Sustainable Systems of Outdoor Pig Production

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Statement of use
This report summarises the findings of research carried out into the distribution and physical characteristics of outdoor pig units in England and Wales. The information within this document is for use by Environment Agency staff and others involved in the management of river catchments where outdoor pig keeping is practised

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GLOSSARY

break crop	:	A non-cereal crop grown in an arable rotation to break up continuous cereal production
EC	:	European Community
FAWC	:	Farm Animal Welfare Council
KE	:	Kinetic Energy
MAFF	:	Ministry of Agriculture, Fisheries and Food
NERC	:	Natural Environment Council
PIC	:	Pig Improvement Company
RAC	:	Reading Agricultural Consultants
soil association	:	A group of soil types that form extensive, often dominant soils in an area
SSLRC	:	Soil Survey and Land Research Centre
WRAP	:	Classification Winter Rainfall Acceptance Potential

EXECUTIVE SUMMARY

The project was initiated to investigate, in parallel with a MAFF-funded programme of research, some of the environmental effects of outdoor pig production. Little is known of the incidence and nature of pollution from land stocked with outdoor pigs or of the potential polluting effects of run-off from such land.

The parallel MAFF-funded project, *Sustainable systems of outdoor pig production*, is researching environmental, welfare and economic aspects of the practice. The environmental studies include the assessment of the impact of a range of management practices on nitrate leaching and gaseous losses of nitrogen compounds. This project complements the MAFF study by assessing the distribution of outdoor pig production nationally and relating the location of a sample of herds to soils, geology, topographical and hydrological features. The resulting data has been used to assess the risk of pollution to surface waters and provide some recommendations designed to reduce that risk.

A survey of outdoor pig units was undertaken with the assistance of companies servicing the pig industry. The survey was statistically significant and covered 68 farms: these accounted for 17% of the national total identified by the University of Exeter and were stocked with approximately 21% of the total sow population.

The location of each unit was related to soil type, proximity to watercourses and other water features, land drainage, slope, erosion risk and rainfall, and the following characteristics identified: stocking rate and type, tenure, previous crop, and vegetation at time of survey. A sample of the sites surveyed was visited to verify observations made by the participants, to observe site-specific risks and suggest means by which they might be mitigated. Risk scores were estimated for six factors and these were accumulated to provide an overall assessment of risk and ranking of sites.

The main risk factor identified for any outdoor pig site are its proximity to surface waters and/or the presence of an underlying aquifer. Pollution risk can be reduced by identifying and controlling vectors that might be used by water moving overland, and by sensitive location and layout of units to reduce the potential for generation of surface run-off. Vehicle access was identified as one significant factor which appears capable of adjustment to reduce the risk of run-off.

Fewer than half of the sites identified in the survey were in areas of high groundwater vulnerability. The reduction of risk to groundwater from outdoor pig production, specifically by nitrates, is dealt with by the associated MAFF-funded project.

The report concludes by making some recommendations for specific measures that might be taken to reduce risk. The design of units should take into account not only ease of management, but also the area of land within and uphill of a unit likely to lead to the generation of surface run-off. It is suggested that vehicle access is controlled and that the inclusion of specially designed buffer features in the layout may also be of benefit in reducing the potential for surface run-off.

The report recommends that a model should be constructed to assess the risk of pollution from proposed outdoor pig sites, and that the model should include measures that could be taken to reduce risk.

Key Words

pigs; outdoor; pollution; erosion; risk; groundwater; surface waters.

1. INTRODUCTION

The keeping of pigs out of doors has been practised since pigs were first domesticated. However in the past century, demand for food has placed pressure on the industry to feed a growing urban population. The historical factor governing location is that pigs have been kept near their food sources whether of agricultural, industrial or domestic origin. The period after the First World War saw a movement of pig-keeping towards the cereal-growing areas of East Anglia and the development of confinement buildings. At the same time the increased use of feed compounds using imported cereals from North America and the improvement of the transport infrastructure allowed pig production to develop in other areas and the pattern we see today was established. Shortages of animal feed, followed by a rapid expansion to satisfy demand in the years following the Second World War led to increasing specialisation, a move towards confinement at all stages of production and ultimately to the concentration of a large share of the total output in fewer and larger units in areas where pig husbandry was already established. (Thornton 1988).

In the 1950s a system of large-scale outdoor pig-keeping was developed by Richard Roadnight of Britwell Salome, Oxfordshire. This system, based on the use of a herd of 400 outdoor sows as an alternative "break crop" to sheep, was adopted wholly or in part by many farmers, especially in the south and east of England.

The 1980s and 1990s have seen an increase in interest in outdoor pig production, largely because of increased profitability of outdoor production, but also due to animal welfare considerations and consumer demands for "green" products. This shift has been accentuated recently by changes in European legislation which will impose a ban on stalls and tethers in pig production. The effect of these influences has been a rapid increase in the number of outdoor pig herds throughout the pig-producing areas of England and Wales and an increasing concern over the potential impact of the practice on the environment.

Present estimates (Sheppard 1996) are that there are approximately 400 outdoor breeding herds in England and Wales, a total of about 100,000 sows. Although the outdoor herd has seen a significant increase in size over the past five years, it is not certain that this trend will continue. Indeed, there may be a return to indoor units; the hard winter conditions of 1996-1997 following a run of relatively mild winters may prompt a reconsideration of stocking practice.

In the late 1960s MAFF commissioned a study of outdoor pig production as part of an investigation of break crops for cereals (Boddington 1967). This study consisted of an initial postal survey of all pig producers in the south and east of England with more than 12 sows or gilts, to locate outdoor herds, followed by a more detailed economic survey of some 46 enterprises. Boddington identified 42 out-door pig-herds in his study area.

At the time of commissioning of this current project, it was thought that there was no specific work on the distribution of outdoor pig production in hand. However, in February 1996 the University of Exeter Farm Economics Department carried out a MAFF-funded survey of all pig herds of more than 20 sows and/or 200 growers/weaners (Sheppard 1996) and it is this survey that has been used to verify the representativeness of distribution of farms surveyed in the course of the work now reported. The Exeter survey identified 151 pig-herds in Boddington's study area, an increase of 359% over 29 years.

The current project was initially established in response to a need to evaluate the potential impact of outdoor pig-keeping on surface waters in England and Wales. Since its inception it has been broadened to identify husbandry patterns that might aid the production of a Code of Practice for sustainable systems of outdoor pig production. It has arisen partly in consequence of theoretical consideration of the potential for nitrogen leaching from outdoor pig units to adversely affect groundwaters (Worthington and Danks 1994) and collaborates with MAFF Contract CSA 2854, *Sustainable Systems of Outdoor Pig Production*. The MAFF-funded project covers not only leaching of nitrate to groundwater but also deals with gaseous emissions from areas stocked with outdoor pigs under a range of management regimes, and the welfare and economic implications of any changes in perceived good agricultural practice. The projects together represent a holistic study of outdoor pig production, its effects on the environment, related welfare matters and the impact of any change in practice on its viability. In addition, the role of soil erosion as a source of pollutants in surface waters has become of greater concern (Royal Commission on Environmental Pollution 1996).

1.1 Current guidance to farmers

Guidance on the production of pigs outdoors is limited to three publications (PIC 1994, Stark, Machin & Wilkinson 1989, Thornton, 1988), all of which give minimal consideration to the environmental issues associated with production. Further guidelines can be inferred from MAFF's Codes of Good Agricultural Practice for the Protection of Soil, Air and Water, although no specific recommendations are made. Some form of guidance will be required for the effective implementation of the EC Nitrate Directive, which stipulates that account should be taken of stocking rates in Nitrate Vulnerable Zones. However, there is no specific guidance on the control of overall risk to the environment from outdoor pig production.

The Farm Animal Welfare Council (FAWC 1996) have produced a report entitled the Welfare of Pigs Kept Outdoors, which, amongst other matters, considers site suitability. Whilst the report specifically considers welfare implications of site characteristics including soil type and drainage, it does not make any reference to the increased risk to the water environment that might result from the implementation of certain of its recommendations, e.g. that some drainage benefit may be derived from locating units on sloping fields.

Guidance from suppliers to the industry comes mainly from specialist field staff, working within basic "common sense" parameters including rainfall, soil type, topography and exposure to adverse weather conditions.

2. THE ENVIRONMENT

The potential impact of outdoor pigs on surface waters is influenced by both the physical characteristics and management of individual site. While the way in which the pig unit is managed is capable of being greatly influenced by the owner/manager, the physical characteristics of the site are largely fixed. Thus each site's inherent suitability, and its associated risks, are intrinsic characteristics, deriving from its geology, soils, topography and drainage characteristics, within the climate of that location. It should therefore be possible to assess inherent suitability of - and therefore the environmental risk at - different sites from knowledge of these factors. A brief discussion of these will set the study in an appropriate context.

2.1 Geology and soils

Geology is only of interest where the risk of outdoor pig production to groundwater is being assessed. Given the complex relationship between soils, drift and solid geology, it is difficult to make simple site-specific assessments of the factors that would be required to deal accurately with the topic in this report.

Soils at all sites in England and Wales can be identified using the 1:250,000 soil map of England and Wales (SSLRC, 1983). This national map shows 296 **soil associations** identified by the most frequently occurring **soil series** - 921 in number - and by combinations of ancillary series. The associations are identified by number codes that themselves relate to dominant soil **sub-groups**, of which 67 are recognized. The numbers further identify **major soil groups** and soil groups. Thus, **association** 1.23a is dominated by soils of a **series** belonging to 1.23, a subdivision of **soil group** 1.2, which is part of **major group** 1. (There are many other more detailed maps, published at various scales, but these give only a very partial coverage of the country).

This system enables the soil at each site to be characterized in terms of the prominent pedogenic characteristics of the soil profile, the inherent characteristics of the soil material, including parent material, particle-size groups, colour, drainage and mineralogical characteristics. Further, the associations can be used to provide a basis for the assessment of potential risk of **accelerated** erosion, particularly when combined with site-specific details (Evans, 1990). Accelerated erosion is caused by man's actions; typically the exposure of soil for agriculture, but includes neither catastrophic erosion events resulting from rare climatic conditions nor "background" erosion.

Evans has placed the soil associations in five major categories of erosion risk based on land use, landform and soil properties, taking into account the frequency, extent and rates of erosion.

Erosion risk in arable land has been sub-categorized to take into account vulnerability to wind and water erosion. He has estimated that 36% of England and Wales is at moderate to very high risk of erosion (both water and wind), including much of the better-drained and more easily-worked land, especially sandy soils. For the purposes of this report the categories which include the risk of wind erosion, and erosion by water, wind, frost, fire and animals in the uplands, have been discounted. Descriptions of accelerated erosion risk as defined by Evans and used in this report are shown in Table 2.1.

Table 2.1 Categories of accelerated erosion risk

Risk level	Score	Description
Very small risk	1-3	Erosion occurs rarely or not at all
Small risk	4-6	Eroding fields are likely to cover 1% or less of the land each year
Moderate Risk	7-9	For arable land between 1 and 5% of the land is at risk of erosion each year.
High risk	10-12	Erosion generally affects more than 5% of fields per year, the median and mean volumes eroded are likely to be greater than those in the smaller risk categories.
Very high risk	13	In the lowlands, erosion rarely affects less than 5% of the fields each year. On average, more than 10% of fields are affected, and two years in five as much as 20-25% is affected. The volume of soil eroded is greater than in any other category.

Evans' original work was based on the actual risk of accelerated erosion, on any single association under the cropping that would normally be expected on that association based on the Soil Survey's assessment of optimum land uses, which would not include outdoor pig production. Evans (1997) has agreed that his original categories of actual risk are appropriate for use in this project as an inter-site comparison of potential risk, with particular reference to outdoor pig production.

It is not possible to assign values for the volumes of material eroded in the five erosion risk categories, since volumes will vary according to the nature of the causal rainfall event, slope, percentage vegetative cover and other site specific factors.

2.2 Surface drainage

Proximity to surface drainage is obviously a key factor in the assessment of risk to surface waters from different land uses. Whilst it is easy to identify watercourses that contain water, conduits that have a potential to direct run-off into the wider surface drainage network should also be taken into account. It is these channels that provide the main vector for the transmission of eroded soil and associated material.

The presence or absence of watercourses is a function of the local geology and topography, and thus may be linked to soil type. However, this study has made use of site-specific observations of stocked areas and identifies the proximity of a range of surface waters, watercourses and conduits.

2.3 Rainfall

No satisfactory relationship has been established between soil erosion and rainfall for England and Wales (Morgan 1985). Evans has proposed that rainfall volume over three successive days was the best predictor of erosion, whilst Morgan advocates that rainfall energy is the best. These factors each have different origins: high volumes are likely to be due to prolonged rainfall events, normally of frontal origin, while high energy rainfall is normally due to convective rainfall events such as thunderstorms. For the purposes of this report, site-specific average annual rainfall and intensity of short and medium-duration rainfall events with a five year return period have been used as indicators of the risk of erosion as a result of rainfall. These two measures are discussed in the following sections, 2.3.1 and 2.3.2.

2.3.1 Average Annual Rainfall

Raindrop impact itself, together with subsequent splash-back, is known to move soil particles and small stones. In areas with similar rainfall intensities, the total rate of mass-transport of soil material on bare ground has been shown to increase with mean annual rainfall (Kirkby, 1969). An average annual rainfall value of 760 mm (PIC and Thornton) has been used by companies and individuals advising on outdoor pig production as a maximum for areas under consideration for outdoor herds.

The risk of accelerated erosion resulting from frontal rainfall on fields stocked with outdoor pigs may be similar to that for arable land, with both depending upon the degree of crop cover. The volume of soil likely to be eroded in a year from land kept bare of vegetation is estimated to be in the region of 50% greater than from that with a growing crop (Evans 1997).

Average annual rainfall is likely to be a reasonable indicator of chronic movement of potentially polluting material from outdoor pig keeping areas. In this report it is used as a general indicator of risk and therefore of site suitability.

2.3.2 Short- and Medium- term rainfall events

Short- and medium-term rainfall events may cause acute movement of large volumes of potentially polluting material from areas stocked with outdoor pigs.

The profile of storm events has been used as part of a model to estimate the scale of flood events (Natural Environment Research Council, NERC 1975). Part of NERC's modelling exercise involved the estimation and mapping of M5 (500-year) and other values for precipitation events of different durations. This also enables indices of the kinetic energy (KE) of all rains falling at a range of intensities to be calculated. This erosivity index has been shown to correlate closely with the incidence of erosion events (Morgan, 1980). The frequency of eroded sites in England and Wales related to soil association and erosivity index is shown in Table 2.2. Erosivity indices are not readily available in a useful form and a simple comparison between maps of mean annual erosivity (KE>10) in Great Britain (Morgan) and M5-60 minute rainfall (NERC) indicates that there is some correlation between erosivity greater than 1100 Jm^{-2} and M5-60 minute rainfall of >20mm. In this report, site-specific estimated 60-minute rainfall events have been used as simple indicators of risk of likely intense convective rainfall events.

2.4 Topography and vegetation

Work in Scotland has suggested that landform is not an important factor in erosion (Spiers and Frost, 1985); and Evans (1990) concluded that accelerated erosion can occur both on valley floors and on hillslopes. No clear-cut relationships between slope angle, slope length and relief have been found. However, Evans has found that rilling generally occurs on slopes steeper than 3° (1:20), situated below a convexity with an upslope crest area exceeding 50 m length and with relief exceeding 5 m (>1:10). Erosion on valley floors is not necessarily associated with rilling on neighbouring slopes, but it is rare for erosion to occur if both sides of the valley are not present within the field, since it is then less likely that sufficient water, at a great enough head, could be generated to cause an incision in the soil. Erosion in valley floors has also been shown to be the result of water flowing from roads or ditches above the field (Evans 1988). Despite the lack of any clear-cut relationship, erosion is commonly found on sloping, rather than flat, land.

Table 2.2 Frequency of eroded sites in England and Wales by soil type and erosivity group (Morgan, 1980).

Soil type	Mapping group	Erosivity group			Total observations
		<900	900-1100	>1100	
Rendzinas	10	1	33	15	49
Brown sands	12, 13	0	11	2	38
Brown calcareous	14	0	7	1	8
earths	15	10	17	16	43
	16, 17	0	6	9	15
Brown earths	18, 20, 21, 23, 25, 27, 29, 30, 31, 62, 63	5	35	10	50
	22, 24	0	4	9	13
Argillic brown	32, 33, 37	0	16	8	24
earths	36	2	1	7	10
Palaeo-argillic earths	38, 39	0	9	4	13
Calcareous	45	0	1	4	5
pelosols	46	0	46	46	92
Stagnogleys	51, 53, 54, 55, 56, 58, 69	1	78	22	101
	52, 57	0	11	22	33
					504

The layout of areas stocked with outdoor pigs is likely to have an effect on the risk of water erosion. As water flows over the surface of the ground it is slowed by surface roughness and deflected and directed by micro-relief such as tractor wheelings. Concentration of flow into wheel ruts or animal tracks may cause a significant increase in the risk of erosion. On the other hand, recent "cultivation" by animals may, in some circumstances, lead to a reduced risk.

It is well-established that erosion risk is greatest on bare soil, and reduces with increasing vegetation cover, being very low for permanent crops which closely cover the soil (Evans, 1990i). Pigs can be found in paddocks with a range from almost full cover to a complete absence of vegetation. Rooting can lead to rapid destruction of vegetation, and nose-ringing, which prevents rooting, can thus have significant beneficial consequences for soil erosion. In addition, high stocking rates maintained over several years are likely to be associated with lack of vegetative cover, while well-managed low stocking rates over short periods may allow vegetation to be maintained.

3. THE SURVEY

3.1 Methodology

A questionnaire was designed for use by field staff of companies involved in the pig industry. The questionnaire sought information data from individual sites and required details of location, stocking, soils, antecedent crops, physical features and overall condition of the unit. A copy of the draft questionnaire is attached at Appendix 1. During the drafting process, consultation was undertaken with the Environment Agency, experts from the pig industry and managers from companies that had agreed to take part in the field study, as well as with individuals having established knowledge and experience of field and postal surveys. The form was informally tested within the group of experts.

As a result the questionnaire was modified to take account of the reactions of the testers and the information required for the successful completion of the project. It was generally felt that the questionnaire needed to be simplified so that minimal writing was involved in the field. This was achieved by giving options for each section. The resulting final questionnaire showed changes designed to make it more "user-friendly" and is attached at Appendix 2. The format adopted was also better suited to analysis and was considered to be far easier to complete.

A group of eleven companies with interests in the pig industry were identified and approaches made to individuals identified within each company. Of the eleven companies approached, seven initially agreed to participate in the survey, one failed to respond to repeated approaches, and three refused to cooperate. One company withdrew from the project after it had been sent the full set of questionnaires it had agreed to take. The reasons for non-participation are given in Appendix 3.

The appropriate member of staff in each participating company was contacted by telephone and a suitable number of questionnaires agreed. It was agreed with several of the participating companies that the questionnaires should only be filled in with the knowledge and consent of the owner of the unit. The agreed number of sets of between five and twelve questionnaires were sent to participating companies, each containing an explanatory leaflet outlining the need for the survey, guidance notes on how to complete the forms, a telephone contact number and a stamped addressed return envelope. A total of 797 questionnaires were distributed in 75 sets. Of these, five sets containing a total of 60 questionnaires were sent to the company which subsequently declined to participate. In addition, some 12 questionnaires were completed by members of Reading Agricultural Consultants.

Questionnaires were sent out to participating companies as soon after 1 July as agreement to participate was received. A deadline of 2 August was initially set for returns, seeking to ensure that sites which had only been stocked for a short period were not surveyed.

3.2 Response to the survey

A target response of 100 questionnaires returned was set at the outset of the project on the basis that, assuming that about 400 outdoor herds existed in the UK, a population of 25% would be likely to be representative of the whole. With almost 800 questionnaires distributed to participating companies and ignoring possible duplication, a minimum response of only 50% would be necessary to cover the entire outdoor herd and a minimum response of 12.5% to meet the project target.

The first returns were received within 21 days of being sent out; none were returned before the desired cut-off date of 2 August and the majority were received on the 16 August. No telephone enquiries were received and feedback from the field was limited to one apology for the late return and a second apology for low returns because of farmer-hostility to the project. Eight returns containing a total of 40 questionnaires were received before the end of August 1995.

In order to increase response to the survey, participating companies were telephoned in late August to elicit further responses: as a consequence a further four sets containing 14 questionnaires were received during September.

Further contact in late October, November and December 1996 failed to elicit any new responses. It was not possible to contact the individual recipients of questionnaire packs because of agreements with their employers, and requests for direct access to field staff were politely refused by one company. No pressure was placed on any company to act against its wishes.

It was decided that the level of response was not adequate to meet the initial aims of the project and further attempts to involve new participant companies were made in December 1996. Revised questionnaires (see Appendix 4) were distributed to one company with an existing agreement, and invitations to participate were refused by two other potential contributors. In addition, producer organisations in areas identified by the University of Exeter (Sheppard, 1996) as having high outdoor pig populations, and showing a low level of response, were contacted and asked to participate. This direct approach produced a further five responses with an excellent reception from surveyed farms.

The level of response to the second approach was still considered to be inadequate and a decision was made to carry out surveys of new sites using Reading Agricultural Consultants' own staff when visiting areas on verification visits. This approach produced a further 12 completed questionnaires. The survey was finally closed in January 1997, with a disappointing response of 68 returns. A table showing details of the responses is attached at Appendix 5.

3.3 Significance of the survey

The correlation between the University of Exeter data pig herd numbers and the RAC sample population was calculated on the basis of numbers of herds per English county and Wales (Appendix 6). The coefficient for the two populations was 0.81 indicating a high degree of correlation and making it possible to draw some valid conclusions from the findings of the current survey.

To check the accuracy of completion of the questionnaires, members of Reading Agricultural Consultants visited a selection of the sites (15 (25.4%) out of the 59 questionnaires completed by respondents) and visually assessed the unit. No deliberate contact was made with the operators, so some details for example tenure, could not be checked, and pig numbers and stocking rates could only be estimated, but site conditions and topography could generally be identified with accuracy. These visits have confirmed the details reported by the respondents to a very high degree, providing confidence in the accuracy of the information provided.

4. THE FARMS

4.1 Pig units

4.1.1 Number of sows

There were seven herds with no breeding sows, and a further four for which no size was declared. The total number of sows returned by the survey was 29,935 (21% of total sow population). Breeding sow herd sizes varied from 60 to 1600, with most herds in the range 200 to 600. The breakdown by size is given in Table 4.1.

23 of the herds also kept weaned growing pigs out of doors, and 6 herds had fattening pigs out of doors. Almost all herds were composites, running sows at all stages of their breeding cycles out of doors, though three had only dry sows out of doors and brought them in for farrowing and/or service.

Table 4.1 Breeding sow herd size

Sow Nos	Number of herds (%)
<100	1
100-250	12
251-500	15
501-750	15
751-1000	4
1000	4

4.1.2 Stocking rate

The great majority (60%) of units stocked their sows at between 18 and 25 per hectare, with most of the rest (25%) at more than 25 per hectare. Few - only c.13% - stocked at less than 18 sows per hectare, with only one herd at less than 12 per hectare. These stocking rates can be compared with the "traditional" stocking rate used by the originator of the system, Richard Roadnight, at five or six per hectare (Thornton 1988).

4.1.3 Stocking period

The great majority (c.90%) of herds had been on their current site for one or two years. Interestingly, about 5% had been on the same site for three years, and a further 5% for more than 3 years; it was understood that normal practice is to stock any one site for a maximum of three years. The herds that had been on site for three years or more were of 2-400 sows, stocked at the rate of 12-18 sows/hectare. The duration of stocking was comparable on both securely-held land and on units on short-term licensed land.

4.1.4 Tenure

About 45% of the herds were stocked on land held on short-term tenancies or licences, the remainder being on either owned land or land held on longer-term tenancies. Stocking rates appeared rather more concentrated in the 18-25 sows/ha range on the short-term licensed land - see Table 4.2.

Table 4.2 Form of occupation and stocking rate - number of units (% of total)

Stocking rate/ha	25+	18-25	12-18	42
Short-term licence	6 (22)	19 (70)	2 (8)	0
Owned/tenanted	9 (27)	18 (55)	5 (15)	1 (3)

The average unit size was larger on the short-term licensed land than on the securely-held land, about 540 sows compared with about 400 sows. The units on securely-held land held many more growing pigs (average 480) than units on short-term licences (average 110); and fattening pigs were kept on six securely-held units, whereas no fattening pigs were kept on units on short-term land.

4.2 Location

The number of units surveyed in each county was essentially dependent on the numbers of questionnaires completed by each participant. The responses can be compared with those identified by the Exeter survey shown in Table 4.3.

Table 4.3 Locations of units

County	Number of units			County	Number of units		
	RAC	Exeter	%		RAC	Exeter	%
North Yorkshire	8	71	11.3	Norfolk	7	76	9.2
South Yorkshire	1	*1..4	100	Suffolk	10	42	24
Nottinghamshire	1	10	10	Hampshire	4	29	14
Lincolnshire	1	19	5.3	Berkshire	1	14	7.1
Dorset	6	28	21.4	Shropshire	6	26	23
Wiltshire	7	25	28	Oxfordshire	7	33	21
Devon	6	51	11.8	Buckinghamshire	1	*1..4	100
Somerset	2	15	13.3	Total	68	400	17

*1..4 : less than four units identified but number not given to maintain confidentiality.

Percentages based on number of units identified by RAC compared with University of Exeter figures.

This range of locations corresponds with expectations, being consistent with the drier parts of the country and significant extent of free-draining land. The Exeter survey used for verification identified that only about 400 of the 624 herds with some outdoor pigs were undertaking the full breeding cycle out of doors, and it is primarily these units that have been surveyed. The survey therefore identified in the region of 17% of all sites in England and Wales.

Table 4.4 Numbers of sows

County	Number of sows			County	Number of sows		
	RAC	Exeter	%		RAC	Exeter	%
North Yorkshire	3052	11137	27.4	Norfolk	4330	26075	17
South Yorkshire	110	6	1833	Suffolk	7425	15317	49
Nottinghamshire	600	3299	18.2	Hampshire	3218	10068	32
Lincolnshire	250	4567	5.5	Berkshire	580	5992	9.7
Dorset	960	6524	14.7	Shropshire	1730	2935	25
Wiltshire	4020	9435	42.6	Oxfordshire	3340	11436	29
Devon	1940	6524	29.7	Buckinghamshire	520	-	-
Somerset	250	3298	7.6	Total	29935	116613	25.7

Percentages based on number of units identified by RAC compared with University of Exeter figures.

The surveys also took into account the number of sows at each site. Table 4.4 shows that this survey identified sites housing 25.7% of the outdoor sows identified by Exeter. This proportion is greater than that for the number of herds, and reflects the fact that the average herd size (440 sows) identified in this survey is greater than that identified in the Exeter survey (355 sows).

Exeter recorded outdoor pigs in all but five English counties, and the totals shown refer to the full survey. All major outdoor pig-producing areas identified by Exeter were represented in the current survey.

Data from the current survey was compared with the full output from the Exeter Survey.

4.3 Soil types

The location of each unit was identified by Ordnance Survey national grid references, and soil associations at these locations were identified from the national soil map, published at 1:250,000 scale. Inevitably this scale leads to approximation, and the descriptions of all associations makes clear the variable nature of these mapping units. In addition, the grid references given by participants may not have been totally accurate in all cases; and extensive units could very well straddle soil boundaries. Bearing these caveats in mind, the soil associations identified with the units are shown in Table 4.5.

This list is notable for the near-total concentration on well-drained soils. Only five units are associated with soils that are described as experiencing slight seasonal waterlogging, and two as having a risk of flooding. (It is unlikely that a flood risk does, in fact, apply to the exact locations of the units, this risk to the unit being too great to accept knowingly).

Six of the units are on soil associations described as affected by groundwater. These soils will, in their un-drained (natural) state, have groundwater present within about one metre of the soil surface for part or all of the year. However, in arable areas, and therefore in areas in outdoor pig production, this ground water is generally lowered by ditches (with or without associated underdrainage) in order to reduce or eliminate the potential adverse effects on cropping. These drainage systems may eliminate any evidence of groundwater for parts of some or most years, depending on local factors. The survey recorded that only one of the six units on soils affected by groundwater had water-carrying ditches locally, suggesting that either the soil mapping was inappropriate or that local influences had permanently lowered the groundwater.

Table 4.5	Mapped Soil Associations at unit locations	
Association	Number of units	Description of major soils
343	17	Shallow, well drained, calcareous, over chalk/limestone
411	1	Slowly permeable calcareous clays
511	4	Well-drained, calcareous over chalk/limestone/gravel
521	2	Well-drained, calcareous, sandy
541	6	Well-drained over permeable rock/stone/chalk/gravel
551	15	Well-drained sandy soils
552	2	Deep sandy, ground water
554	1	Deep sandy, ground water
561	2	Deep permeable over alluvium, risk of flooding, groundwater
571	4	Well-drained over various rocks
572	4	Fine loamy and silty, slight seasonal water-logging common
581	3	Well-drained fine and coarse loamy over various rocks
582	1	Fine loamy over clayey, slight seasonal waterlogging
641	2	Deep sands, with or without groundwater
643	1	Slowly permeable subsoils, seasonal waterlogging
711	1	Slowly permeable fine loamy over clayey
861	2	Deep permeable sandy, groundwater

The nature of the soil at the units was also indicated by the participants. Table 4.6 details the topsoil types found at the sample sites as indicated in the responses.

A fully detailed comparison of these results with the mapped soil associations is not worthwhile, as there is bound to be local variation within a mapped association. However, all except four of the soil type descriptions were feasible within the mapped association. This correlation gives confidence to the replies obtained and to the relevance of identifying the mapped associations.

Table 4.6 Topsoil types identified by participants

Description	Number
Sand	38
River gravel	5
Chalk	7
Limestone	3
River silts	3
Clay over limestone	1
Clay over chalk	8
Clay with flints	3
Total	68

4.4 In-field drainage

59 of the 68 sites had in-field drainage information returned. Nine of these recorded the presence of in-field underdrainage, the other 50 sites being undrained. Four of these were located on association 343 and one each on associations 541, 551, 552, 561, and 572.

Table 4.7 Soil types on drained fields

Soil Association	Soil type identified at given locations
343g	chalk
343h	sand
343c	river silt
343b	sand
541r	river gravel
551a	sand
552a	sand
561b	river gravel
572c	sand

When these are compared with the Soil Survey's broad descriptions of the constituent soils (Table 4.7), the presence of underdrainage seems unlikely on the sites mapped as associations 343, and 551. All others could reasonably be expected to have underdrainage, principally for groundwater control. However, two of the three sites with underdrainage on association 343 are reported to have ditches close (<10m) to the unit; and the unit on association 557 is reported to have a ditch within 20m. Thus only one report of the existence of underdrainage appears to be of doubtful validity.

Only two sites out of 57 were reported to have been mole-drained, and only one of these two had an underdrainage system installed. Both of these units were described as having river silt soils, and mole drainage would not be expected on these soils. In contrast, half the sites (28 out of 57) had been subsoiled, and slightly over half would be subsoiled in the future. Subsoiling occurred across the whole range of soil types, and appears to be related to specific needs to loosen compacted land rather than being associated with drainage requirements.

While there appeared to have been more past moling and subsoiling - and more intention to subsoil in the future - on securely-held land than on short-term licensed land, this may be a reflection of the occupiers' knowledge rather than a factual record.

4.5 Standing water and run-off

Standing water (other than in wallows) was recorded in 19 out of 68 sites, but the lack of association with soil type suggests that its presence or absence was more dependent on the date of observation relative to recent rain rather than to inherent soil characteristics. The fact that observations, though intended to be concentrated over a short period, were in fact spread over several months, devalues this information.

Evidence of run-off was recorded at 21 out of 68 units, about 30%. It is not possible to link this with soil type, due to the multiplicity of types, the relatively small numbers involved, and the variation in the time of inspection.

4.6 Surface water drainage in the locality

With the benefit of hindsight, these questions could have been more carefully detailed, and the replies may be ambiguous. Thus three respondents indicated no ditches or watercourses adjacent to the field at question 7a, but did indicate ditches adjacent to the field at question 7b. 36 of the units were reported to have no ditches or watercourses adjacent to the field, and a further 21 had local ditches that were predominantly dry. Thus only 11 out of the 68 (16%) indicated the existence of local wet watercourses.

Question 7b identified the distance between the stocked area and local watercourses. 51 (75%) of the responses indicated that there were no surface drainage features within 50 m of the stocked area, suggesting minimal risk to surface waters.

Seven responses (10.25%) indicated watercourses and/or lakes and/or ponds within 10m of the units, and a further 10 (14.75%) identified surface waters within 20 m. Whilst some of these responses may have been mistakes, as noted above, the proportion of sites within a distance from which they could potentially have some effect on surface waters during periods of high rainfall is significant (25%).

Table 4.8 Proximity to watercourses/bodies

Description	Adjacent	10 metres	20 metres	50 metres +
Ditch	3 (4.4%)	4 (5.9%)	8 (11.8%)	53 (77.9%)
River or stream	0	1 (1.5%)	3 (4.4%)	64 (94.1%)
Lake or pond	0	0	2 (2.9%)	66 (97.1%)
Nearest feature	3 (4.4%)	4 (5.9%)	10 (14.7%)	51 (75%)

Note: 50m+ could be up to 1000m.

It is worth noting that while there is no reason to doubt the above responses (apart from the three already noted), observation of units during ratification has identified that one unit, identified as more than 50m from a watercourse is currently located immediately adjacent to a stream.

4.7 Slope

There was a higher proportion of incomplete entries in this section than in any other, 18 out of 68 (c.25%); the reason for this is not known. The predominant slope estimated varied from 1:30 to 1:100. The minimum slope varied from flat to 1:20, and the maximum from 1:500 to 1:10. Ten of the 50 answers indicated maximum slopes of 1:10. Due to the complex nature of slopes, it is not safe to seek to associate these slopes with any other factor in any more than a general way.

4.8 Vegetation

This aspect of the survey is inevitably subject to difficulty of interpretation. Because units vary in the duration of occupation of a single site, inspection on a single summer date will see some which have been on the sites for only about a year, while others may have been on the sites for approaching two or three years. This will obviously have a potential effect on the state of the vegetation seen. Antecedent weather conditions may also have an effect on vegetation, in 1996 the prolonged dry period may have led to grass die-back in areas that would normally have had cover.

The delayed nature of the responses to this question has also reduced the value of this part of the survey, as the site visits will have straddled the most common moving date in August/September. Thus some units will have been visited at the end of occupation, while others will have been visited soon after the commencement of new occupation.

The nature of the vegetation when first stocked was identified in terms of previous cropping in 66 responses, as shown in Table 4.9.

Table 4.9 Nature of previous crop

	Grass	Cereals	Other Combinable	Potatoes	Sugar Beet	Set-aside	Other	Total
Number	40.3	1.25	1.25	1.25	1	8.5	0.25	66
(%)	20	61	2	2	1.5	13	0.5	100

Those fields which had previously been in grass were supplemented by grass undersown in cereals in nine cases, and by one crop of herbage seed. They were also supplemented by nine cases of 2-year leys established on set-aside. Thus a total of 28 sites (42%) were in well-established grass when first stocked (or, at least, the grass should have been well-established). Almost all the rest, 37 (56%) were stocked onto regenerated stubble, with an unknown proportion of grass. One of the stubbles was very honestly declared as having no vegetation, one unit of 500 sows was established on land that had grown sugar beet, and one unit was described as regenerated stubble, although the preceding crop was recorded as potatoes.

Units on short-term licensed land were all established on land previously cropped with grass, cereal, combinable crops or set-aside, with a concentration on land previously in cereals. Owned and rented land had a wider spread of previous cropping, and less concentration on land previously in cereals - see Table 4.10.

Table 4.10 Previous cropping relating to tenure (%)

	Grass	Cereal	Other Combinable	Potatoes	S. Beet	Set-aside	Other
Secure	27	46.5	1	3.5	2.5	18.5	1
Short-term	14	75	4	-	-	7	-

4.9 Rainfall

Average annual rainfall for each site was estimated from the Met. Office data set, with adjustment for altitude. In addition, M5-1hour hour values were calculated. The mean and extreme values found for the identified sites are shown in Table 4.11.

Table 4.11 Rainfall statistics

	Average annual rainfall (mm)	M5-60 minute rainfall (mm)
Minimum	563	17.5
Mean	734	19.44
Maximum	996	20.9

The ranges of average annual rainfall and M5-60 values cover those found in the majority of eastern, central and southern England, excluding the extreme S.W. Peninsula. The mean value for average annual rainfall (734 mm) is only 25 mm below the normally recommended maximum of 760 mm, and the maximum well in excess. 26 sites (38%) had average annual rainfalls in excess of 760 mm.

4.10 Winter Rainfall Acceptance Potential

This report has so far dealt mainly with factors that are dominant in influencing the risk of acute run-off events. However, chronic run-off from land stocked with outdoor pigs may present a risk to surface waters and run-through a risk to groundwaters. As part of the work required for the completion of the Flood Studies Report (NERC 1975), the Soil Survey produced an index of Winter Rainfall Acceptance Potential (WRAP) (Farquharson et al 1978), and by inference an index of Winter Run-off Potential. The WRAP classification of the soils of a site provides an indicator of the relative ability of those soils to accept rain falling during the winter months, and its inverse the risk of water running-off that site. All of the surveyed locations have been identified on the 1:1,000,000 map of WRAP produced by the Soil Survey and classified within the restrictions of working at such a scale.

The WRAP/Winter Run-off Potential classifications are shown in Table 4.12.

Table 4.12 WRAP Classification

Class	Winter Rain Acceptance Class	Winter Run-off Potential
1	Very high	Very Low
2	High	Low
3	Moderate	Moderate
4	Low	High
5	Very Low	Very High

Of the 68 sites surveyed, 7 (10%) were found to be in WRAP class 4. This identifies the site as having a high potential for run-off during rainfall events and therefore a relatively high risk of polluting any nearby surface waters. Of these sites 6, (9% of the total sample) had less than 10% vegetation on at least part of the stocked area, presenting a still greater risk of run-off from the site.

4.11 Risk to groundwater

Risk to groundwater from diffuse pollution depends on the attenuating characteristics of the weathered layer overlying the aquifer and the presence of a significant aquifer. For the purposes of this project, risk to groundwater has been assessed using the Environment Agency's Groundwater Vulnerability Map (National Rivers Authority 1992). Sites were identified on the 1:1,000,000 scale map and risks attributed according to the criteria laid out in Table 4.13.

Table 4.13 Groundwater vulnerability

Vulnerability Score	Geological Class	Soil Class
1	Major Aquifer	High
2		Intermediate
3		Low
4	Minor Aquifer	
5	Non-Aquifer	

Of the 68 sites surveyed, 30 sites (44%) were located in areas of high groundwater vulnerability. The level of risk to groundwater from outdoor pig production is at present uncertain and is the subject of a separate MAFF-funded research project CSA 2854.

5. RISK ASSESSMENT

Assessment of risk to surface waters entails the appraisal of the interaction between a range of factors, i.e. soil, slope, rainfall, proximity to watercourse, stocking rate and vegetation. Whilst these factors are not in themselves difficult to identify, their interactions are complex.

In order to compare the relative risk of outdoor pig production at the sites to surface waters, a simple model has been built to describe the risk, based on the parameters used in the survey. Whilst several models exist that specifically assess risk for individual sites, they usually require comprehensive data of a technical nature and so do not lend themselves to this project.

This project has identified seven factors that influence the incidence and magnitude of risk to surface waters, i.e. soil erosion risk, slope, vegetation, average rainfall, M5-60 rainfall, stocking rate and proximity of watercourses.

For the purposes of this study, it has been assumed that slope is the dominant influence on erosion and all other influencing factors, with the exception of rainfall, are secondary and can be related to slope to provide a simple risk assessment. The risk scores are not based on any long-term observation and are designed only to provide a comparison.

Assessment of each individual risk is considered in the following 6 sections and the overall risk is considered in paragraph 5.7. The following tables show the risk scores for rainfall criteria and each of the other four physical parameters when related to maximum slope. Scores reflecting risk are between one and one hundred and have been developed from adaptations from simple arithmetical progressions using previous modelling work (Thompson 1984), recent erosion monitoring (Evans 1996, Royal Commission on Environmental Pollution 1996) and the authors' experience of erosion.

The risk scores can be used separately to identify risk of erosion resulting from individual factors, or the scores can be accumulated to provide a ranking of sites. No great reliance should be placed on the latter approach since the level of interaction and degree of influence of the various factors on erosion is complex and considerably more long-term field observation would be required to verify the model.

5.1 Slope

Slopes at individual sites were identified in the questionnaire using a sliding-scale and estimates made of maximum, minimum and typical slopes. Slope is a major factor influencing run-off in relation to other factors identified in the study, though the section dealing with slope was the most commonly uncompleted section of the returned questionnaires. In the assesment of risk, the dominant slope at each site has been categorized into ranges: flat, 1:100, 1:50, 1:20 and 1:10. A matrix of relative risk scores has been compiled for each of the following categories related to slope: stocking rate, Soil Association risk class, proximity to surface waters, vegetation cover.

5.2 Stocking rate

Scores for stocking rate have been taken directly from the questionnaire returns and placed into categories based on the typical stocking rates identified in the MAFF-funded project Sustainable Systems of Outdoor Pig Production. The matrix of relative risks has been compiled using dominant slope, as identified in paragraph 5.1 above, in combination with stocking rate. The final matrix is shown at Table 5.2.

Table 5.2 Scores for stocking rate -v- slope

		Dominant slope				
		Flat	1:100	1:50	1:20	1:10
	<18/ha	0	10	20	30	40
Sows	12-18/ha	10	22	35	49	60
	18-25/ha	20	35	50	65	80
	>25/ha	30	47	65	82	100

The resulting risk scores fell between 10 and 65 with a mean of 36 and median of 35, reflecting a normal distribution with an emphasis on the flatter nature of the majority of fields in outdoor pig production. There was no apparent relationship between stocking rate and any other of the criteria surveyed.

5.3 Soil Association risk class

The relative risk of soil erosion as identified by Evans (1990) has been related to dominant slope and the matrix at Table 5.3 has been prepared in order to relate risk to actual slope at individual sites as opposed to the typical slope of a soil association as identified by the Soil Survey.

Table 5.3 Soil Association risk class -v- slope

			Dominant slope				
		Risk	Flat	1:100	1:50	1:20	1:10
	1-3	very slight	1	4	10	18	28
	4-6	slight	5	13	22	33	46
	7-9	moderate	10	22	34	48	64
Risk	10-12	high	15	31	46	63	82
	13	very high	20	40	60	80	100

The risk scores for the surveyed units, assessed according to the above values, fell between one and 60 with an average of 21 and median of 22. The three highest risk scores were for sites with soils in the highest risk class 13, indicative of a very high risk. All three sites fell into the upper 50 percent of sites ranked according to total risk, ranking 48, 63 and 67 out of 68, and were located in South Yorkshire, Nottinghamshire and Devon respectively. The remainder of the sample showed no overall pattern although sites in Devon (5 out of 6) and Wiltshire (6 out of 7), representing 15% of the sample, were biased toward the upper 50% of the sample when ranked according to risk.

5.4 Surface water drainage in the locality

The risk of run-off from land affecting surface waters due to proximity has been assessed using a combination of slope and proximity. The risk of run-off from flat land is minimal, but increases with slope, and also increases with closer proximity to potentially-affected surface waters. The matrix in Table 5.4 reflects the potential for run off, once started, to travel easily over intermediate ground.

Table 5.4 Distance from watercourse/waterbody -v- slope

		Dominant slope				
		Flat	1:100	1:50	1:20	1:10
Distance	>50m	0	5	10	15	20
	20m	20	30	40	50	60
	10m	40	50	60	70	80
	0m	60	70	80	90	100

Risk scores of surveyed units assessed for proximity to surface waters fell in the range 0 to 70 with a mean of 13 and median of 5, showing a heavy skew of sample site locations away from surface waters. This suggests that the majority of sites are located in areas without surface drainage networks. Some evidence of a regional pattern was apparent with a majority of sites in Norfolk (6 out of 7) and Suffolk (8 out of 10) being in the lower 50% of the sites ranked according to risk, and a majority of sites in Devon (4 out of 6), Wiltshire (6 out of 7) and Hampshire (4 out of 4) in the upper 50%. This group of 34 sites represents 50% of the total sample.

5.5 Vegetation cover

Vegetative cover is a major influence on erosion potential. Land stocked with outdoor pigs rarely has uniform vegetation cover and erosion risk will vary from paddock to paddock, land with more than 10% cover will have a relatively low chance of eroding and land with more than 50% cover may be susceptible to chronic losses of surface material but be less vulnerable to acute events. Table 5.5 shows the estimated relative risk of erosion related to vegetative cover and slope.

Table 5.5 Vegetation at time of survey -v- slope

		Dominant Slope				
		Flat	1:100	1:50	1:20	1:10
Vegetation Cover	>50%	0	5	10	20	40
	10%-50%	5	21	37	53	70
	<10%	10	32	54	76	100

Risk scores for the surveyed units fell into the range 0 to 54, with a mean of 24 and median of 21, showing that whilst slope is a major factor in this category, vegetation on the majority of sites covered less than 50% of the area. Scrutiny of the main matrix shows that 39 sites (57%) had no detectable vegetation whatsoever in one or more of the stocked areas.

5.6 Rainfall

Average annual rainfall (AAR) (1941-70) in most of lowland England and Wales lies between 550 mm and 2,000 mm, although the latter is not common in outdoor pig producing areas. A maximum of 760 mm (30") is commonly used by the pig industry (PIC 1992). AAR for each site has been estimated and three categories of risk defined, i.e. less than 650 mm, 651-760 mm and more than 761 mm.

M5-60 values in England and Wales vary between 16 mm/hr in lowland areas and 27 mm/hr in mountainous areas. The range of M5-60 values identified in this study is between 17.5 mm and 20.9 mm. No guidance on the location of outdoor pig units is given using M5 rainfall statistics, therefore any cut-off between notional high and low risk is arbitrary; 20 mm/hr is used as the boundary between relatively high and low risks in this report. Table 5.6 gives a crude assessment of relative risk according to rainfall characteristics.

Rainfall risk scores for the surveyed units cover the full range from 0 to 100 with a median of 50 and mean of 49. This suggests that there is a bias towards locations with a relatively low average annual rainfall and rainfall intensity. Out of the sample of 687 sites (10%) had an average annual rainfall greater than 760 mm and an M5-60 minute rainfall intensity of greater than 20 mm. With the exception of two in Hampshire these sites were all located in Devon.

Table 5.6 Rainfall risk categories

		M5-60	
		<20 mm/hr	>20 mm/hr
Average	<650 mm	0	50
Annual	651 - 760 mm	50	75
Rainfall	>760 mm	75	100

5.7 Total risk

The total risk score is based on the sum of risk scores for all of the above five categories, a potential total of 500. The range of scores fell between 30 and 273, with a mean of 143 and standard deviation of 60. Three sites had scores greater than 270, two in Devon and one in Wiltshire. Six sites had scores lower than 50, two each in Suffolk and North Yorkshire and one each in Norfolk and Shropshire.

The three highest risk sites were in high rainfall areas, and located close to surface waters. The two sites at highest risk were also situated on highly vulnerable soils in Wiltshire and Devon, in descending order of risk.

Generally there was no significant regional pattern of risk with most areas being represented throughout the sample, although sites on the eastern side of the country had low scores relative to sites in the west. This is confirmed by a simple count showing that in Suffolk (9 out of 10), Norfolk (5 out of 7), North Yorkshire (7 out of 8) and Oxfordshire (6 out of 7) fell into the lower 50%, and in Devon (6 out of 6), Wiltshire (6 out of 7), Dorset (4 out of 6) and Hampshire (4 out of 4) fell into the higher 50%; this group represents 55 sites, 80% of the sample.

6. DISCUSSION

The dominant issues controlling risk to surface waters and groundwater are proximity to watercourses or potential conduits and existence of a vulnerable aquifer under the stocked area. These issues are supplemented by other influencing factors and potential controls that are specific to stocked areas and the vulnerable waters in question. These are discussed in the following two sections.

6.1 Surface waters

It is apparent that the single criterion which has greatest influence on the likelihood of surface waters being polluted is the proximity of stocked areas to surface water carriers. Provided that there is no potential vector for surface water to flow directly or indirectly from stocked areas, then flow of polluted water into the surface water system simply cannot occur. There are many areas of the country where this applies, and in these areas there is no potential hazard to a surface water system, however much run-off may occur from a unit. This may cause some inconvenience to others, e.g. mud on roads, and may have other secondary consequences for the environment, but is not dealt with in this report.

Thus far it is easy to be dogmatic. Whilst it is relatively easy to identify the several factors which favour run-off leaving a unit, it is not so simple to define those steps which will prevent or reduce it. The following paragraphs summarise a selection of factors and ways in which their effects might be mitigated.

It is clear that access to the unit needs to be very carefully considered, perhaps more than any other factor, in circumstances where tracks to the paddocks run up and down the slope and pass close by or over a watercourse. In the worst case seen during checks on completed questionnaires, a site access was at the lowest corner of a sloping field, with a hard-surfaced track leading from that point to a ford through a stream just a matter of twenty metres or so from the field gate. Thus all run-off was directed to surface waters.

Field gateways are often found at the lowest points of fields, where they meet the public highway, and where a surface water drainage system exists in the carriageway it will often conduct the water direct to the nearest watercourse. In an ideal situation, all access to units in areas with nearby watercourses should enter fields at points that will not channel surface water to any point from which overland flow to a ditch or watercourse is possible. Similarly, access should not be directly onto surfaced tracks or highways with surface water drainage systems that might provide a conduit to surface waters. These conditions are likely to be achievable in some cases, but in many will be impossible. The peripatetic nature of many units reduces the ability to undertake permanent measures to reduce or change the use of highways for access.

Where access to the public highway with a drainage system discharging to surface waters is inevitable, the site should not be used if slopes and accesses give rise to a reasonable risk of flow out of the field and onto the highway, either directly or via in-field ditches.

Vectors within a stocked area may also influence run-off and their effectiveness could be reduced in several ways. It has been noted that the layouts of many outdoor pig units include long, straight tracks, often running up and down the dominant slope in the field, which tends to exacerbate run-off. The layout of paddocks within the unit can also increase potential for run-off with long, open slopes and small dams along fence lines that may well channel water. The total removal of linear features running up- and down-slope is impossible, but their impact could be mitigated by reducing their downslope length by varying the dimensions of paddocks and offsetting boundary lines.

Another factor which fieldwork for the current survey has highlighted is the need for unit staff to gain mechanical - usually conventional tractor and trailer - access to the unit several times a day, every day of the year, regardless of weather conditions or the condition of the land. The role of wheelings as a potential carrier of soil is clearly highly important. It is easy to visualize a unit on which the pigs and pasture are managed in ways which minimize potential sheet run-off, but this excellent management is effectively nullified by machine access creating surface drains which concentrate flow. The problems created by tractor access have been reduced at one Oxfordshire unit by using liquid feed which is piped to the paddocks, thus greatly reducing the need for daily tractor access.

Radial layouts reduce the need for tractor access across large parts of units, although they are commonly seen as being suited only to smaller units of up to 300 sows. It may be advantageous to adopt multiple radial units for herds of 500 sows or more. Pseudo-radial layouts could also be designed to adapt the concept to field shapes and local topography.

Compaction is not confined to access tracks and reduced infiltration rates can occur throughout a unit. Many soils are vulnerable to poaching by trampling and bare soil can also be compacted and sealed by falling rain. The establishment and maintenance of grass cover will almost always improve infiltration and reduce the incidence of run-off.

Access tracks could also be managed to reduce risk. It is very difficult to maintain grass cover on a well-used access and tracks could be duplicated and rotated to reduce problems. The surface of main tracks could be stabilised using chopped straw, wood chippings or some other biodegradable material. Where such changes in practice are not feasible, the use of low ground pressure vehicles might reduce the level of compaction and thus risk of run-off.

Compaction and creation of small dams by rooting along paddock boundaries could be reduced by adopting a feeding method which encourages more extensive rooting across the stocked area. In order to reduce the build-up of run-off, one unit manager cultivates strips across slopes, thus creating a strip of land with a higher capacity for infiltration.

Stocked areas may also concentrate and channel run-off from unstocked upslope areas. The location and layout of any unit needs to be considered in terms of its position in the landscape and surrounding land uses, not in isolation.

The use of buffer zones between watercourses and stocked areas, and within stocked areas, may also be of benefit. The minimisation, or at least slowing-down, of run-off entering the stocked site may provide considerable benefits. These aims could be achieved by either locating the unit carefully within the local topography, or more practically by the provision of untrafficked, well-grassed or even possibly cultivated buffer zones on the upper and lower slopes of units in hilly or rolling countryside. Although such areas would not prevent catastrophic erosion events, they would go some way towards mitigating the impact of low-level surface transport of sediment and other polluting material.

Initial planning of units should be carried out with an eye to minimizing risk of run-off. This might be achieved by avoiding access tracks running up and down slopes and maximizing the number of boundaries between stocked areas running along contours. Antecedent cropping could also be managed in a way that is sensitive to pigs as a following crop, rather than simply fitting pigs in as a convenient break crop with no regard to the establishment or maintenance of a green cover.

Observation of sites in the course of checking completed questionnaires has shown that those with the highest risk of run-off are concentrated in rolling landscapes with sandy soils, with streams and rivers in many valley bottoms, in areas with higher rainfall, typified by parts of the south-west of England. It is not the intention of the authors to condemn outdoor pig keeping in any specific area, and some units in the south-west appear to pose relatively low risk of contaminating surface waters. However, the relatively high incidence of reported erosion events in the south-west does emphasize the necessity to locate and manage herds very carefully in sensitive areas.

Although it was not possible to identify any distinction in this survey, it may be the case that short-term occupiers are less concerned about the effects of soil loss from the units than those who hold the land securely. While both are concerned with the routine problems of access and the day-to-day problems of working within the unit, only the latter are directly concerned with the long-term yield potential of the land. Given the seeming general lack of concern about erosion shown by the farming industry as a whole, perhaps there is no such distinction.

The attitude of the majority of pig farmers to the impact of soil erosion on their own subsequent operations and the water environment is not well known. It would be interesting to interview all the farmers concerned with outdoor pigs in order to identify whether soil erosion is a perceived problem. Some farmers make considerable efforts to control risk, using some of the techniques outlined above. The main concerns of the majority of farmers with outdoor pigs were related to the difficulties encountered when first cultivating an uneven field. It is, however, interesting that a leading farmer has recently written in his regular column in the farming press to the effect that outdoor pigs can be bad for the soil and environment (Hepworth 1997).

If outdoor pig keeping is to continue to hold its perceived position as welfare and environmentally friendly, it is imperative that practical and economic guidance is provided to farmers. Principally, recommendations for location should be compiled, and guidelines can be drawn up on management techniques designed to reduce the likelihood of soil leaving a site. This may not provide total security in all circumstances, and further work will be required in order to strengthen details, and particularly to ensure that measures are implemented by the industry.

6.2 Groundwater

Outdoor pig keeping is best kept to freely draining land, which often coincides with water-bearing solid geology. It is therefore important that husbandry techniques are identified to reduce the risk of potential pollutants entering any important aquifers or being transmitted to surface waters by deep percolation. If an area is classified as having groundwater that is highly vulnerable to pollution, the risk can only be controlled by good husbandry. In theory, the main factors controlling the level of risk to groundwater from nitrate pollution are the presence of growing vegetation to mop-up surplus nutrients, and the quantity of excess nutrients applied.

The area used for outdoor pig production in England and Wales is in the region of 8,500 ha. When compared with the total area in cereal production (3,180,000 ha), of which 42% (1,335,600 ha) is sown in the spring, and the still more "leaky" potato crop (171,000 ha) and horticultural crops (187,000 ha) (Nix 1996), this is a relatively small proportion, although it has been increasing to this level steadily over the past five years. Bearing in mind the relatively small area stocked with outdoor pigs and the dispersed nature of the industry, it is difficult to control the level of risk from outdoor pigs other than by recommending improved management to reduce leaching potential and reduced stocking rates to reduce the overall nutrient load per unit area. Detailed information about this should derive from the parallel MAFF-funded project.

In the interim, the only practical means to control risk to groundwater in areas such as source protection zones which may or may not have been designated Nitrate Vulnerable Zones under the EC Nitrate Directive, are controls on stocking rates.

New feed compounds have been developed that are better utilised by pigs with consequential reduction in the volume of nitrogen excreted. Whilst the benefits of such feedstuff have been demonstrated in housed pig herds, no work has been carried out to demonstrate that its use reduces the amount of nitrogen available leaching from land stocked with outdoor pigs.

Initial results from the MAFF project CSA 2854 indicate that nitrogen leaching losses can be reduced by up to 85% through management of vegetation and stocking rate (Chambers 1997). Thus far there is no evidence to quantify the reduction in nitrogen losses due to the establishment and maintenance of vegetation on land stocked with outdoor pigs. Also, work has not yet been carried out on the fate of nitrogen held in the upper soil layers when stocked land is cultivated and returned to arable agriculture.

Nevertheless, logic suggests that if pigs are stocked on bare fields following "leaky" arable crops such as potatoes, there is likely to be a greater loss of nitrate to groundwater than from a comparable unit stocked on land with a full grass cover following a cereal crop: it would be surprising if this was not the case.

7. CONCLUSIONS

The conclusions that can be drawn from the results of this work are limited by the size of the sample achieved. However, many valid generalizations on overall pollution risk and the location of areas of relatively high and low risk can be made using information extracted from the questionnaire returns. The findings of this report are significant in that they identify various measures that can be taken to control the risk of pollution of the water environment and lay the foundation for initiatives that could be adopted by a responsible industry.

7.1 Surface waters

- **Keep stocked areas away from watercourses**

- **Avoid direct links between stocked areas and surface waters**

  Risk to surface waters is governed primarily by proximity to vulnerable waters and suitable vectors. In the absence of either of these two factors the risks posed to surface waters by outdoor pig production are minimal.

- **If linking vectors are unavoidable, reduce their impact**

  Design the layout of the unit with reduced lengths of open slopes and number of wheelings leading to the vulnerable area, thus holding surface water inside the unit and allowing it to infitrate rather than run-off: for example, create layouts with paddocks offset down the slope: length of slope will be reduced and, with it, potential for run-off.

  Avoid gateways at low points in fields to reduce run-off to highways and drainage systems.

  Ensure there is a well-grassed, untrafficked and uncompacted strip of land between all stocked and trafficked areas and nearby surface waters: The width needs to vary according to soil and site factors.

- **Take topography into account when designing layouts**

  Align paddocks across slopes to restrict build-up of overland flow.

  Assess risk of run-off from land upslope of the stocked area.

- **Reduce/manage tractor access**

  Trackways and fencelines running up and down slopes should be kept short to *control* velocity of run-off. Radial or pseudo-radial layouts reduce both need and opportunity for tractor-access. It may be advantageous to adopt multiple radial layouts for large herds.

- **Reduce compaction, improve infiltration**

  Maintain grass cover, where it exists, on internal access tracks or the surface of tracks stabilized using chopped straw or a similar degradable material. Manage stocking to maintain green cover in paddocks.

  Where possible provide alternative access routes so that tracks can be rested.

  Run-off might also be reduced by changing feeding methods to systems that encourage more extensive disturbance of the soils within stocked areas. In some areas it may be possible to use liquid feed systems that would reduce the frequency of tractor access. Use low-ground-pressure machinery for as many routine activities as possible.

  On some sites it may be beneficial to install cultivated buffer strips (bare or seeded) across slopes to intercept run-off and reduce build-up of surface flow.

- **Treat outdoor pigs as a crop within the normal farming rotation**

  Plan antecedent cropping to provide established crop cover when pigs are brought onto the site. Plan following crop and fertiliser regime to take maximum benefit from available nutrients.

- **Prepare contingencies and manage to reduce pollution risks**

  Keep records of local watercourses so that run-off can be tracked and silt trapped before it leaves the farm. It may be possible to install basic silt traps in farm ditches. In the event of a severe erosion incident, inform the Environment Agency so that the impact can be assessed and remedial works planned.

  Monitor ground conditions inside the unit and change management to reduce risk to an acceptable level.

7.2 Groundwater

There is a high potential for pollutants from outdoor pig units to to reach the groundwater of major aquifers, but in national terms the level of damage may only be relatively small in view of the small proportion of land stocked with pigs compared with the total area used for growing spring cereals, potatoes or horticultural crops. The actual level of risk will be assessable using the findings of the MAFF-funded project due to be completed in 1998. The results of the detailed study into the potential for pollution of groundwater from areas stocked with outdoor pigs are awaited with interest, and no specific recommendations in this respect can be made.

- **Manage stocking rates**

  Stocking rate can be used to reduce the build-up of surplus nitrogen during the stocking period.

- **Use Low-N feeds**

  The use of targetted feed compounds may reduce the amount of surplus nitrogen from a given number of pigs.

- **Maintain green cover**

  Green cover on stocked areas will help retain surplus nitrogen in the upper parts of the soil profile making it available for following crops. Pigs should not be stocked on land immediately following root and vegetable crops.

8. RECOMMENDATIONS

The authors of this report believe that in order to enhance its already good image, a responsible industry will want to minimize the risk to all water resources from outdoor pig production. It is recommended that any further work relating to risk to surface waters should assume that some risk is present from any area stocked with outdoor pigs, and that work on a set of recommendations to reduce the risk of acute erosion should be undertaken. This initial work should be followed by the preparation of a model to enable the risks to both surface and groundwater to be assessed for any proposed site for outdoor pig production, and measures put in place to reduce to an acceptable minimum any risks identified.

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1. Your Details

Date: ....

a) Name:	
b) Company:	

2. The Farm

a) Address: (Confidential to RAC)	
b) National Grid ref. of field(s):	

3. Pigs

a)	Approx date of introduction of pigs to field(s)					
b)	Approx. time in field(s)					
c)	Number of pigs in field(s)					
d)		25+ sows/ha (10+/acre)		**<u>OR</u>** Actual Stocking Rate		
	Stocking rate	18-25 sows/ha (7-10/acre)		"		
	(Tick <u>one</u> box only)	12-18 sows/ha (5-7/acre)		"		
		<12 sows/ha (<5/acre)		"		
e)	Stocking rate	Growers (/ha)		Fatteners (/ha)		
f)	Unit type	Mixed Unit		Dry sows only		
	(Tick boxes)	Individual farrowing pens		Growers/fatteners		

4. Vegetation

a) Previous crop	Grass	
(Tick one box only)	Cereals	
	Other combinable crops (please specify)	
	Potatoes	
	Sugar Beet	
	Set Aside	
	Others (please specify)	

Appendix 1

What was the vegetation when the field was first stocked:			
b) Inside Paddocks	Nil		
	Regenerated stubble		
	Undersown stubble		
	Grass		
	Other (please specify)		
c) Outside paddocks	Nil		
	Regenerated stubble		
	Undersown stubble		
	Grass		
	Other (please specify)		

d) Growing vegetation today - Please identify the proportion of the area that is green (range)

Service pens	100%...............:...............50%...............:...............0%
Dry sow pens	100%...............:...............50%...............:...............0%
Group farrowing	100%...............:...............50%...............:...............0%
Individual farrowing	100%...............:...............50%...............:...............0%
Growers	100%...............:...............50%...............:...............0%
Fatteners	100%...............:...............50%...............:...............0%
Outside paddocks	100%...............:...............50%...............:...............0%

e) Are the access tracks rutted? (Yes or No) ....

5. Soil Type

What is the predominant soil type of the field used for the pigs (please tick one box only):

sand		limestone		river gravel	
chalk		clay over limestone		river silts	
clay over chalk		other (please describe)			

6. Slope

Please estimate the predominant slope in the stocked area: **1 : ......**

Estimate the range:

	Flat			Flat	
	1:100			1:100	
From Minimum	1:50		**To Maximum**	1:50	
	1:20			1:20	
	1:10			1:10	

5. Drainage

Please identify the drainage characteristics in the areas where the pigs are kept:

a) General surface drainage - in an average year, on a year-round basis.	no ditches/watercourses immediately next to field		
	predominantly **wet** local ditch system		
	predominantly **dry** local ditch system		
	local river/stream (including winterbournes)		
b) proximity of stocked areas to watercourses	How near are the nearest **ditches** (to nearest 10 m)		m
	How near is the nearest **river/stream** (to nearest 10 m)		m
c) proximity of stocked areas to groundwater resource (if known)	How near is the nearest **spring** (to nearest 10 m)		m
	How near is the nearest **well** (to nearest 10 m)		m
	How near is the nearest **borehole** (to nearest 10 m)		m
d) Subsurface drainage (if known). Installation dates would also be useful.	Have the stocked areas been **underdrained**	(Yes/No)	
	Have the stocked areas been **moledrained**	(Yes/No)	
	Have the stocked areas been **subsoiled**	(Yes/No)	
e) Surface water	Is there any evidence of run-off from the unit	(Yes/No)	
	Is there any evidence of standing water (other than in wallows)	(Yes/No)	

1. Your Details

Date: ....

a) Name:	
b) Company:	

2. The Farm

a) Address (location of pigs): Confidential to RAC				
b) National Grid ref. of field(s):				
c) Short-term tenancy?	Yes		No	

3. Pigs

a)	Approximate number of sows in field(s)				
b) Stocking rate (Tick one box only)		25+ sows/ha (10+/acre)		**OR** Actual Stocking Rate	
		18-25 sows/ha (7-10/acre)			
		12-18 sows/ha (5-7/acre)			
		<12 sows/ha (<5/acre)			
c)	Stock Numbers	Growers 7-30 kg		Fatteners 30kg+	
d)	Unit type (Tick boxes)	Mixed Unit		Dry sows only	
		Individual farrowing pens		Growers/fatteners	

Vegetation

a) Previous crop *if known* (Tick one box only)	Grass	
	Cereals	
	Other combinable crops (please specify)	
	Potatoes	
	Sugar Beet	
	Set Aside	
	Others (please specify)	

Appendix 2

b) What was the vegetation when the field was first stocked *if known*: (tick box)		
	Nil	
	Regenerated stubble	
	Undersown stubble (grass)	
	Established Ley - two years +	
	Other (please specify)	

c) Growing vegetation today - Please identify the proportion of the area that is green (range)

Service pens	100%...........75%..........50%...............25%........10%........0%
Dry sow pens	100%...........75%..........50%...............25%........10%........0%
Group farrowing	100%...........75%..........50%...............25%........10%........0%
Individual farrowing	100%...........75%..........50%...............25%........10%........0%
Other (please specify)	
	100%...........75%..........50%...............25%........10%........0%
Outside paddocks	100%...........75%..........50%...............25%........10%........0%

d) Are the access tracks rutted?	Yes	No

e) How many years will the site be stocked?	1	2	3	3+

5. Soil Type

a) What is the predominant soil type of the field used for the pigs (please tick one box only):

sand		limestone		river gravel	
chalk		clay over limestone		river silts	
clay over chalk		other (please describe, loam etc.):			
clay-with-flints					

6. Slope

a) Please estimate the predominant slope in the stocked area 1 : ......

b) Estimate the range:

From Minimum			To Maximum		
	Flat			Flat	
	1:100			1:100	
	1:50			1:50	
	1:20			1:20	
	1:10			1:10	

7. Drainage

Please identify the drainage characteristics in the areas where the pigs are kept:

a) General surface drainage - in an average year, on a year-round basis. (tick one box)	no ditches/watercourses immediately next to field				
	predominantly **wet** local ditch system				
	predominantly **dry** local ditch system				
	local river/stream (including winterbournes)				
b) proximity of stocked areas to watercourses (if within 1,000 m)	How near are the nearest **ditches**	0m	10m	20m	50m+
	How near is the nearest **river/stream**	0m	10m	20m	50m+
	How near is the nearest **lake/pond**	0m	10m	20m	50m+
c) proximity of stocked areas to groundwater resource *(if known)*	How near is the nearest **spring**	0m	10m	20m	50m+
	How near is the nearest **well**	0m	10m	20m	50m+
	How near is the nearest **borehole**	0m	10m	20m	50m+
d) Subsurface drainage *(if known)*. Installation dates would also be useful.	Have the stocked areas been **underdrained**			Yes	No
	Have the stocked areas been **moledrained**			Yes	No
	Have the stocked areas been **subsoiled**			Yes	No
	Will the stocked area be **subsoiled**			Yes	No
e) Surface water	Is there any evidence of run-off from the unit			Yes	No
	Is there any evidence of standing water (other than in wallows)			Yes	No

Explanatory Notes
National Survey of Locations of Outdoor Pig Units in England and Wales

1. Your Details

a) & b) Name and Company are required in case of a query.

2. The Farm

a) **A location such as "*1 mile N of Little Badham*" will be sufficient.** The location of the field is necessary to avoid duplication of records in the survey. The large number of surveyors being used may lead to duplication. The information will also be used in the analysis of distribution of the national outdoor pig herd.

If a farm has more than one stocked area on which the site or stocking characteristics clearly differ, multiple forms should be used.

b) The Ordnance Survey's six-figure **National Grid Reference** should be used wherever possible, as explained on many maps and road atlases. Alternatively, please send a map clearly marking the units.

c) A **short-term** tenancy is where the pig farmer rents land from an arable farmer as part of a rotation. This tenancy is normally for one and not more than two years.

3. Pigs

a, b, & c) This section gives an indication of the **stocking practice** at the unit. Pig density should be for the whole field including trackways - 150 sows on 10 ha = 15 sows/ha (discounting boars and weaners).

d) The **type of unit** will show any potential for variation in stocking density.

4. Vegetation

a, & b) The **previous crop** and **vegetation when first stocked**, when taken with soil and stocking information, will enable current practices to be identified and potential future best practice to be planned.

c) **Growing vegetation today** will help identify current best/successful practice.

Guidance 4c) *This section should give an impression of the degree of grass cover in each section of the unit. 100% would be a well-established, undamaged permanent sward, 1-99% is based on your best estimate and 0% would be totally bare ground with no sign of vegetation.*

5. Soil Type

This will help identify the main **soil types** used in areas of the country. "Other" could be used for clays of East Anglia, moorland soils etc - please describe.

6. Slope

a) The **predominant slope** should be the impression given by the area as a whole.

b) The **range of slopes** should take account of plateaux and any banks that might be in the field.

Guidance 6 ***Estimates of slope can be very broad, for instance: 1:100 is barely perceptible over a short distance, 1:50 is noticeable when walking over the field, 1:20 would not have any noticeable effect on a moving vehicle and 1:10 may require a change of gear. Assess steeper slopes from driving knowledge.***

7. Drainage

a) A broad description of the **general surface drainage** characteristics in the immediate area of the farm.

a, b) **Wet** ditches would be in contact with any local water table, **dry** ditches may sometimes be wet during the winter because of land or surface drainage. A river or stream is any flowing waterbody.

b, c) If there are **no** features within 50 m of the site, ring **50 m+**.

d) **Guidance** *Underdrained land is drained permanently with clay or plastic pipes, **moledrainage** is carried out regularly in heavy soils to improve the performance of permanent drainage systems, and **subsoiling** is loosening carried out to relieve soil compaction.*

e) **Run-off** and **standing water** do not need to be present at the time of the survey. Signs of run-off include rills and sediment deposits in tractor ruts or off -field. Standing water might have left a cracked layer of silt.

Appendix 3

Reasons given for non-participation in the project.

"The company is no longer trading."

"The company has recently completed an internal questionnaire that placed a significant burden on the sales force and whilst we sympathise with the aims of the project, we would rather not impose a second questionnaire on our staff so soon after we have completed our own."

"We don't have any field staff."

"We feel that the aims of the project are not in the interests of our customers."

National Survey of Location of Outdoor Pig Units

1. **Your Details** **Date:** ....

a) Name:	
b) Company:	Environment Agency

2. The Farm

a) Address: (Confidential to RAC)	
b) National Grid ref. of field(s):	| | || | | || | | |

3. Vegetation

a) Growing vegetation today - Please identify the proportion of the area that is green (range)

Service pens	100%...........75%..........50%...............25%........10%........0%
Dry sow pens	100%...........75%..........50%...............25%........10%........0%
Farrowing	100%...........75%..........50%...............25%........10%........0%
Growers	100%...........75%..........50%...............25%........10%........0%
Fatteners	100%...........75%..........50%...............25%........10%........0%
Outside paddocks	100%...........75%..........50%...............25%........10%........0%

b) Are the access tracks rutted?	Yes	No

4. Slope

a) Please estimate the predominant slope in the stocked area: **1 : ......**

b) Estimate the range:

	Flat	☐		Flat	☐
	1:100	☐		1:100	☐
From Minimum	1:50	☐	**To Maximum**	1:50	☐
	1:20	☐		1:20	☐
	1:10	☐		1:10	☐

5. Drainage

Please identify the drainage characteristics in the areas where the pigs are kept:

a) General surface drainage - in an average year, on a year-round basis. (tick one box)	no ditches/watercourses immediately next to field				
	predominantly **wet** local ditch system				
	predominantly **dry** local ditch system				
	local river/stream (including winterbournes)				
b) proximity of stocked areas to watercourses (if within 500 m)	How near are the nearest **ditches**	0m	10m	20m	50m+
	How near is the nearest **river/stream**	0m	10m	20m	50m+
	How near is the nearest **lake/pond**	0m	10m	20m	50m+
e) Surface water	Is there any evidence of run-off from the unit			Yes	No
	Is there any evidence of standing water (other than in wallows)			Yes	No

Question	2c		3a	3b				3c		3d			
	Short Term		Number of sows	Stocking Rate				Stock Nos					
Number	yes	no		25+	18-25	12-18	<12	Growers	Fatteners	Mixed	Individual farrowing	Dry sows	Growers fatteners
477	1	0	180	1	0	0	0			1	1	0	0
488	0	1	102	1	0	0	0	270		1	0	0	1
487	0	1	330	1	0	0	0	1500	1500	1	0	0	1
729	1	0	600	0	1	0	0			0	0	1	0
731	0	1	110	1	0	0	0			*	0	*	0
730	0	1	250	0	1	0	0			1	0	0	0
306	1	0	60	1	0	0	0	100		1	0	0	1
308	0	1	280	0	1	0	0	480		1	1	0	1
305	1	0	250	0	1	0	0	800		1	0	0	1
307	0	1	120	0	1	0	0	320		1	0	0	1
311	0	1	250	0	1	0	0	871		1	0	0	1
781	0	1	220	0	0	1	0			1	1	0	0
783	1	0	600	0	1	0	0	1000		0	0	1	1
780	1	0	200	0	0	1	0	800		1	0	0	1
779	0	1	400	0	0	1	0			0	1	0	0
782	0	1	320	0	0	1	0		60	1	0	0	1
299	1	0	850	0	1	0	0	160		0	1	0	1
290	1	0	550	0	0	1	0			1	1	0	0
537	1	0	590	0	1	0	0			1	0	0	0
538	1	0	590	0	1	0	0			1	0	0	0
539	0	1	1230	0	1	0	0			1	0	0	0
541	1	0	680	0	1	0	0			1	0	0	0
542	1	0	750	1	0	0	0			1	1	0	0
543	0	1	500	*	*	*	*			1	1	0	0
544	1	0	500	0	1	0	0			1	1	0	0
548	0	1	625	0	1	0	0			1	0	0	0
547	1	0	800	0	1	0	0			1	1	0	0
546	1	0	380	0	1	0	0			1	1	0	0
545	1	0	280	0	1	0	0			1	1	0	0
774	0	1	230	0	1	0	0	520	1390	1	0	0	1
775	0	1	200	1	0	0	0			0	*	0	0
776	0	1	1500	0	1	0	0	3100	1500	1	1	0	1
777	0	1	350	1	0	0	0	800		1	0	0	1
778	0	1	300	0	1	0	0	900		1	0	0	1
598	0	1	300	0	1	0	0	1000		1	0	0	1
597	1	0	50	0	1	0	0	250		1	0	0	1
599	0	1	100	0	1	0	0	300	500	1	0	0	1
602	1	0	150	0	1	0	0			0	1	0	0
600	0	1	150	0	1	0	0	450		1	0	0	1
604	1	0	200	0	1	0	0			1	0	0	0
764	0	1	300	0	1	0	0	1000		1	1	0	1
767	1	0	1100	1	0	0	0			0	1	1	0
765	0	1	245	1	0	0	0	700		1	1	1	1
766	1	0	430	1	0	0	0			0	1	1	0
784	0	1	618	1	0	0	0	2183		1	0	0	1
786	0	1	580	0	1	0	0			0	0	1	0
785	0	1	750	0	1	0	0			0	0	0	0
787	0	1	250	0	1	0	0	1000		0	0	0	1
788	0	1	150	1	0	0	0			1	0	0	0
1	0	1	600	1	0	0	0			0	1	0	0
2	0	1	300	0	0	1	0	1000	750	1	0	0	1
645	1	0	900	0	1	0	0			1	0	0	0
646	1	0	650	1	0	0	0			1	1	0	0
647	1	0	1600	0	1	0	0			1	0	0	1
789	0	1	200	0	1	0	0			1	1	0	0
790	0	1	270	0	0	0	1			1	0	0	1
791	1	0	800	0	1	0	0			1	0	0	1
792	1	0	600	0	1	0	0			1	0	0	0
793	0	1	500	0	0	1	0			0	0	1	1
794	0	1	420	0	1	0	0			1	0	0	0
795	0	1	550	0	0	0	0			1	0	0	0
796	*	*	400	0	1	0	0			*	*	*	*
797	*	*	30	0	0	1	0			*	*	1	*
798	1	0	520	0	1	0	0			1	0	0	0
799	1	0	280	1	0	0	0			1	*	*	*
800	0	1	365	0	1	0	0	960		1	0	0	0
801	*	*	400	0	1	0	0			1	1	0	0
802	*	*		*	*	*	*			1	0	0	0

Question	4a							4b			
	Previous Vegetation							Vegetation when first stocked			
Number	Grass	Cereals	Combine	Potatoes	S. Beet	Set Aside	Others	Regen	U'sown	Ley	Other
477	1	0	0	0	0	0	0	0	0	1	0
488	1	0	0	0	0	0	0	0	0	1	0
487	0	1	0	0	0	0	0	1	0	0	0
729	0	1	0	0	0	0	0	1	0	0	0
731	0	0	0	1	0	0	0	1	0	0	0
730	0	1	0	0	0	0	0	0	1	0	0
306	0	0	0	0	0	1	0	1	0	0	0
308	0	0	0	0	0	1	0	0	0	1	0
305	0	1	0	0	0	0	0	1	0	0	0
307	0.5	0	0	0	0	0.5	0	0	1	0	0
311	1	0	0	0	0	0	0	0	0	1	0
781	0	1	0	0	0	0	0	0	1	0	0
783	0	1	0	0	0	0	0	1	0	0	0
780	1	0	0	0	0	0	0	0	0	1	0
779	0	1	0	0	0	0	0	1	0	0	
782	1	0	0	0	0	0	0	1	0	0	0
299	0	1	0	0	0	0	0	0.5	0.5	0	0
290	0	1	0	0	0	0	0	1	0	0	0
537	0	1	0	0	0	0	0	1	0	0	0
538	1	0	0	0	0	0	0	0	0	1	0
539	0	0.25	0.25	0.25	0	0	0.25	0.5	0	0.5	0
541	0	0	0	0	0	1	0	0	0	1	0
542	0	1	0	0	0	0	0	1	0	0	0
543	0	0	0	0	1	0	0	0	0	0	NIL
544	0	1	0	0	0	0	0	1	0	0	0
548	0	1	0	0	0	0	0	0	1	0	0
547	0	1	0	0	0	0	0	0	1	0	0
546	0	1	0	0	0	0	0	1	0	0	0
545	0	1	0	0	0	0	0	1	0	0	0
774	0	1	0	0	0	0	0	1	0	0	0
775	0	1	0	0	0	0	0	1	0	0	0
776	1	0	0	0	0	0	Herbage S	0	0	0	Herbage S
777	1	0	0	0	0	0	0	0	0	1	0
778	0	1	0	0	0	0	0	0	1	0	0
598	0	0	0	0	0	1	0	0	0	1	0
597	0	1	0	0	0	0	0	1	0	0	0
599	0	1	0	0	0	0	0	1	0	0	0
602	1	0	0	0	0	0	0	0	0	1	0
600	1	0	0	0	0	0	0	0	0	1	0
604	0	1	0	0	0	0	0	1	0	0	0
764	0	0	0	0	0	0	Stubble T	0	0	0	NIL
767	0	1	0	0	0	0	0	1	0	0	0
765	0	1	0	0	0	0	0	0	1	0	0
766	0	1	0	0	0	0	0	1	0	0	0
784	1	0	0	0	0	0	0	0	0	1	0
786	0	1	0	0	0	0	0	1	0	0	0
785	0	0	0	0	0	1	0	0	0	1	0
787	0	1	0	0	0	0	0	1	0	0	0
788	0	0	0	0	0	1	0	0	0	1	0
1	1	0	0	0	0	0	0	0	0	1	0
2	0	1	0	0	0	0	0	1	0	0	0
645	0	1	0	0	0	0	0	1	0	0	0
646	0	1	0	0	0	0	0	1	0	0	0
647	0	1	0	0	0	0	0	1	0	0	0
789	0	1	0	0	0	0	0	1	0	0	0
790	0	1	0	0	0	0	0	1	0	0	0
791	0	1	0	0	0	0	0	1	0	0	0
792	0	1	0	0	0	0	0	1	0	0	0
793	0	0	0	0	0	1	0	0	0	1	0
794	0	0	0	0	0	1	0	0	0	1	0
795	1	0	0	0	0	0	0	1	0	0	0
796	0	1	0	0	0	0	0	1	0	0	0
797	*	*	*	*	*	*	*	*	*	*	*
798	0	0	1	0	0	0	0	1	0	0	0
799	0	1	0	0	0	0	0	0	0	1	0
800	0	1	0	0	0	0	0	0	1	0	0
801	0	1	0	0	0	0	0	1	0	0	0
802	0	1	0	0	0	0	0	1	0	0	0

Question	4c						4d	4e			
	Growing vegetation							Years stocked			
Number	Service	Dry sows	Group	Individual Farrowing	Other	Outside	Rutted Access	1	2	3	3+
477	10	10	0	10	*	100	0	0	0	1	0
488	0	60	0	40	*	100	0	0	1	0	0
487	0	15	90	90	*	100	0	0	1	0	0
729	0	0	10	*	*	50	0	0	1	0	0
731	0	0	50	*	*	50	0	1	0	0	0
730	0	25	25	*	*	50	1	0	1	0	0
306	0	0	0	*	*	0	1	1	0	0	0
308	0	0	0	0	*	0	0	0	1	0	0
305	0	0	0	0	*	100	0	1	0	0	0
307	0	0	0	0	*	0	0	1	0	0	0
311	0	10	50	*	*	*	0	0	1	0	0
781	75	75	75	75	*	75	0	0	0	1	0
783	10	10	10	10	*	25	0	0	1	0	0
780	*	75	75	*	*	75	0	0	0	0	1
779	*	50	*	75	*	50	0	0	0	0	1
782	*	25	25	25	*	50	0	0	0	0	1
299	0	25	*	75	*	50	1	1	0	0	0
290	10	5	10	5	*	*	0	1	0	0	0
537	5	5	5	*	*	25	0	0	1	0	0
538	5	5	5	*	*	25	0	0	1	0	0
539	20	40	80	*	*	*	0	0	1	0	0
541	60	60	80	*	*	*	0	0	1	0	0
542	0	0	*	0	*	15	0	1	0	0	0
543	0	0	*	0	*	10	0	0	1	0	0
544	0	0	*	0	*	10	0	0	1	0	0
548	0	0	0	*	*	10	0	0	1	0	0
547	0	0	50	50	*	10	0	0	1	0	0
546	0	0	0	0	*	10	0	0	1	0	0
545	0	0	0	0	*	10	0	0	1	0	0
774	0	0	0	*	*	*	1	1	0	0	0
775	50	25	50	*	*	*	0	1	0	0	0
776	75	25	75	100	*	*	1	0	1	0	0
777	25	25	100	*	50	50	0	0	1	0	0
778	25	10	*	100	75	*	0	0	1	0	0
598	10	0	10	*	*	10	0	0	1	0	0
597	0	0	10	*	*	*	0	1	0	0	0
599	0	0	0	*	*	*	0	0	1	0	0
602	10	75	75	*	*	*	0	1	0	0	0
600	0	10	25	*	*	*	1	1	0	0	0
604	50	50	75	*	*	*	0	1	0	0	0
764	*	10	*	25	*	*	0	0	1	0	0
767	10	10	*	50	*	10	0	0	1	0	0
765	0	0	*	100	*	*	0	0	1	0	0
766	25	0	50	50	*	0	1	0	1	0	0
784	0	0	0	*	0	*	1	1	0	0	0
786	0	0	50	*	50	*	0	0	1	0	0
785	25	50	50	50	50	*	0	1	0	0	0
787	0	0	0	0	*	0	1	0	1	0	0
788	25	25	75	*	25	*	0	0	1	0	0
1	75	75	0	100	*	*	0	1	0	0	0
2	0	0	0	0	*	0	0	0	1	0	0
645	75	50	75	*	*	*	0	0	1	0	0
646	25	25	25	75	*	*	0	0	1	0	0
647	25	25	25	*	*	*	0	0	1	0	0
789	75	75	*	50	*	*	0	0	1	0	0
790	0	0	*	*	*	5	1	0	0	1	0
791	0	0	0	*	*	5	1	0	1	0	0
792	5	5	*	5	*	25	1	0	1	0	0
793	60	40	60	*	*	75	0	0	1	0	0
794	70	70	*	60	*	80	0	0	1	0	0
795	0	0	0	0	0	5	0	0	1	1	0
796	0	0	30	*	*	25	0	0	1	0	0
797	*	0	*	*	*	0	0	*	*	*	*
798	0	0	0	*	*	0	0	0	1	0	0
799	10	10	50	*	*	*	1	0	1	0	0
800	0	10	100	*	*	*	0	0	1	0	0
801	0	0	*	10	*	*	0	*	*	*	*
802	0	0	5	*	*	*	0	*	*	*	*

Question	5a								6			7a			
									Slope range			Drainage			
Number	sand	limestone	river gravel	chalk	clay over limestone	river silts	clay over chalk	clay with flints	1:	min	max	1	2	3	4
477	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
488	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
487	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
729	1	0	0	0	0	0	0	0	50	100	10	1	0	0	0
731	1	0	0	0	0	0	0	0	50	0	50	1	0	0	0
730	0	0	0	0	1	0	0	0	20	0	50	1	0	0	0
306	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
308	0	0	0	0	0	0	1	0	50	100	50	1	0	0	0
305	0	1	0	0	0	0	0	0	50	0	20	1	0	0	0
307	1	0	0	0	0	0	0	0	50	0	50	0	0	1	0
311	0	0	0	1	0	0	0	0	100	0	100	0	0	1	0
781	1	0	0	0	0	0	0	0	100	100	50	0	1	0	0
783	1	0	0	0	0	0	0	0	100	100	20	0	1	0	0
780	1	0	0	0	0	0	0	0	50	50	20	0	0	1	0
779	1	0	0	0	0	0	0	0	50	50	50	0	0	1	0
782	1	0	0	0	0	0	0	0	50	50	20	0	1	0	0
299	0	0	0	1	0	0	0	0	20	20	10	1	0	0	0
290	1	0	0	0	0	0	0	0	100	0	500	1	0	0	0
537	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
538	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
539	1	0	0	0	0	0	0	0	100	0	50	1	0	0	0
541	1	0	0	0	0	0	0	0	50	0	10	0	0	1	0
542	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
543	1	0	0	0	0	0	0	0	100	0	50	0	0	1	0
544	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
548	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
547	1	0	0	0	0	0	0	0	100	0	50	1	0	0	0
546	1	0	0	0	0	0	0	0	100	0	50	1	0	0	0
545	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
774	1	0	0	0	0	0	0	0	100	0	100	1	0	0	0
775	0	0	0	0	0	0	0	1	50	0	20	1	0	0	0
776	0	0	0	1	0	0	0	0	40	0	50	0	0	0	1
777	1	0	0	0	0	0	0	0	100	0	10	0	0	1	0
778	0	0	0	1	0	0	0	0	50	100	10	1	0	0	0
598	0	0	0	0	0	0	1	0	50	0	50	1	0	0	0
597	0	1	0	0	0	0	0	0	100	0	50	0	0	1	0
599	0	0	0	1	0	0	0	0	100	0	50	0	0	1	0
602	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
600	0	0	0	1	0	0	0	0	100	0	10	0	0	1	0
604	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
764	1	0	0	0	0	0	0	0	100	0	100	0	1	0	0
767	0	0	1	0	0	0	0	0	100	0	100	1	0	0	0
765	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
766	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
784	0	0	0	0	0	0	1	0	60	100	10	1	0	0	0
786	0	0	0	0	0	0	0	1	40	0	20	*	*	*	*
785	0	0	0	1	0	0	0	0	60	100	10	1	0	0	0
787	1	0	0	0	0	0	0	0	70	0	100	1	0	0	0
788	1	0	0	0	0	0	0	0	75	0	50	1	0	0	0
1	0	0	1	0	0	0	0	0		100	50	0	0	0	1
2	1	0	0	0	0	0	0	0		0	0	1	0	0	0
645	1	0	0	0	0	0	0	0		0	100	0	0	1	0
646	1	0	0	0	0	0	0	0		0	50	0	0	1	0
647	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
789	0	0	0	0	0	1	0	0	100	0	50	0	0	1	1
790	0	0	0	0	0	0	1	0	100	0	100	0	0	1	0
791	1	0	0	0	0	0	0	0	100	100	50	1	0	0	0
792	0	0	0	0	0	0	1	0	100	0	50	1	0	0	0
793	0	0	0	0	0	0	1	0	100	0	50	1	0	0	0
794	0	0	0	0	0	1	0	0	100	0	50	1	0	0	0
795	1	0	0	0	0	0	0	0	0	0	10	0	1	0	0
796	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
797	1	0	0	0	0	0	0	0	30	50	20	1	0	0	0
798	0	0	0	0	0	0	0	1	100	0	100	1	0	0	0
799	1	0	0	0	0	0	0	0	100	100	10	0	0	1	0
800	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
801	0	0	0	0	0	0	1	0		0	20	1	0	0	0
802	1	0	0	0	0	0	0	0	50	50	15	1	0	0	0

Question	7b											
	Surface Waters											
	ditches (m)				River/stream (m)				Lake/pond (m)			
Number	0	10	20	50+	0	10	20	50+	0	10	20	50+
477	0	0	0	1	0	0	1	0	0	0	0	1
488	0	0	0	1	0	0	0	1	0	0	0	1
487	0	1	0	0	0	1	0	0	0	0	0	1
729	0	0	0	1	0	0	0	1	0	0	0	1
731	0	0	0	1	0	0	0	1	0	0	0	1
730	0	0	0	1	0	0	0	1	0	0	0	1
306	0	0	0	1	0	0	0	1	0	0	0	1
308	0	0	0	1	0	0	0	1	0	0	0	1
305	0	0	0	1	0	0	0	1	0	0	0	1
307	0	1	0	0	0	0	0	1	0	0	0	1
311	0	0	0	1	0	0	0	1	0	0	0	1
781	0	0	1	0	0	0	0	1	0	0	0	1
783	0	0	0	1	0	0	0	1	0	0	0	1
780	0	0	0	1	0	0	0	1	0	0	0	1
779	0	0	0	1	0	0	0	1	0	0	0	1
782	0	0	1	0	0	0	0	1	0	0	0	1
299	0	0	0	1	0	0	0	1	0	0	0	1
290	0	0	0	1	0	0	0	1	0	0	0	1
537	0	0	0	1	0	0	0	1	0	0	0	1
538	0	0	1	0	0	0	0	1	0	0	0	1
539	0	0	0	1	0	0	0	1	0	0	0	1
541	0	0	0	1	0	0	0	1	0	0	0	1
542	0	0	0	1	0	0	0	1	0	0	0	1
543	0	0	0	1	0	0	0	1	0	0	0	1
544	0	0	0	1	0	0	0	1	0	0	0	1
548	0	0	0	1	0	0	0	1	0	0	0	1
547	0	0	0	1	0	0	0	1	0	0	0	1
546	0	0	0	1	0	0	0	1	0	0	0	1
545	0	0	0	1	0	0	0	1	0	0	0	1
774	0	0	0	1	0	0	0	1	0	0	0	1
775	0	0	0	1	0	0	0	1	0	0	0	1
776	0	0	1	0	0	0	1	0	0	0	0	1
777	1	0	0	0	0	0	0	1	0	0	0	1
778	0	0	0	1	0	0	0	1	0	0	0	1
598	0	0	0	1	0	0	0	1	0	0	0	1
597	0	0	0	1	0	0	0	1	0	0	0	1
599	0	0	0	1	0	0	0	1	0	0	0	1
602	0	1	0	0	0	0	0	1	0	0	0	1
600	0	0	0	1	0	0	0	1	0	0	0	1
604	0	0	0	1	0	0	0	1	0	0	0	1
764	0	0	1	0	0	0	0	1	0	0	0	1
767	0	0	0	1	0	0	0	1	0	0	0	1
765	0	0	0	1	0	0	0	1	0	0	0	1
766	0	0	1	0	0	0	0	1	0	0	0	1
784	0	0	0	1	0	0	0	1	0	0	0	1
786	0	0	0	1	0	0	0	1	0	0	0	1
785	0	0	0	1	0	0	0	1	0	0	0	1
787	0	0	0	1	0	0	0	1	0	0	0	1
788	0	0	0	1	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	1	0	0	0	1	0
2	0	0	0	1	0	0	0	1	0	0	0	1
645	0	0	0	1	0	0	0	1	0	0	0	1
646	0	0	0	1	0	0	0	1	0	0	0	1
647	0	0	0	1	0	0	0	1	0	0	0	1
789	1	0	0	0	0	0	0	1	0	0	0	1
790	0	0	1	0	0	0	0	1	0	0	0	1
791	0	0	0	1	0	0	0	1	0	0	0	1
792	0	0	0	1	0	0	0	1	0	0	0	1
793	0	0	0	1	0	0	0	1	0	0	0	1
794	0	0	0	1	0	0	0	1	0	0	0	1
795	0	1	0	0	0	0	0	1	0	0	0	1
796	0	0	0	1	0	0	0	1	0	0	0	1
797	0	0	0	1	0	0	0	1	0	0	0	1
798	0	0	0	1	0	0	0	1	0	0	0	1
799	0	0	1	0	0	0	0	1	0	0	0	1
800	1	0	0	0	0	0	0	1	0	0	1	0
801	0	0	0	1	0	0	0	1	0	0	0	1
802	0	0	0	1	0	0	0	1	0	0	0	1

Question	7c											
	Ground Water											
	spring (m)				well (m)				borehole (m)			
Number	0	10	20	50+	0	10	20	50+	0	10	20	50+
477	0	0	0	1	0	0	0	1	0	0	0	1
488	0	0	0	1	0	0	0	1	0	0	0	1
487	0	0	0	1	0	0	0	1	0	0	0	1
729	0	0	0	1	0	0	0	1	0	0	0	1
731	0	0	0	1	0	0	0	1	0	0	0	1
730	0	0	0	1	0	0	0	1	0	0	0	1
306	0	0	0	1	0	0	0	1	0	0	0	1
308	0	0	0	1	0	0	0	1	0	0	0	1
305	0	0	0	1	0	0	0	1	0	1	0	0
307	0	0	0	1	0	0	0	1	0	0	0	1
311	0	0	0	1	0	0	0	1	0	0	0	1
781	0	0	1	0	0	0	0	1	0	0	1	0
783	0	0	0	1	0	0	1	0	0	0	1	0
780	0	0	1	0	0	0	0	1	0	0	1	0
779	0	0	0	1	0	0	0	1	0	0	0	1
782	0	0	0	1	0	0	0	1	0	0	0	1
299	0	0	0	1	0	0	0	1	0	0	0	1
290	0	0	0	1	0	0	0	1	0	0	1	0
537	0	0	0	1	0	0	0	1	0	0	0	1
538	0	0	0	1	0	0	0	1	0	0	0	1
539	0	0	0	1	0	0	0	1	0	0	0	1
541	0	0	0	1	0	0	0	1	0	0	1	0
542	0	0	0	1	0	0	0	1	0	0	0	1
543	0	0	0	1	0	0	0	1	0	0	0	1
544	0	0	0	1	0	0	0	1	0	0	1	0
548	0	0	0	1	0	0	0	1	0	1	0	0
547	0	0	0	1	0	0	0	1	0	0	0	1
546	0	0	0	1	0	0	0	1	0	0	0	1
545	0	0	0	1	0	0	0	1	0	0	0	1
774	0	0	0	1	0	0	0	1	0	0	0	1
775	0	0	0	1	0	0	0	1	0	0	0	1
776	0	0	0	1	0	0	0	1	0	0	0	1
777	0	0	0	1	0	0	0	1	0	0	0	1
778	0	0	0	1	0	0	0	1	0	0	0	1
598	0	0	0	1	0	0	0	1	0	0	0	1
597	0	0	0	1	0	0	0	1	0	0	0	1
599	0	0	0	1	0	0	0	1	0	0	0	1
602	0	0	0	1	0	0	0	1	0	0	0	1
600	0	0	0	1	0	0	1	0	0	0	0	1
604	0	0	0	1	0	0	0	1	0	0	0	1
764	0	0	0	1	0	0	0	1	0	0	0	1
767	0	0	0	1	0	0	0	1	0	0	0	1
765	0	0	0	1	0	0	0	1	0	0	0	1
766	0	0	0	1	0	0	0	1	0	0	0	1
784	0	0	0	1	0	0	0	1	0	0	0	1
786	0	0	0	1	0	0	0	1	0	0	0	1
785	0	0	0	1	0	0	0	1	0	0	0	1
787	0	0	0	1	0	0	0	1	0	0	0	1
788	0	0	0	1	0	0	0	1	0	0	0	1
1	0	0	0	1	0	0	0	1	0	0	0	1
2	0	0	0	1	0	0	0	1	0	0	0	1
645	0	0	0	1	0	0	0	1	0	0	0	1
646	0	0	0	1	0	0	0	1	0	0	0	1
647	0	0	0	1	0	0	0	1	0	0	0	1
789	0	0	0	1	0	0	0	1	0	0	0	1
790	0	0	0	1	0	0	0	1	0	0	0	1
791	0	0	0	1	0	0	0	1	0	0	0	1
792	0	0	0	1	0	0	0	1	0	0	0	1
793	0	0	0	1	0	0	0	1	0	0	0	1
794	0	0	0	1	0	0	0	1	0	0	0	1
795	0	0	0	1	0	0	0	1	0	0	0	1
796	0	0	0	1	0	0	0	1	0	0	0	1
797	0	0	0	1	0	0	0	1	0	0	0	1
798	0	0	0	1	0	0	0	1	0	0	0	1
799	0	0	0	1	0	0	0	1	0	0	0	1
800	0	0	0	1	0	0	0	1	0	0	0	1
801	0	0	0	1	0	0	0	1	0	0	0	1
802	0	0	0	1	0	0	0	1	0	0	0	1

Question	7d								7e			
	Subsurface drainage								Surface water			
	underdrained		moledrained		subsoiled (past)		subsoiled (future)		Run-off		standing water	
Number	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no
477	1	0	0	1	0	1	1	0	0	1	0	1
488	0	1	0	1	0	1	1	0	0	1	0	1
487	0	1	0	1	1	0	1	0	0	1	0	1
729	0	1	0	1	0	1	0	1	0	1	0	1
731	0	1	0	1	1	0	0	1	0	1	0	1
730	0	1	0	1	0	1	0	1	0	1	0	1
306	0	1	0	1	0	1	0	1	0	1	0	1
308	0	1	0	1	0	1	1	0	1	0	0	1
305	0	1	0	1	0	1	1	0	0	1	0	1
307	0	1	0	1	0	1	1	0	1	0	1	0
311	0	1	0	1	0	1	0	1	0	1	0	1
781	1	0	0	1	1	0	0	1	1	0	0	1
783	0	1	0	1	1	0	0	1	1	0	0	1
780	1	0	0	1	0	1	1	0	1	0	0	1
779	0	1	0	1	1	0	0	1	1	0	0	1
782	0	1	0	1	1	0	1	0	0	1	0	1
299	1	0	0	1	1	0	0	1	0	1	0	1
290	0	1	0	1	1	0	1	0	0	1	0	1
537	0	1	0	1	1	0	1	0	0	1	0	1
538	0	1	0	1	0	1	1	0	0	1	0	1
539	0	1	0	1	1	0	1	0	0	1	0	1
541	0	1	0	1	1	0	1	0	1	0	0	1
542	0	1	0	1	1	0	1	0	0	1	1	0
543	0	1	0	1	0	1	1	0	1	0	1	0
544	0	1	0	1	1	0	1	0	0	1	1	0
548	0	1	0	1	0	1	0	1	0	1	0	1
547	0	1	0	1	0	1	1	1	0	1	0	1
546	0	1	0	1	1	0	1	0	1	0	0	1
545	0	1	0	1	0	1	0	*	0	1	0	1
774	1	0	0	1	1	0	1	0	0	1	0	1
775	0	1	0	1	1	0	1	0	1	0	0	1
776	0	1	0	1	0	1	0	1	0	1	1	0
777	0	1	0	1	0	1	0	1	0	1	1	0
778	0	1	0	1	1	0	1	0	1	0	1	0
598	0	1	0	1	1	0	0	1	0	1	0	1
597	0	1	0	1	0	1	0	1	0	1	0	1
599	0	1	0	1	1	0	1	0	0	1	0	1
602	0	1	0	1	0	1	0	1	0	1	0	1
600	0	1	0	1	0	1	1	0	0	1	0	1
604	0	1	0	1	0	1	0	1	1	0	0	1
764	1	0	0	1	1	0	1	0	1	0	1	0
767	0	1	0	1	0	1	0	1	0	1	1	0
765	0	1	0	1	1	0	1	0	0	1	0	1
766	1	0	0	1	1	0	1	0	0	1	1	0
784	0	1	0	1	1	0	1	0	1	0	1	0
786	0	1	0	1	0	1	0	1	1	0	0	1
785	0	1	0	1	1	0	0	1	0	1	0	1
787	0	1	1	0	0	1	0	1	1	0	0	1
788	0	1	0	1	1	0	0	1	0	1	0	1
1	0	1	0	1	1	0	1	0	0	1	1	0
2	0	1	0	1	1	0	1	0	0	1	0	1
645	*	*	*	*	*	*	*	*	0	1	0	1
646	*	*	*	*	*	*	*	*	0	1	0	1
647	*	*	*	*	*	*	*	*	0	1	0	1
789	1	0	1	0	0	1	1	0	0	1	0	1
790	0	1	0	1	0	1	1	0	1	0	1	0
791	*	*	*	*	*	*	*	*	1	0	1	0
792	*	*	*	*	*	*	*	*	1	0	1	0
793	*	*	*	*	*	*	*	*	0	1	0	1
794	*	*	*	*	*	*	*	*	0	1	0	1
795	0	1	0	1	0	1	0	1	0	1	1	0
796	*	*	*	*	*	*	*	*	0	1	1	0
797	*	*	*	*	*	*	*	*	0	1	0	1
798	0	1	0	1	0	1	0	1	1	0	1	0
799	0	1	0	1	1	0	0	1	1	0	0	1
800	1	0	0	1	1	0	1	0	0	1	0	1
801	0	1	*	*	*	*	*	*	0	1	1	0
802	0	1	*	*	*	*	*	*	0	1	1	0

Question Number	Rainfall M5 60 min	M5 24 hr	WRAP Class	10k2 AAR	Erosion Risk	Soil Association	Description	County
477	18.5	40.7	4	640	1'	561b	Typical brown alluvial soil	Yorks N
488	18.4	42.3	4	640	1'	561b	Typical brown alluvial soil	Yorks N
487	18.6	40.9	2	686	7*	541r	Typical brownearth	Yorks N
729	19.8	43.6	1	734	13*	551b	Typical brown sand	Notts
731	18.8	40.8	2	584	13*–	551d	Typical brown sand	Yorks S
730	19.2	42.2	1	620	4	343c	Brown rendzina	Lincs
306	19.5		1	870	4	572j	Stagnogleyic argillic brownearth	Dorset
308	19	45.2	1	821	5+ – 4	571g	Typical argillic brownearth	Wilts
305	19.3	51.1	4	996	7	343a	Brown rendzina	Wilts
307	19.7	46.9	1	781	7	571h	Typical argillic brownearth	Wilts
311	19.4		1	893	7+	343h	Brown rendzina	Dorset
781	20.7	49.3	1	950	13*	551a	Typical brown sand	Devon
783	20.8	49.5	1	899	10–	541b	Typical brownearth	Devon
780	19	46.6	1	918	7	572c	Stagnogleyic argillic brownearth	Somerset
779	20.7	48.6	1	836	4	572f	Stagnogleyic argillic brownearth	Devon
782	20	47.6	1	941	13*	551a	Typical brown sand	Devon
299	19.8	43.0	1	699	7*	343g	Brown rendzina	Norfolk
290	20.5	42.0	1	590	5	343f	Brown rendzina	Norfolk
537	20.6	42.6	1	579	2+	521+	Typical brown calcareous sand	Suffolk
538	20	41.0	1	591	7	511e	Typical brown calcareous earth	Suffolk
539	18.9	41.6	1	600	7*	551g	Typical brown sand	Suffolk
541	20.9	43.3	1	590	2+	521+	Typical brown calcareous sand	Suffolk
542	20.2	41.4	1	622	5	343f	Brown rendzina	Norfolk
543	19.6	43.1	3	690	7*	551g	Typical brown sand	Norfolk
544	18.8	39.5	1	634	5–	861b	Typical humic sandy gley soil	Norfolk
548	19.8	43.0	1	600	10*	551e	Typical brown sand	Suffolk
547	20	44.0	1	720	7*	551g	Typical brown sand	Norfolk
546	20.3	42.2	3	589	4	572n	Stagnogleyic argillic brownearth	Norfolk
545	18.5	40.7	1	590	10*	551e	Typical brown sand	Suffolk
774	20	47.6	1	770	7+	343h	Brown rendzina	Wilts
775	19.4	53.4	1	959	1	581d	Typical palaeo–argillic brownearth	Dorset
776	19.8	52.5	4	870	1	641b	Typical gley podzol	Hants
777	18.9	45.7	1	820	1	641b	Typical gley podzol	Hants
778	19	44.7	1	771	7+	343h	Brown rendzina	Wilts
598	19	45.2	1	821	7+	343h	Brown rendzina	Wilts
597	20.2	48.9	1	970	7	343b	Brown rendzina	Somerset
599	17.5	48.1	1	933	4	343i	Brown rendzina	Dorset
602	19.3	41.1	2	690	1+	643a	Stagno–gley podzol	Wilts
600	19.4	51.4	1	959	7+	343h	Brown rendzina	Dorset
604	19.4	51.4	1	930	7+	343h	Brown rendzina	Dorset
764	18.6	41.9	2	634	11	552a	Gleyic brown sand	Yorks N
767	17.9	42.6	4	689	7*	541r	Typical brownearth	Yorks N
765	18.7	41.1	2	634	11	552a	Gleyic brown sand	Yorks N
766	18.5	42.6	2	745	7*	541r	Typical brownearth	Yorks N
784	20	47.0	1	823	1	581d	Typical palaeo–argillic brownearth	Hants
786	19.9	47.4	1	750	4	582c	Stagnogleyic palaeo–argillic brown earth	Berks
785	19.8	46.5	2	791	1	581b	Typical palaeo–argillic brownearth	Hants
787	18.9	41.6	1	640	13*	551a	Typical brown sand	Salop
788	18.7	43.0	1	701	13*	551a	Typical brown sand	Salop
1	18.6	40.9	1	803	10–	541b	Typical brownearth	Salop
2	18.9	41.6	1	640	13*	551a	Typical brown sand	Salop
645	19	41.2	1	563	7*	551g	Typical brown sand	Suffolk
646	18.4	39.2	1	591	10*	551e	Typical brown sand	Suffolk
647	20.5	42.4	1	589	5–	861b	Typical humic sandy gley soil	Suffolk
789	20		3	700	4	343c	Brown rendzina	Oxford
790	19.8		1	690	1	411a	Typical calcareous pelosol	Oxford
791	20.5		4	642	7	343a	Brown rendzina	Oxford
792	19.9		1	644	7	511g	Typical brown calcareous earth	Oxford
793	19.8		1	656	7	511g	Typical brown calcareous earth	Oxford
794	19.7		2	594	5	571u	Typical argillic brownearth	Oxford
795	19.8		4	644	10*	554a	Argillic brown sands	Oxford
796	18.6		1	735	13*–	551d	Typical brown sand	Salop
797	18.7		1	710	1+	711b	Typical stagnogley soil	Salop
798	20.1		1	800	7+	343h	Brown rendzina	Bucks
799	19.8		3	587	7	571o	Typical argillic brownearth	Suffolk
800	18.7		1	697	7	343b	Brown rendzina	N Yorks
801	18.9		1	930	4+	511f	Typical brown calcareous earths	Devon
802	20.3		1	899	10–	541b	Typical brown earths	Devon

Estimated total numbers of outdoor pig herds and of breeding sows, rearing and feeding pigs, by English county and Wales, 1 February 1996
Data from the National Survey of Pig Production Systems, 1 February 1996, University of Exeter Agricultural Economics Unit

COUNTY		O.D.Herds	NO. OF OUTDOOR BREEDING SOWS/SERVED GILTS		NO. OF OUTDOOR REARING/FINISHING PIGS	
			In farrowing accommodation	In dry sow accommodation	Rearing	Feeding
Bedfordshire	1	7	216	1023	134	0
Berkshire	2	14	1412	4580	5720	0
Buckinghamshire	3	1...4	0	0	703	1132
Cleveland	4	1...4	0	342	0	0
Cambridgeshire	5	1...4	43	200	501	0
Cheshire	6	11	120	715	54	0
Cornwall	7	15	83	507	0	0
Cumbria	8	0				
Derbyshire	9	1...4	0	41	0	0
Devon	10	51	2075	4445	5093	572
Dorset	11	26	1638	4886	4866	194
Durham	12	6	160	366	0	0
Essex	13	8	91	315	151	39
Gloucestershire	14	11	282	1146	1127	0
Hampshire	15	29	2035	8033	6647	366
Isle of Wight	16	1...4	59	407	1247	0
Worcester	17	10	161	269	569	21
Hertfordshire	18	1...4	78	612	1667	0
Kent	20	7	131	0	94	58
Lancashire	21	1...4	0	46	205	0
Leicestershire	22	1...4	12	33	20	0
Lincolnshire	24	19	767	3800	4135	1938
Merseyside	25	0				
Greater London	26 & 27	1...4	0	40	0	0
Norfolk	28	76	9632	16443	45949	1604
Northamptonshire	29	1...4	260	1230	1674	0
Tyne & Wear	30	0				
Northumberland	31	7	384	2325	2575	0
Nottinghamshire	32	10	483	2616	4828	9
Oxfordshire	33	33	2553	8883	9302	93
Avon	34	1...4	24	70	0	0
Shropshire	35	26	476	2459	1971	0
Somerset	36	15	661	2637	991	0
Staffordshire	37	7	119	657	351	0
Suffolk	38	42	4346	10971	19280	434
Scilly Isles	39	0				
Surrey	40	1...4	22	94	218	0
Sussex W & E	41 & 42	5	503	4013	17458	0
Warwickshire	43	6	144	79	0	0
Greater Manchester	44	0				
Wiltshire	45	25	1454	7981	5329	173
West Midlands	46	0				
S Yorkshire	47	1...4	0	6	0	0
N Yorkshire	48 & 50	71	2526	8611	17975	385
W Yorkshire	49	6	12	558	457	0
Humberside	51	32	2111	5260	16849	911
Wales	52 – 60	12	0	244	54	43
TOTAL		624	35073	107146	179093	7970

NOTES
Herd numbers greater than 0 and less than 5 expressed as "1...4" to protect confidentiality
Total number of herds undertaking the full breeding cycle outdoors approx. 400, average herd size (all sows) 375
See The Structure of Pig Production in England and Wales, University of Exeter Agricultural Economics Unit, June 1996 for more information on herd sizes, definition of terms, raising of data, etc.

This table specifically produced for Reading Agricultural Consultants, 28 November 1996

Question							
	Risk Assessment						
Number	Soil/ Slope	Vegetation /Slope	Stocking Rate	Proximity to Watercourse	Rainfall	Total Score	Location
307	34	54	50	60	75	273	Wilts
782	60	37	35	40	100	272	Devon
802	46	54	50	10	100	260	Devon
784	10	54	65	15	100	244	Hants
299	48	53	65	15	50	231	Norfolk
729	60	54	50	10	50	224	Notts
305	34	54	50	10	75	223	Wilts
598	34	54	50	10	75	223	Wilts
777	4	21	47	70	75	217	Hants
308	22	54	50	10	75	211	Wilts
778	34	37	50	10	75	206	Wilts
783	31	35	35	5	100	206	Devon
775	10	37	65	10	75	197	Dorset
781	40	5	22	30	100	197	Devon
597	22	32	35	5	100	194	Somerset
1	31	5	47	30	75	188	Salop
785	10	37	50	15	75	187	Hants
779	22	10	35	10	100	177	Devon
786	22	37	50	15	50	174	Berks
789	13	5	35	70	50	173	Oxford
731	60	37	65	10	0	172	Yorks S
600	22	32	35	5	75	169	Dorset
774	22	32	35	5	75	169	Wilts
798	22	32	35	5	75	169	Bucks
780	34	10	35	10	75	164	Somerset
788	40	21	47	5	50	163	Salop
599	13	32	35	5	75	160	Dorset
311	22	21	35	5	75	158	Dorset
541	10	37	50	10	50	157	Suffolk
543	22	32	47	5	50	156	Norfolk
776	10	10	50	10	75	155	Hants
801	13	32	35	0	75	155	Devon
797	1	54	35	10	50	150	Salop
767	22	21	47	5	50	145	Yorks N
800	10	5	20	60	50	145	N Yorks
791	22	32	35	5	50	144	Oxford
546	13	35	35	5	50	138	Norfolk
547	22	21	35	5	50	133	Norfolk
487	10	0	30	40	50	130	Yorks N
790	4	32	10	30	50	126	Oxford
290	13	32	22	5	50	122	Norfolk
306	5	10	30	0	75	120	Dorset
799	22	21	47	30	0	120	Suffolk
730	22	37	50	10	0	119	Lincs
764	31	21	35	30	0	117	Yorks N
602	1	5	20	40	50	116	Wilts
766	10	5	30	20	50	115	Yorks N
787	40	32	35	5	0	112	Salop
604	10	0	20	0	75	105	Dorset
646	31	21	47	5	0	104	Suffolk
793	22	5	22	5	50	104	Oxford
796	20	10	20	0	50	100	Salop
542	5	10	30	0	50	95	Norfolk
792	22	32	35	5	0	94	Oxford
538	10	10	20	0	50	90	Suffolk
795	15	10	20	40	0	85	Oxford
539	22	21	35	5	0	83	Suffolk
537	1	10	20	0	50	81	Suffolk
647	5	5	20	0	50	80	Suffolk
645	22	5	35	5	0	67	Suffolk
794	13	5	35	5	0	58	Oxford
765	15	10	30	0	0	55	Yorks N
545	15	10	20	0	0	45	Suffolk
548	15	10	20	0	0	45	Suffolk
2	20	10	10	0	0	40	Salop
477	1	5	30	0	0	36	Yorks N
544	5	10	20	0	0	35	Norfolk
488	0	0	30	0	0	30	Yorks N
Maximum	60	54	65	70	100	273	
Average	20.5	23.8	36.4	13.2	48.9	142.8	
Minimum	0	0	10	0	0	30	