportionate cost to the eventual resale value. Thus, the market anticipated high development costs that were not economic when balanced against the potential returns. To overcome the reluctance and to aid the regeneration process, the LDDC chose to market the area with sufficient information on the ground conditions and soil quality, so that discussions with potential developers could advance with realistic considerations being given to the ground costs. It therefore needed a means for collecting and presenting the necessary data.

2. Data collection and collation

Shortly after its inception the LDDC began to collect existing site investigation and other relevant ground data from the area. This was to be made available to any interested party. Initially, old site investigation reports were amassed from local authorities and other public bodies. However, it was found that the existing data was often not quantified and invariably did not cover the primary areas of interest. In order to overcome this, and provide detailed quantified information on the potential development areas, a systematic programme of investigation was implemented through term contracts. The first of these was let in October 1983 and these ran continuously to the closure of LDDC in 1998.

Two contracts were let, one for geotechnical site investigation and another for chemical and environmental site investigation. The provision of a separate contract for the chemical and environmental issues in civil engineering site investigation is believed to have been unique and recognised the importance of geoenvironmental issues in the regeneration process of the former industrial areas.

The use of the term contracts and the systematic collection of any other available information meant that a large amount of data was going to be collected in a relatively short space of time. It was expected that eventually some 10,000 borehole records would be processed. However, the LDDC had been set up to work with only a limited staff. In addition it was known that its offices would move to a number of different buildings during the course of its life. These practical constraints posed specific problems for the effective storage and subsequent retrieval of the data once collected (Howland, 1989, 1992). Computer based systems were evaluated as the best option.

As part of a wider advisory brief to the LDDC, AF Howland Associates produced four separate purpose written systems that stored and maintained the data on soil quality. These were developed progressively during a ten year period. This was partly led by an increasing appreciation of the geoenvironmental issues associated with the redevelopment of brownfield sites. Importantly, the systems were required to provide data for the entire docklands area. The basis was that they should store and allow access to primary factual data, but provide a means of filtering the data to provide a rapid response to a variety of needs within the regeneration process.

3. The systems

Four separate systems were developed. These were a geotechnical database, a geochemical database, a groundwater model and an historic land use register. The underlying principle with each of these was that systematic collection and collation of data meant that a regional understanding for the area could be developed. This allowed a rapid assessment of any site even before actual ground investigation had taken place.

The reliability of the assessment was much greater than could have been achieved from other published data because of the finer resolution of the information making up the systems. As additional data became available its reliability and accuracy could be assessed against the context of the regional understanding.

The regional approach has an advantage over a more usual site specific assessment. It takes account of the much greater amount of data making up the regional understanding and allows the specific data from any one site to be balanced against the expectation. This approach is particularly suited to risk assessments of geoenvironmental hazard, which require a source–pathway–target characterisation of contaminants and is therefore influenced by conditions that extend beyond arbitrary site boundaries.

3.1. Geotechnical database

The geotechnical database was the first of the four systems (Fig. 2). The primary source of the stored data was site investigation reports. These gave the variation of a number of discrete parameters at a point location, each recorded against depth. They were therefore of a form that is inherently suited to simple tabulation and storage by computer, while the use of a database offered a means of allowing more rigorous enquiries than simple listed retrievals.

The development software for the system was a high level relational database utility which was assessed as particularly suited to the style of the information to be stored and has been described fully elsewhere (Howland, 1989). It enabled rapid and very selective retrieval of the data and allowed output in either printed or graphical format.

3.2. Geochemical database

Although the chemical and environmental term contract was in place from early on, the data from it was not included in the geotechnical database. The expectation was that the results would have a random character so that only limited regional interpretation would be possible.

This view was subsequently changed. Contaminants could be associated with specific industries and the possibility of contaminant migration meant that patterns in the distribution of the contaminants were likely to be present. A similar relational database approach was developed to allow the data to be stored. This was compatible with the geotechnical database in that the data was similarly referenced against depth and national grid reference and allowed for the storage of a wide array of possible determinands.

Where the boundaries of development sites changed during the planning procedures, data for the new sites could be filtered from the database. The system also allowed the results to be compared to published guidelines to give a summary of hazard assessment.

3.3. Groundwater model

Docklands is underlain by two principal aquifers, a lower aquifer that comprises the Chalk and the more sandy facies of the overlying solid geology and an upper aquifer that consists of the Thames Gravels, a sandy gravel that blankets the entire area below a cover of made ground and alluvium. Over part of the area the two aquifers are in contact but become increasingly separated by a clay aquiclude towards the west. The natural hydrogeology of the area is consequently a complex system confused further by the increasing urbanisation.

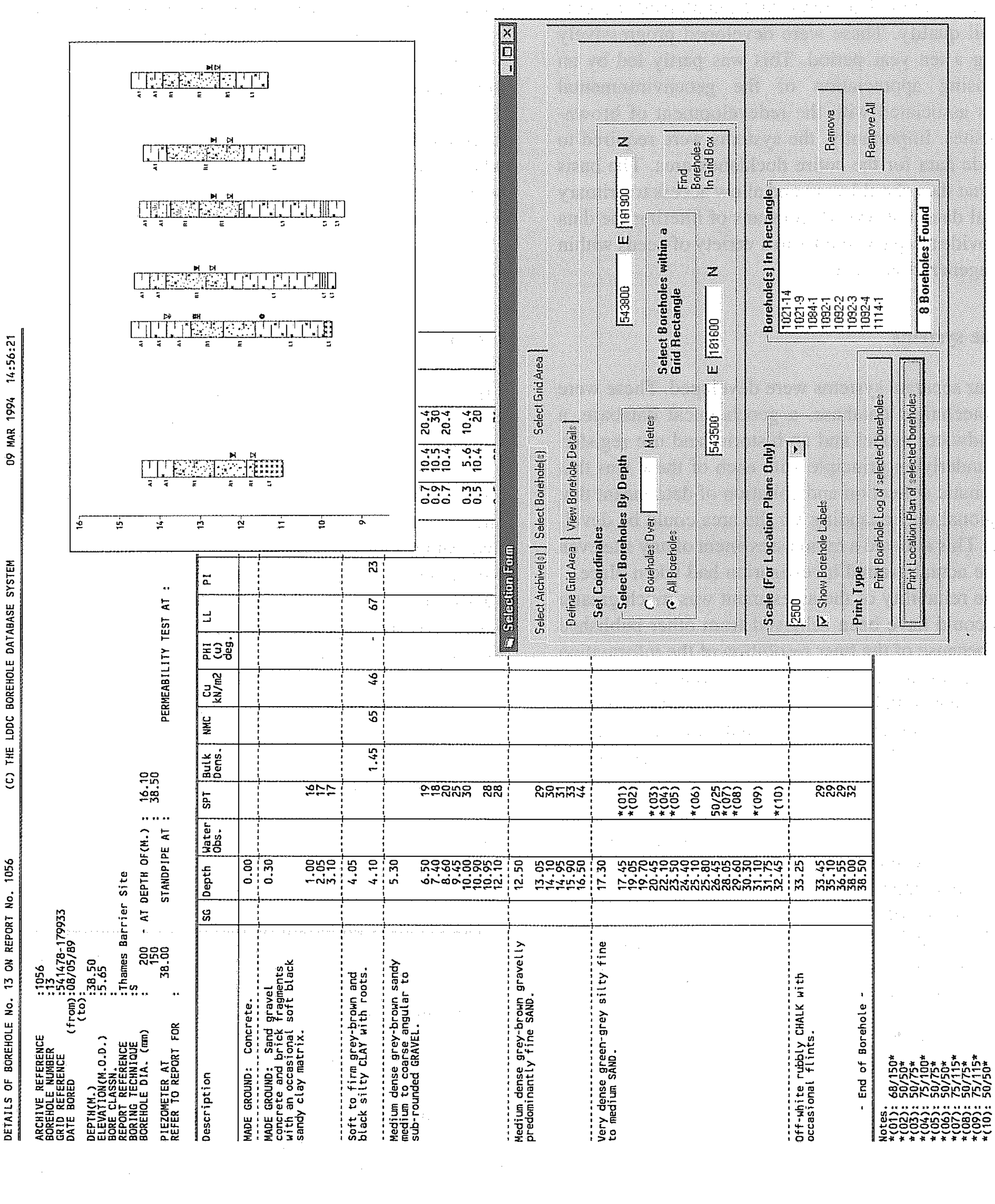

Fig. 2. Typical selection screen and output from the geotechnical database.

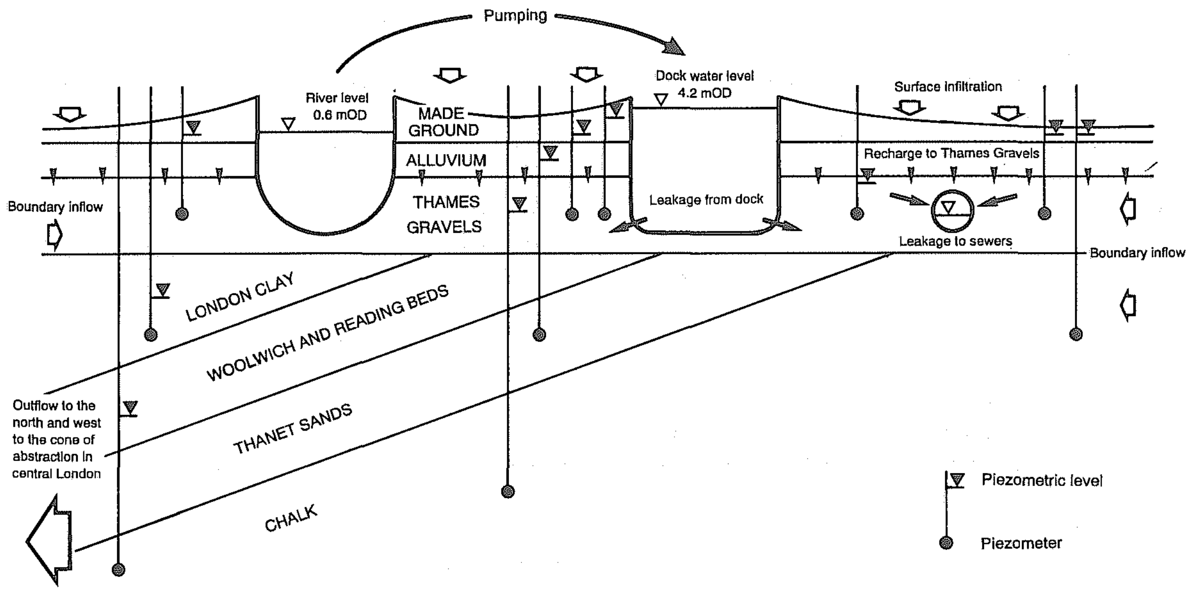

Fig. 3. Schematic representation of the hydrogeological controls in docklands.

The success of LDDC in regenerating the docklands area meant that the interaction between the development and the groundwater became increasingly important, particularly as a consequence of the scale of the associated engineering works increased. A full appreciation of the mechanics of the groundwater system (Fig. 3) was necessary both for effective engineering design and in order to ensure that movement controls to pollution were correctly established.

The multi-layer system in the docklands area meant that the model needed to be three dimensional. Although a number of hydrogeological models existed, these were suited to a natural system in which the layers were horizontal and of uniform thickness. In the docklands area the geological strata dipped and so were of variable thickness and even wedged out and disappeared. This required a new modeling technique to be developed and was undertaken at the University of Birmingham by Professor Ken Rushton (Howland et al., 1993).

The model gave the balance of the overall recharge and discharge to the area. Although this showed the situation at a point in time, time sensitive changes could be assessed by adjusting the various parameters. Thus, the consequences of natural variations, such as global warming, on flow patterns and groundwater levels could be determined. Similarly, the influence of new engineering works could be modelled. This could be a short term effect, perhaps during a dewatering phase for a new excavation, or a longer effect if the works were sufficient to disrupt an established flow pattern.

Changes to the groundwater regime can be used to assess the actual or potential for contaminant migration. When used in conjunction with the geochemical database, which provides information on the mobility of the contaminants present, the groundwater model gives the mechanism by which movement would take place and the speed at which it could occur. This provides a strong understanding of the source–pathway–target association for contaminant migration.

3.4. Historic land use register

Once the mechanism of contaminant migration could be understood with the groundwater model, a means of providing for the rapid assessment of the potential for land to be contaminated was needed to supplement the actual data held in the geochemical database. This was carried out by a review of the past activities in the area. The concept had similarities to the philosophy of the register of contaminating use that was then proposed under Section 143 of the Environmental Protection Act. However, it took the principle further in that not only was the presence of a contaminating use established, but so was history of the site. Regardless, the exercise was not intended to define actual contamination, or assess the by-products that any industrial process may have produced, but merely to establish the potential for contamination by association with the activity or occupant.

The data was recorded in cartographic form using a series of transparent overlays to the published ordnance survey 1:2500 plan of the area. In order to provide a full picture, data was retrieved from maps and plans at both larger and smaller scales, from books, directories and aerial photographs. The data was referenced to individual indexed plots shown on the overlay. Each plot represented the maximum extent of any industrial process or occupant, regardless of any periods of expansion or contraction.

Three overlays were used to represent heavy industry, light industry and artificial water (Fig. 4). Heavy industry was separated from light industry both for ease of illustration and to identify those areas where chemical and associated industry, metallurgy, non-food animal products, oil, gas and electricity processing or generating took place. Light industry represents those activities such as wind and water power generation, food processing, engineering, textiles, leather, clothing and footwear, bricks, tiles, pottery, glass, paper, timber and large retail units. Artificial water includes docks, wharves, ponds, reservoirs and former river lines. The maximum extent only, was recorded. Also included, were pumps, wells, and fountains since they can be associated with large underground cisterns.

A subsequent development of the historic land use register was to convert it to a computer based system and free it from the constraints of a traditional paper cartographic system. A proprietary geographic information system (GIS) utility was used as the basis of the application. This used the digitised ordnance survey plans of docklands and allowed the digitised information from the map overlays of the historic land use register to be referenced against this. An ability to represent the original indexed plots as polyline blocks on the GIS meant that they could be linked to an attribute list allowing the historic data for each plot to be instantly displayed on screen. The facility for moving around the background map and ability to move into an area of interest made retrieval of the data more intuitive for the casual user and quicker to implement.

The power of the GIS offered an opportunity to incorporate the data from the other systems to provide a single geoenvironmental register (Fig. 5). This would provide a single system detailing not only the past history, but also the geotechnical and contamination data. It could also include details of any remediation undertaken in the area so that ongoing assessments of hazard could be made, which allowed for the actual ground conditions. This final compilation was not fully completed before the LDDC was disbanded but showed that a simple means of interrogation of all geoenvironmental data was possible using a map based graphical interface.

4. Summary

A series of systems detailing geoenvironmental information collected from standard sources gave LDDC rapid access to information on soil quality. This also allowed the information to be retrieved. Output was in graphical or tabulated textual format. Some statistical processing of the data prior to output offered a useful summary of the data and enhanced its immediate value. In particular, chemical data was compared automatically to values of acceptability or other guideline criteria.

An understanding of the groundwater regime was provided by a dynamic computer model. This allowed rates and directions of groundwater movement to be determined under any set of conditions that may have developed through natural changes, or as a result of the development of the area.

A register of historic land use gave a cartographic index of the industrial activities in the area together with any water features and provided a measure of the potential for contamination to be present.

Each system operated independently, but when used together the combined data gave a total environmental statement, which benefited the regeneration process.

The final development of the systems was to combine the data held on each into a single GIS to provide a geoenvironmental register with the data searched and retrieved through a map based front end.

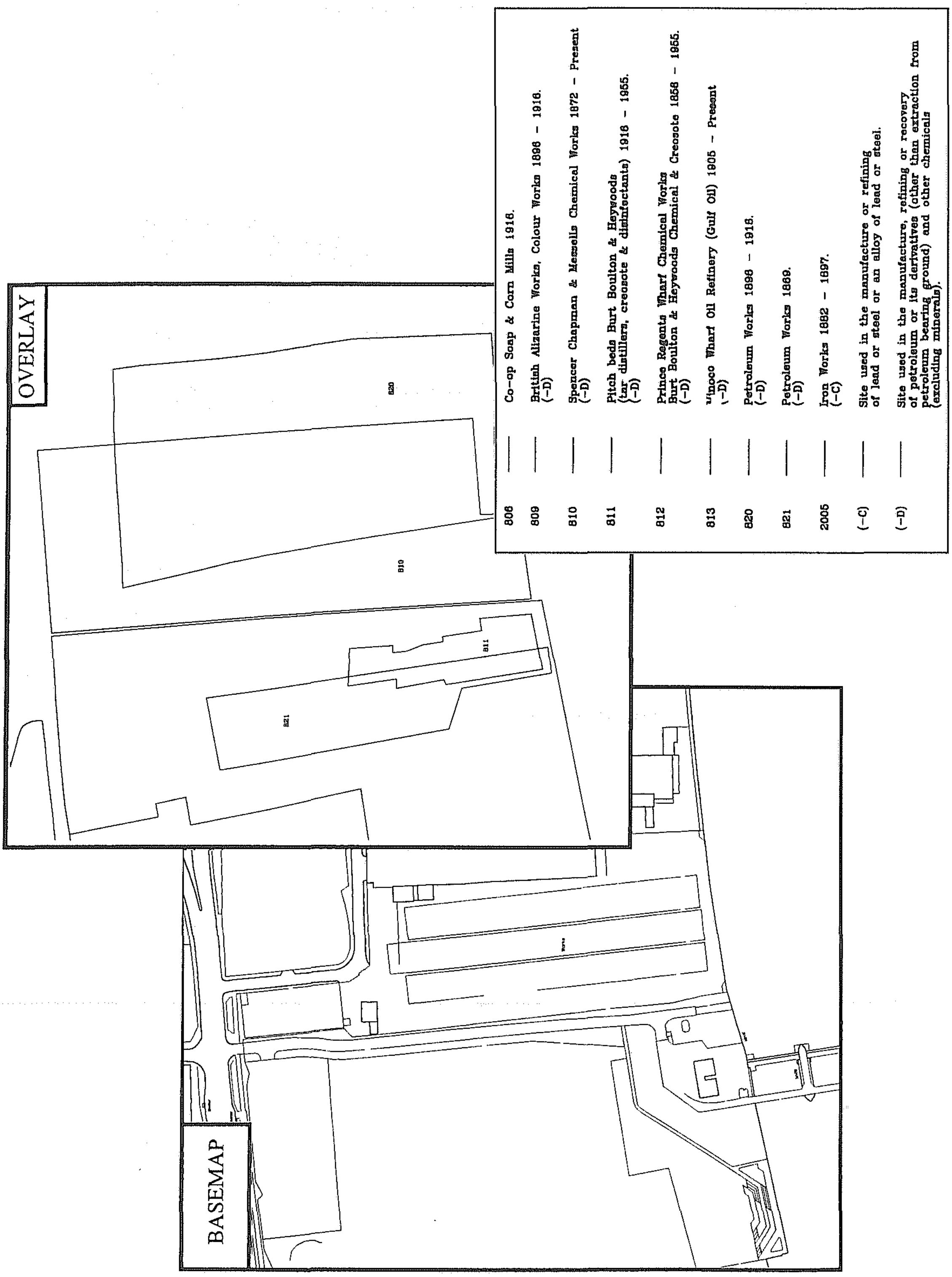

Fig. 4. Typical overlay detail from the historic land use register.

Fig. 5. The geoenvironmental register for docklands: use of a graphic interface on a geographic information system to zoom to areas of interest and display a variety of data which can be filtered to show only pertinent information.

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