

Out of site out of mind?

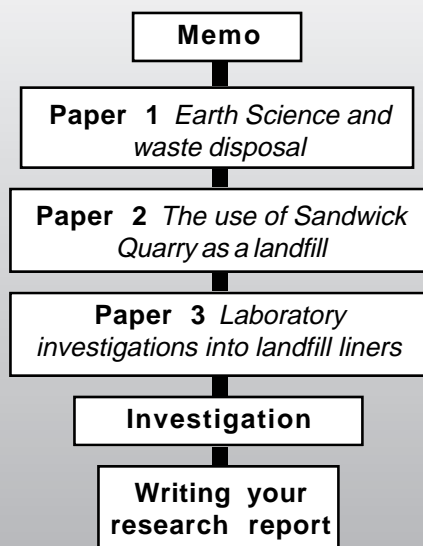
Pupil Research Brief

Teachers' Notes

Syllabus Coverage *Subject Knowledge and Understanding*

- ❑ humans reduce the amount of land available for other animals and plants by dumping waste
- ❑ human activities may pollute water with toxic chemicals
- ❑ human activities may pollute land with toxic chemicals which may be washed from land into water
- ❑ human activities may pollute water with toxic chemicals
- ❑ unless waste is properly handled more pollution will be caused

Route through the Brief



Introduction

In this Brief the pupils take on the role of new research students in a university environmental chemistry unit. The unit has been asked by a waste disposal company to make a recommendation concerning the most suitable natural material, or combination of materials, to act as a liner for a landfill site. Pupils are asked to read background papers, report back to their team and then plan and carry out the investigations. A report must be written to the waste disposal company, who will then use it in an application to the county council for a licence.

Experimental and investigative skills

- planning experimental procedures
- obtaining evidence
- analysing evidence and drawing conclusions
- evaluating evidence

Prior knowledge

Before attempting this Brief pupils should be aware of acid and alkali reactions, neutralisation and some common examples of waste materials from domestic and industrial sources, including sources of water pollution. Although not essential, it would be advantageous to the pupils if they were familiar with rock types, particularly sedimentary rocks, their properties and uses.

Pupil Research Brief

Teachers' Notes continued

Running the Brief

Pupil grouping

Pupils could work in a number of groupings during this Brief. Suggestions are:

Initial briefing - whole class; teacher briefly introduces and sets the context for the Brief

Planning meeting - groups of 6 suggested. One pupil could be nominated as the research team leader (Dr. J. Brown)

Analysis of three background papers - suggested that pairs of pupils could each be given one of the papers to analyse and report back to the meeting with summaries

Carrying out investigation - pairs or groups of three or four (depends on equipment availability)

Analysis of results - in pairs, threes or individually if the work is to be assessed

Communication - compilation of written reports (individual or group) and whole class discussion of results (optional)

Timing

The Brief should take 2-3 hours of classroom time. The time spent on the investigation can vary but the setting up of the test liners (cells) and the collection of leachate could be done in a double lesson. To save time, the papers could be set for homework. It would be beneficial if pupils could be given the opportunity later to report back to the rest of their group. Extra time may be needed to write up individual investigation reports, if these are to be used for examination assessment purposes

Activities

The teacher should issue the pupils with the **Study Guide** which provides pupils with a summary of what they should produce as they work through the Brief.

It can also act as a checklist for pupils to monitor their own progress. The Head of the Chemistry Division (teacher) should issue each group with a copy or copies of the **fax** and the **memo**. Each group will require one copy of each of the three **background papers**.

The memo acts as an agenda for group discussion and directs the pupils towards the required reading. The Brief is written so as to encourage the pupils to divide the reading tasks to save time (and paper) as well as giving them practice in communicating their findings. The papers are not 'real' but they are realistic. They draw on government documents, planning applications, and research carried out in the School of Earth Sciences, University of Birmingham.

Paper 1 is written in a journalistic style and gives some background information about landfills, especially the vital role played by the geology of the area. The pairs looking at this paper are encouraged to reflect on the content by having to address comments written on the paper by the Head of the Chemistry Division. This paper describes some of the issues associated with landfill sites.

Paper 2 is a report of a site investigation. This is an important prerequisite to obtaining a licence for waste disposal in landfill sites. The paper describes the location and gives site details. In addition, it mentions some of the practical ways that landfill sites can be managed to reduce pollution and nuisance.

Paper 3 provides information about methods of researching liner materials, including examples of setting up test columns or cells. It also provides technical background into the composition of some materials suitable for liners. Again, comments written on the paper direct pupils in their reading.

The **final report** could be written in sections, with each pair producing a specific section, or it could be given to each pupil as a complete task. The sub-sections of the final report are listed on the fax sheet. This should guide the pupils towards a realistic report structure.

Currently, a great deal of research is taking place into liner technology. This involves investigating the relative merits of different liner materials (both synthetic and natural) and in devising tests on liners. Some of the latter involve compressed air testing of seams (welds) and electronic mapping. Leak detection has evolved its own very advanced technology. Modern landfill sites use complete containment as the most effective means of controlling pollution. Landfill gas and leachate is collected and then pumped away from the site for

Pupil Research Brief

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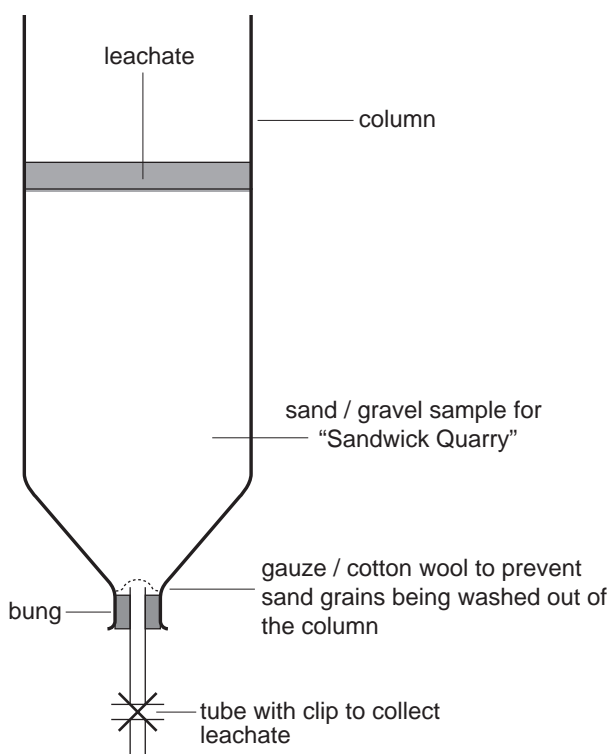
treatment or to be used. The work that the pupils are being asked to carry out mimics the work in some research establishments, in that the pupils are designing and testing 'controlled cells'.

Investigation and technical details

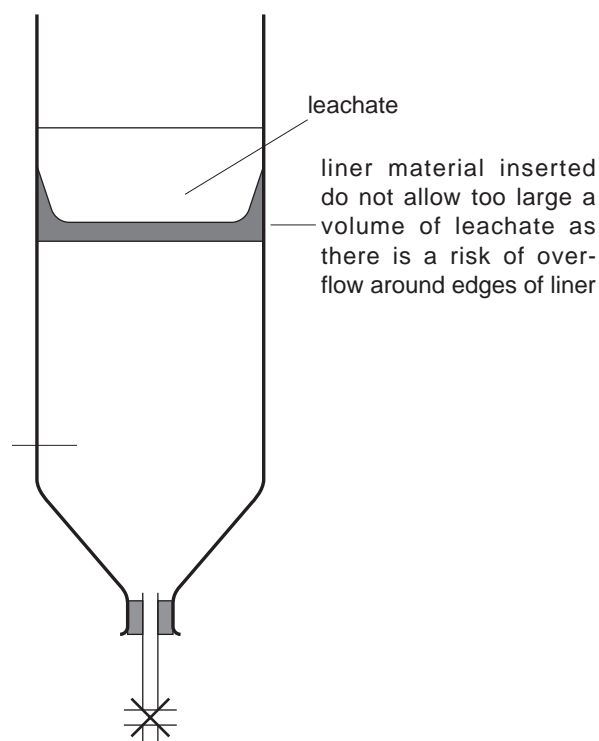
The pupils take on the role of consultants, providing an answer to the question "What will be the best liner for the site?" Possible solutions/models can range from column experiments such as outlined in Figure 1 to scale models such as that in Figure 2. These models can be as sophisticated as the group wish. Paper 3 - Laboratory investigations into landfill liners - is based on the research carried out at the School of Earth Sciences, University of Birmingham, as mentioned in the Introduction.

"Toxic" chemicals leaching from the site (leachate) could include cooking oil, acids (using normal pH range considered safe), food colourings or inks to give visible trace etc. The "leachate" will need to be prepared beforehand and could include a mixture of the above. If food colourings or inks are used, pupils could follow the movement of leachate through the column. Following collection at the end of the column the leachate could be analysed in simple terms e.g. pH, looking for traces of oil, and clarity.

Fig. 1 : Column Experiments
a) model using sand and gravel



b) model using liner materials above sand and gravel



Notes on Figure 2 (on next page)

1. Use damp sand and gravel to facilitate model making.
2. A hole will need to be drilled into the base of the tank to take a bung or tap.
3. The tank should be supported at the clay end to encourage drainage of the "leachate" towards the tap.
4. An alternative to the tap is to use plastic tubes as model "boreholes" down through the sand and collect samples from the bottom of these using a tube and syringe.

The fax transmission refers to rock samples from the Quarry that must be used to find out if they react with the leachate. Three sample materials from the quarry could be:

- clay
- sand
- chalk (calcium carbonate powder)

Possible other lining materials that could be incorporated to extend the investigation could include:

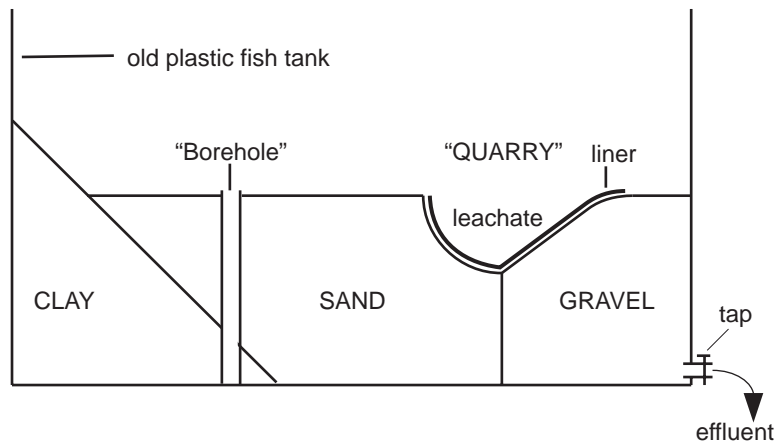
- waste paper
- plastic sheeting
- cement powder
- coal dust
- soil

plus any other sensible suggestions from the pupils.

Pupil Research Brief

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Figure 2. A model of Sandwick quarry



Pupils should be able to make predictions based on the background information and their knowledge of materials. Variables include the types of pollutants; type and depth of liner; sand or gravel as the rock and volume/rate of flow of the pollutants.

Different groups could be given different aspects of the problem with perhaps some using the column type experiment, whilst others used the modelling approach.

Using IT. Light sensors could be used to measure leachate clarity.

Safety issues

PLEASE NOTE: It is also important that you prepare your own risk assessments for the practical work in this Brief in the usual way.

Dilute acids: irritant

If swallowed: wash mouth and give water to drink. Seek medical attention.

If in eyes: flood eye with flowing tap water for at least 10 minutes. Seek medical attention

If on skin: flood area with water. Remove contaminated clothing. Seek medical attention if skin damaged.

Wear eye protection

Calcium hydroxide (cement powder): irritant

If swallowed: wash mouth and give water to drink. Seek medical attention.

if inhaled: remove to fresh air. Seek medical attention if breathing is even slightly affected.

If in eyes: flood eye with flowing tap water and keep it flooded until no further effects. Seek medical attention and inform that material is alkali.

If on skin: brush off solid and flood area with water. Remove contaminated clothing. Seek medical attention if large area affected or blistering occurs.

Wear eye protection. Wash hands after use. Cover cuts - gloves may be advisable.

Dusts (coal / cement)

Breathing affected; more serious for asthmatics.

If affected: remove calmly to fresh air. Allow asthmatics to take medication; seek immediate medical attention if attack persists.

Do not allow dust to rise into air.

Assessment issues for *Experimental and Investigative Science* (National Curriculum for England and Wales, Northern Ireland Curriculum)

| | | | |
|---|--------------------|---|---------------------|
| P | Planning | O | Obtaining evidence |
| A | Analysing evidence | E | Evaluating evidence |

There are two investigations ,i.e. investigating the reaction between leachates and different rock samples and using columns or models to look at the effect of using various landfill liners.

The level of scientific knowledge needed to carry out these investigations will possibly restrict the level of marks which can be achieved by pupils in **Skill Area P** to the middle range or below. This is also likely to limit the marks available for **Skill Areas O, A and E.**

Pupil Researcher Brief

Teachers' Notes continued

Scottish syllabus coverage

Standard Grade Biology - *Biosphere*

Further pupil research opportunities

Pupils could seek out further information on dealing with waste materials such as incineration and reed bed technology. They could carry out a survey into how the local authority treats waste and to what extent recycling of waste takes place. Pupils could also monitor their own household waste on a weekly/monthly basis and identify what and how much could be recycled.