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The Public Analyst in Land Reclamation

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The Public Analyst is increasingly becoming involved in the redevelopment of potentially polluted sites. The reasons for this and the ways in which the analyst may be called upon for advice are discussed. An approach to site surveys is outlined and areas of difficulty remaining are highlighted.

The uninitiated may question why an analytical chemist should have any role to play in the area of land reclamation, which would appear to be the domain of the engineer. While a limited amount of analysis, principally the determination of sulphate and pH, has been carried out routinely for many years to ascertain the effects of ground and ground water conditions on building materials such as concrete, the input of the chemist to redevelopment has been limited until quite recently. The increasing importance of the analyst, whether a Public Analyst or not, has largely been brought about by the change in the type of land now being developed.

In the past, and still today given the choice, the tendency has been to build on or develop "Green Field" sites. The reason for this is clear as developing such virgin land poses fewer problems for the engineer. However, there is now an increasing emphasis on redeveloping "second hand" sites which have previously been used for a multitude of purposes. This change in emphasis has been brought about by a variety of reasons.

1. There is an ever increasing demand for building and recreational land while the total land area of our islands is essentially constant.
2. There is increasing pressure to maintain green belts and open country which limits the outward expansion of our towns and cities and necessitates the use of urban sites to satisfy the demand for development land.
3. More sites are becoming available in urban areas due to the changing emphasis of the economy away from the large scale heavy industries. The sites vacated are often in desirable development areas and may be of a substantial size. The Strathclyde Regional Chemist's Department is currently involved in work on part of a redevelopment site in Glasgow which was formerly occupied by a Steel Works and extends to over 70 acres. The total area involved is twice that. The change from manufactured to natural gas has released hundreds of gas works sites for redevelopment. These were often built on the outskirts of towns and villages in the early 19th century and, due to the expansion of the communities they served, now form prime town centre sites.

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4. In many places attempts are being made to repopulate city centre areas which have largely been abandoned for residential use in favour of the suburbs. This requires land in inner city areas for new housing developments. The emerging ex-industrial sites can help to fulfil this demand, and indeed are often the only available sites.
5. As the emphasis of the economy changes there is often a need to redevelop land simply to remove unsightly derelict areas such as disused dockland, abandoned waste tips, and redundant factory areas.

The previous uses of the sites to be developed can vary considerably; we can expect to meet the following.

Steel works and related sites.
Gas and Chemical works (often associated with steel making in addition to town gas manufacturing plant).
Metal plating works.
Scrapyards.
Oil storage facilities.
Garages and vehicle repair works.
Sewage farms.
Waste disposal sites for both domestic and industrial waste.
Asbestos works.
Warehousing.
Dockland areas.

It is not unusual to find that sites have changed their use on one or more occasions in the past and in some areas the demolition of residential property can reveal traces of earlier industrial use. The problems that may be encountered in the course of redevelopment can be roughly divided into the two categories of physical difficulties and chemical pollution.

1. *Physical difficulties*

Ex-industrial sites often include a large amount of "made up ground" with poor load-bearing capacity. In addition mine shafts and shallow workings, underground ducts, tanks and pipes may be present causing considerable problems to the engineers. Before building begins on any site soil and mineral surveys are carried out by the engineers with the aim of locating any physical problems so that buildings and foundations can be designed appropriately. While this is not strictly the realm of the chemist, apart from the sulphate determinations usually carried out, the data obtained during site surveys are often useful in supplementing the engineers' data which is normally based on a limited number of boreholes. The author has personal experience of sites where the data obtained during a chemical survey have been used to correct mis-interpretation of the data obtained during the engineering survey.

2. *Chemical pollution*

Most industrial sites are potentially polluted by "chemicals" due to accidental spillages, deliberate dumping of waste products, or incomplete removal of

contaminated plant. It is in this area that the analyst has a major input in ascertaining the type and extent of pollution.

The types of pollutants that may be present will depend upon the previous use of the site. Metals, hydrocarbons, polychlorinated biphenyls and even low level radioactive materials (derived from luminous paint) are possible contaminants of scrap yards; phenols, cyanides, sulphides and tars commonly occur in gasworks and related sites; sewage farms may have a heavy metal problem; oil storage depots are likely to be contaminated by hydrocarbons, and landfill sites could contain almost anything. The range of possible pollutants is almost endless but with experience it is possible to decide the most likely pollutants for a particular site. Experience has shown that sites with metal structures present often have lead and/or zinc present presumably derived from rust proofing, priming and painting.

The presence of chemical pollutants can have serious consequences for site development. The different pollutants have various effects which can be significant in deciding the remedial action necessary in relation to the end use proposed. Several types of problems can be enumerated.

1. *Phytotoxicity*

   This will be of importance if land is to be used for agriculture, housing with gardens, or landscaping, but will be of little significance where the development involves mainly hard cover. The main phytotoxic elements commonly found are copper, nickel and zinc though other pollutants, such as hydrocarbons and acids, can also cause plant failure.

2. *Direct Human Toxicity*

   High levels of metals, such as lead and cadmium, cyanides, solvents, etc. are toxic by direct ingestion. This may be a hazard where buildings are erected and workers are exposed to the toxic materials during excavation work. These directly toxic materials can also be significant in areas where children may come into contact with the pollutants and ingest them either directly, by eating soil, or indirectly by transferring them to food or sweets following contamination of their hands. Tarry materials, many of which contain carcinogens which are toxic in the longer term, also come within this grouping.

3. *Indirect human toxicity*

   Certain elements may be taken up by food plants grown in contaminated ground and hence ingested when the plants are consumed.

4. *Attack on building materials*

   The most widely known example of attack on building materials is sulphate attack on concrete; however, there are other potential problems. Solvents can attack plastics and the migration of phenols through plastic pipes causing taints in water supplies is well known. Metal pipes laid through sulphate-rich soils may fail due to attack by sulphate-reducing bacteria.

5. *Aesthetic problems*

In some cases contaminants may not be present at levels which would be significant on the grounds of toxicity or attack on building materials but may still cause offensive odours or unsightly discolouration. In such cases, for certain end uses, such as housing, remedial action may be required.

Clearly the significance of the presence of pollutants will depend upon the end use of the site. In the case of landscaped areas phytotoxicity will be the most important consideration. For housing with gardens, the most sensitive end use, few pollutants are acceptable, while industrial use, with a high proportion of surface cover, can tolerate quite high levels of many pollutants.

In theory any site can be used for any purpose. Engineers have the necessary expertise to build on physically difficult sites though the cost of the foundation work necessary may make some, if not all, types of development uneconomic. The techniques used by engineers to determine the ground conditions in a physically difficult but "clean" site, and the remedial actions necessary to develop such sites, are well established. It is similarly possible to use any chemically polluted site for any end use though the cost could be prohibitive. In the case of chemical pollution the techniques of site survey and the remedial measures necessary are less well known and even the possible presence of pollutants, and the need for remedial action have not been considered in the past by many developers, including some local authorities. The author has personal experience of one ex-gas works site where work had actually started on a housing development when spent oxide was unearthed. The site survey that consequently followed delayed the work for some time at a not inconsiderable cost.

Public analysts are now becoming increasingly involved with the redevelopment of sites which are, potentially or actually, chemically contaminated. Their involvement was initially within the Local Authorities, to whom they provide a wide range of scientific services, but the expertise available is now regularly called upon by other developers. The analyst may be involved in several stages of the development from pre-construction survey to post-completion monitoring. The major areas are discussed below.

1. *Site survey*

The site survey is a most important step in redeveloping a potentially polluted site and the one requiring the largest input of resources from the analyst. The only way to determine pollution levels on a site is to carry out a thorough survey aimed at identifying and quantifying the pollutants present. In the past such work was often omitted but, as more derelict land is rehabilitated, and developers are made aware of the potential problems they face, site surveys are becoming the norm (at least in some areas). The Interdepartmental Committee for the Redevelopment of Contaminated Land has published several guidance notes in which it indicates that surveys are essential in most cases before development of contaminated sites. A good survey will identify polluted and, of equal importance, clean areas and will identify the types and quantities of pollutants present. Only when these data are available can safe and economic development be carried out.

It is essential to carry out a survey at the earliest possible point in the development, preferably before site use is decided and certainly at the outline planning stage. The major reasons for an early survey are as follows.

(a) The results will be available to assist in the choice of an appropriate end use. It is pointless spending substantial sums on planning only to find the proposed development is not viable due to pollution.
(b) A thorough survey of a large site will take an appreciable time to complete, generally in the order of months rather than days. If the work is initiated late in the development expensive delays can occur. This occurred on one site studied by the author where a survey was requested only when pollutants were discovered during excavations for foundations.
(c) If remedial work is necessary it can be integrated into the development. This may allow the development to be designed to minimise problems, e.g. by siting car parking areas over contaminated areas, and if removal of contaminants is necessary this can be integrated with other earthworks to minimise additional cost.

The survey work required will vary from site to site and only general principles can be laid down. The approach adopted in Strathclyde, which follows current recommendations and has proved satisfactory in practice, is as follows.

(a) Examine all available data on the site including old site plans, historical maps and written histories of the area. Ex-employees and local residents can often provide useful information and the results of the engineering soil and mineral surveys, if these have been carried out before the chemical survey, can give valuable clues to site conditions. A preliminary site visit should be made, though this will probably give little more information as most structures will have been demolished to ground and the area will often have been grassed, or covered with stone chippings as temporary landscaping.
(b) Having obtained all the information possible a sampling pattern is decided and the parameters to be determined are established. If the work is to be on a commercial basis, pricing can be undertaken at this point. The sampling pattern will generally be a grid modified in the light of information obtained relating to previous use.
(c) Before starting site work the various authorities should be approached to establish whether live services are present. Experience has shown that this information is not always reliable and it is prudent to assume any services found are live.
(d) Sampling is then carried out on site. This will normally require a JCB type excavator to dig pits to about 3 m though on occasions it will be necessary to resort to boreholes. It is considered essential that members of the analyst's staff are on site during the excavation to take samples and prepare pit logs. It is preferable that the person who will prepare the report is on site at this stage. A portable tape recorder has proved the most practical means of taking notes on site as writing becomes difficult in

the cold, wet and windy conditions which are often encountered. The accurate positioning of sample pits is essential. This is best achieved by having an accurately surveyed grid marked by the client but if this is not possible careful positioning from fixed points using a measuring tape is adequate.

(e) Having obtained the samples analysis is carried out for pollutants. Total analysis is impossible but care should be taken to cover all likely pollutants. This will entail rapid examination of a large number of samples for numerous substances.

(f) The final stage of the site survey is the preparation of the report. This will be read by engineers, architects, environmental health officers, potential developers and possibly members of the public and should therefore be in a form that can be understood by people with little or no chemical knowledge. It should include all the data obtained, maps and plans of the site, pit logs, standards adopted and recommendations for development and remedial work.

Once the site survey has been completed and the report submitted this may end the analyst's involvement, particularly if the results show a clean site, but often advice is sought in later stages of the development.

2. *Advice on remedial action*

Though the survey report will have given some recommendations, these must normally be of a general nature only. Discussions will often follow to decide the types of development which are most appropriate on the grounds of safety and cost, and the remedial action needed for a particular end use. One site examined in Strathclyde was badly polluted at one end but clean elsewhere. It was hoped to build housing on the polluted area while the clean area would be used for car parking and a community hall. The cost of remedial action was greatly reduced by interchanging the two uses.

3. *Advice on waste disposal*

In some cases it will prove necessary to remove more or less polluted material from the site. This is not always easy as suitable facilities to accept contaminated waste are scarce in some areas. At present there is only one landfill site in the whole of Scotland licensed to accept these more difficult wastes. The analyst is often consulted with respect to the classification of material as "Special Waste" and to give advice on suitable disposal routes. This can involve negotiations with waste disposal contractors, waste disposal authorities, environmental health officers and others. The public analyst has a particular advantage here as he will normally be in regular contact with such people in the course of his routine duties.

4. *General scientific back-up and advice to developers*

The site developers will normally be engineers with little, if any, knowledge of chemical properties of materials or toxicology. The ready access to a chemist at all stages of work on a polluted site is of great value. Many problems can be

readily sorted out in discussion but practical help, such as gas monitoring or supervision of removal of polluted material from the site may also be needed.

The increased involvement of chemists in the redevelopment of potentially polluted sites has led to a much more rational, safe, and cost effective approach to development. Difficulties are still encountered on chemical problems particularly in the areas of developer education, application of standards, analytical methodology and waste disposal.

Developer education

There are still many sites developed without consulting chemists. Developers need to be educated so that they are aware of the pitfalls awaiting them and will carry out site surveys at an early stage in the development.

Standards

The problem of applying standards to allow logical and consistent interpretation of the analytical results obtained in a survey is the most difficult and yet arguably the most important part of the survey. Engineers work to strict, well defined, standards but such standards are not yet available in the area of chemical pollution. Some advice is available from the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL), the Agricultural Development and Advisory Service (ADAS), and other sources but it is often imprecise and even contradictory. The recent Harwell report on "Gas Works and Related Sites" is probably the best guidance available at present as it draws together data from numerous sources and discusses the data on toxicological grounds. Much of the information contained in the report is of value in assessing sites unrelated to gas works. This is an area where the public analyst's training is of considerable use as he or she is no stranger to having to set standards and justifying them, possibly in court. It is of interest to note that the approach to applying standards to analytical figures recommended in the Harwell report is that originally developed by the Greater Manchester Laboratory some years ago.

Analytical Methodology

Analytical methods still leave a lot to be desired. Many are essentially empirical and it is not possible to obtain "Standard Polluted Soil" in order to check methods. This is an area where more research is needed.

Waste Disposal

With the present fragmented system of "toxic" waste disposal it is often difficult and unnecessarily expensive to dispose of polluted materials which must be taken from the site. This is only one aspect of the unsatisfactory nature of toxic waste management currently practised and it is unlikely to improve significantly until the system as a whole is revised.

As more sites are investigated in more areas the increased volume of data and experience accumulated will help solve some of the outstanding problems in what is still a relatively new area of work for the analytical chemist. With each

site investigated a little more is learnt so that ultimately we can hope to develop the handling of chemical pollution to the stage already reached by the engineers in handling physical problems.

References

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