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Annex 33a-UK

Secondary measures for the protection of groundwater – Summary Report

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ANNEX 33a – UK

Water Resources Management in Cooperation with Agriculture

SECONDARY MEASURES FOR THE PROTECTION OF GROUNDWATER

SUMMARY REPORT

Report Ref. No. 08/WR/26/5

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1 Introduction

This Report is a summary of the Main Report into Secondary Measures for the Protection of Groundwater. The document considers the groundwater and nitrate issue in the national context and the requirements of the EU's Drinking Water Directive and Nitrates Directive (91/676EEC), followed by a brief discussion of the Water Resources Management in Cooperation with Agriculture (WAgriCo) Project. After a brief overview of the WAgriCo project in Dorset, the selection methodology of the farmers with whom measures were discussed in Part 2, On-farm Interview and Part 3, Postal Survey is described.

Potential secondary measures that would contribute to the reduction of nitrate entering the 'water chain' and groundwater aquifers, are presented and described, and the schemes and implementation arrangements outlined. Potential benefits are estimated, potential implications and risks described.

Following from Part 1 desk-based review, farmer views and opinions from Part 2 On-farm Interviews are then presented, divided into farmer categories where appropriate. These are collated with results from Part 3, Postal Survey that completed the active investigation phase. Discussion and conclusions from Parts 1, 2 and 3, and from a WAgriCo Workshop follow and recommendations are presented.

Two Maps enable both the priority river and groundwater catchments to be viewed in relation to current priority areas for agri-environment schemes.

2 Background

With some one-third of the public water supply in UK derived from groundwater abstraction, high quality groundwater is of strategic importance to the UK water industry and general public.

Sources of nitrogen in water systems include agriculture, point sources such as sewage treatment works and industrial discharge, atmospheric deposition, and nitrate leached from non-agricultural land such as woodland and rough grazing land. Nitrate losses from non-agricultural but vegetated land such as mountains, forests, and amenity land are typically smaller than those from agricultural land, since farming systems apply additional nitrogen to promote crop growth and increase food and other crop production. Losses from agricultural land are estimated to account for 61% of the nitrogen which enters surface waters in England and Wales, although smaller (59%) for England alone (Hunt *et al.*, 2004). The dominant source of nitrate from other sources is sewage effluent (32%) followed by non-agricultural land and industry. The relative contribution of agriculture is greater in the more rural regions than in densely populated areas.

Plants cannot take up atmospheric nitrogen directly, but take up ammonia and nitrate which are highly water soluble when added to soil as fertiliser. The most used nitrogen fertilisers are ammonium nitrate (27% or 34.5% N), urea (±46% N) as granules or prills, and liquid nitrogen (28% N).

2.1 WAgriCo and farmer interactions

The Project is collaborative with partnerships in both Germany and UK, the latter including: ADAS UK Ltd; Environment Agency; National Farmers Union; UK Water Industry Research Ltd, and Wessex Water Services Ltd. The Project is part-funded by EU Life, Defra and by the German and UK partners. WAgriCo aims to develop appropriate best agricultural practices that can be implemented to minimise diffuse water pollution. All references to WAgriCo in this document relate to WAgriCo in the UK.

Launched in October 2005 for a 3-year period, WAgriCo aims to develop a programme of measures or solutions that can be implemented to achieve and/or sustain good quality groundwater, particularly

regarding nitrate levels derived from agricultural land use. WAgriCo identified 6 Primary Measures for increasing the efficiency of organic and inorganic fertiliser use and, in certain groundwater catchment areas in Dorset. WAgriCo's 6 Primary Measures are:

a) adoption of appropriate inorganic fertiliser recommendations;

b) enhanced manure management plans;

c) establishment of cover crop either post-harvest or by undersowing;

d) calibration of fertiliser spreader;

e) shifting from Autumn to Spring application of organic fertilisers, and;

f) use of a nitrogen (N) efficiency calculation to determine nitrogen surpluses and payment increase in nutrient efficiency, hence leading to more efficient balancing of N applications with each farming situation.

2.2 Project Area

WAgriCo is centred on the Rivers Frome, Piddle and Wey catchments in Dorset (Map 1). Landform, soils and landuse are described in the Main Report. The 3 river catchment areas together comprise some 433 km^2 or 17% of Dorset's land area of 2,542 km^2, with the River Frome at 254 km^2 or 10%, representing the largest proportion.

Within these river catchment areas are 6 groundwater catchments, as demarcated by WAgriCo covering an estimated 166 km^2 (Map 2), of boreholes from which public water supplies are derived. It is upon these groundwater catchment areas that the WAgriCo programme is focussed. This groundwater is at risk of exceeding the 50 mg/l nitrate maximum. Given that there is currently no nitrate removal capability in place at the distribution plants of these boreholes, if put into supply in its current form then this water could be non-compliant with the EU Drinking Water Directive at certain times of the year. In Dorset, all public water supplies are obtained from groundwater.

3 Methodology

In order to achieve the programmed objectives of the Review, the investigation was divided into 3 Parts, each of which followed on from and built on the results of the previous Part. The main focus of the Review is Secondary Measures that might benefit groundwater quality.

3.1 Part 1: Document review

The research into Secondary Measures in Part 1 included the identification of:

a) existing schemes in which farmers receive payment for voluntary measures;

b) other water protection measures that are not presently existing, but could be incorporated into voluntary schemes; and,

c) any water protection measures that are being undertaken or planned to be undertaken within the conservation designated sites within the river catchments.

Part 1 was largely investigative, involving telephone and to a lesser extent face-to-face discussions with those involved in administering, planning and implementing projects and schemes that might influence land management to the benefit of water quantity and quality. A list of those contacted and their organisations and projects is presented in the Main Report, Appendix 1.

3.2 Part 2: On-farm Interviews

Based upon the findings of Part 1 investigations, a Questionnaire was developed for On-farm Interviews. Twenty farmers within the 3 catchment areas agreed to be interviewed on-farm.

Those interviewed covered a full geographical range, encompassing arable, dairy, beef, sheep, pig and poultry production. Of these participants, 8 were located within the groundwater catchment areas of the boreholes (Map 2), and had participated in WAgriCo's on-farm support for Primary Measures, whilst the remaining 12 were elsewhere within the 3 target river catchments (Map 1). Participants encompassed a wide range of farmer age, capital constraints, farm enterprises, farm size and resistance to change, as to be at least indicative of the farmer population as a whole. Full detail of the On-Farm Interview process, payments to interviewees, size of unit, enterprises, stocking density, farm staff, and farmer age and training are presented in the Main Report, Section 4, including Table 8, with farmers' recorded quotations in the Main Report, Appendix 5.

3.3 Part 3: Postal Survey

Based on the results from the Part 2 face-to-face On-farm Interviews described above, a second Questionnaire was developed for postal distribution to some 260 farmers within the 3 river catchments with the target of receiving 50 or more responses. This Questionnaire is presented in Main Report, Appendix 4 with farmers' written quotations in Appendix 7. A total of 62 completed questionnaires were received. Details of the Postal Survey process, size of farm units and enterprises are presented in Main Report, Section 6.

4 Results, Part 1: Document review

Schemes are described, first the Defra-supported agri-environment and other schemes, followed by those schemes and projects implemented by business and non-profit making organisations. Within each scheme description, a list is presented of options that might impact water quality and quantity.

Much of Dorset, including the bulk of the 3 WAgriCo priority river and 6 groundwater catchment areas are within the Nitrate Vulnerable Zones (NVZ) that currently cover some 55% of England. However, NVZs are not considered within the remit of this Review.

4.1 Regulations and Government-supported schemes

4.1.1 Cross Compliance under Single Payment Scheme

Farmers currently receive financial support through the Single Payment Scheme (SPS) on the condition that they conform to certain management standards under Cross Compliance (XC). XC measures are considered below as to their impact upon water quality.

There are three elements of XC:

a) specific European legal requirements, Statutory Management Requirements (SMRs);

b) domestic legal requirements requiring that land is maintained in Good Agricultural and Environmental Condition (GAEC); and,

c) a requirement for each Member State, but not individual farmers, to maintain a minimum level of permanent pasture not to be included in the crop rotation for 5 years or more.

The main XC requirements that relate to this Review's investigation are presented in Table 1. Together with GAECs, SMRs must be conformed to under XC by those that claim payments under the SPS; the large majority of commercial farmers.

Review of XC for current and future water quality measures. Compliance with the 9 GAECs listed below has a positive beneficial effect on groundwater quality and quantity, by restricting the area of land to which fertiliser is applied (GAECs 5, 12, 14), but also regulates the use of fertiliser (GAEC 5) on old pasture. Measures designed specifically to minimise water run-off and soil erosion also enhance the potential for water percolation into the soil profile (GAEC 2, 3, 4, 9), hence the quantity of groundwater. In addition, GAECs 2, 3 and 12 are designed to increase soil organic matter content, which enables the soil C:N ratio to increase, thus reducing nitrogen levels in soil solution. Overall, XC Measures under GAEC provide a positive effect on groundwater quality and the potential for leaching of nitrates.

Table 1 Cross Compliance: GAEC Measures directly influencing groundwater quality

GAEC No.	Cross Compliance requirements	Description and Conditions
1	Soil Protection Review	Develop, implement and annually update the measures to maintain soil structure & organic matter and prevent erosion.
2	Post-harvest management of Land	From Day 1 after harvest of a combinable crop until end-Feb, one of following: over-wintered stubble; rough soil surfaces created, temporary cover crop established, or; sown with crop within 10 days of seedbed preparation
3	Waterlogged soil	Restriction on use of motorised vehicle on waterlogged soil, except under certain conditions.
4	Crop residue burning restrictions	Must not burn cereal straw or stubble, residues of oilseed rape, field beans or peas harvested dry.
5	Environmental Impact Assessment (EIA)	By cultivation or fertiliser application, must not increase productivity of any land uncultivated in last 15 years or that is semi-natural.
6	Sites of Special Scientific Interest	Notify Natural England (NE) of any measure likely to damage special interest features, comply with all NE management orders, and do not destroy/damage special interest features.
9	Overgrazing & unsuitable supplementary feeding	Must not overgraze the natural and semi-natural vegetation or carry out unsuitable supplementary feeding, except for animal welfare reasons
12	Agricultural land which is not in agricultural production	Must establish green cover asap after 1 March, cut scrub every 5 years, but not cut vegetation 1 Mar-31 Jul, apply/ store fertiliser, FYM or slurry
14	Protection of hedgerows and watercourses	Must not cultivate or apply fertiliser (inorganic /organic/lime/sewage sludge etc) in 2m of centre of hedge/watercourse/field ditch, or land within 1m of top of watercourse or ditch

4.1.2 Set-aside

Set-aside was introduced as part of a programme for tackling the over production of cereals within the EU. Following changes in the global market for cereals with increased demand and vastly reduced

global stockpile, obligatory Set-aside was amended in 2008 to 0%. Further details of Set-aside management rules are presented in the Main Report.

Review of Set-aside for current and future water quality measures. The reduction to 0% obligatory Set-aside rate, combined with the major increase in Feed wheat price from £90 per tonne ex-farm in early 2007 to £180 in January 2008 although reducing to £150 by June 2008, has lead to an increase in the area of land under cultivation receiving inorganic and/or organic fertilizer.

Set-aside obligation for each arable farmer has previously been important in taking land out of production and reducing the use of nitrogen fertilizer on arable land by some 8-10%. The only options currently available within that would encourage arable farmers to continue with Set-aside-type land management on a field scale are under Environmental Stewardship.

4.1.3 England Catchment Sensitive Farming Delivery Initiative

The England Catchment Sensitive Farming Delivery Initiative (ECSFDI) aims to raise awareness of diffuse water pollution and encourage early voluntary action by farmers and land managers to tackle it.

ECSFDI was launched in April 2006 in 40 priority catchments in England as a partnership between Defra, Natural England and the Environment Agency (EA). Catchments were chosen on the basis of a risk assessment of diffuse agricultural pollution and the prioritisation of designated Sites of Special Scientific Interest (SSSI). The Rivers Frome and Piddle are selected as priority catchments.

Catchment Sensitive Farming Officers (CSFOs) are responsible for individual catchments with Catchment Steering Groups involving local stakeholders including water companies, farm advice deliverers, conservation bodies, farming organisations and farmers themselves. As well as offering advice to farmers, the ECSFDI can provide grant aid to address diffuse pollution on-farm. ECSFDI is to be extended for a further 3-year period until 2011.

Review of ECSFDI for current and future water quality measures. Specialist advice is provided on topics such as agronomy, the management of nutrients, soils, manures and pesticides as well as on-farm visits, farm resource protection planning, soil and slurry testing, identifying problem areas on-farm for nutrient loss, farmer workshops and on-farm demonstrations.

ECSFDI has been operative for 2-years and it is perhaps too early to be able to quantitatively assess any consequential change in water quality. ECSFDI's monitoring and evaluation framework includes farmer engagement, awareness and attitudes and changes in farm practices. It also covers environmental monitoring although it is recognised that water quality responses are generally not likely within the time scale of the programme. Models will be used to enhance the monitoring work and to predict the environmental improvements. However, ECSFDI's focus is upon the minimisation of surface water run-off rather than groundwater quality enhancement.

4.1.4 Agri-environment Schemes

It should be noted that the agri-environment schemes described below were not designed specifically to target groundwater protection, but to conserve wildlife, maintain and enhance landscape quality and character, protect the historic environment and natural resources, promote public access and understanding of the countryside, and natural resource protection. That some options within these schemes do have some benefit for water quality, could be interpreted as almost incidental. There is however, a growing recognition of the need to provide options within schemes that are of benefit to water quality and have sufficiently attractive payments for farmers to be encouraged in their uptake.

The text that follows describes briefly the agri-environment schemes that are either closed to new entrants or for which farmers can apply currently, and makes reference to specific measures of benefit to both surface and groundwater. Table 2 lists the secondary measures in each scheme of potential benefit to groundwater together with an estimate of the potential benefit of each measure.

South Wessex Downs Environmentally Sensitive Area

Initiated in 1993, extended in 1998 and closed to new applicants in 2005, this Environmentally Sensitive Area (ESA) is a 'whole-farm' scheme on 50,700 ha (507 km^2) of the South Wessex Downs (SWD. The main threat to the area has been the ploughing or improvement of grassland, together with undergrazing in some areas leading to scrub encroachment. Those SWD ESA options potentially of benefit to groundwater quality and quantity are indicated in Table 2.

Of particular interest are the options for low input permanent grassland and Downland (over 2100 ha in agreement), Downland turf creation (254 ha in agreement), arable or ley grassland reversion to permanent grassland (206 ha in agreement), extensive grazing supplement and woodland management and regeneration option for all woodland. Each of these options under SWD ESA has restricted nutrient inputs, either no more than 50:25:25 or no inorganic/organic fertiliser applications at all.

Review of SWD ESA for current and future water quality measures. This scheme has encouraged farmers to retain relatively unproductive grassland, and to return limited areas of arable land to permanent grassland, largely with reduced or no inorganic fertiliser. Although no data appears to exist, this scheme may not only have enhanced landscape and wildlife, but also reduced the level of N applied to land under ESA Agreement.

The Environmental Impact Assessment (uncultivated Land and Semi-natural Areas) (England) Regulations, 2001 prevent the unauthorised cultivation of any grassland with less than 30% content of ryegrass species. However, the ESA payments will have reduced applied nitrogen on substantial areas and hence water runoff into surface water and leachate into groundwater. In addition, the extensive grazing supplement requires the reduction of grazing to below 0.25 Livestock Units (GLUs) per ha per annum, itself encouraging a reduction in fertiliser application.

Countryside Stewardship Scheme

Closed to new entrants in 2005, the range of options within Countryside Stewardship Scheme (CSS), particularly for arable cropping, is more extensive than in the SWD ESA Scheme. These arable options in CSS include: arable reversion to grassland; arable field margins and 'beetle banks' of 2m wide grassland strips within the field; over-wintered stubbles followed by a conventional Spring crop of low input Spring cereal or Spring/Summer fallow, and; conservation headlands with no herbicide or no herbicide/fertiliser. In addition, CSS enabled applicants to choose to manage 4-12m field margins in intensive grassland without inputs including fertiliser. Such options reduce the inadvertent application of fertiliser into ditches and streams as well as providing a filter for water run-off together with soil and nutrients. The 13 most relevant land management options within CSS as secondary measures for groundwater quality and quantity enhancement are summarised in Table 2 below.

CSS applicants had also a range of capital items, such as hedge restoration or replanting, which when carefully positioned across the slope, can slow up water run-off and enable percolation to continue thus benefiting water penetration and groundwater quantity.

Review of CSS for current and future water quality measures. Reducing nitrogen applications to both grassland and arable land can have substantial benefits to the nitrogen that leaches from the soil profile and reaches the groundwater. In addition, financial support for the continued use of permanent pasture for agriculture and food production through livestock enterprises retains a land use that seldom erodes unless poached by supplementary feeding of out-wintered cattle, often from ring feeders. It would seem that the combination of measures in CSS provides financial support to retain grassland and minimise the use of inorganic and organic fertiliser, and has a multiple benefit for both wildlife and the quality of water both surface water and groundwater.

The discontinuation of Extensification Payments during the conversion of the previous Common Agricultural Policy (CAP) to SPS, takes away the incentive to reduce stocking density, and hence to reduce nitrogen applications to grassland. Thus, with the absence of a scheme that financially supports the retention of low-input grassland, the only practical restriction on nitrogen use is its price and the application threshold established within the SMRs of Cross Compliance (Main Report, Appendix 1).

Organic Farming Scheme

Under the Organic Farming Scheme (OFS), farmers moving from conventional to organic farming methods received financial support during the conversion process. Although existing 5 year Agreements continue, OFS closed to new entrants in March 2005 and in England has been superseded by the Organic Entry Level Stewardship (OELS).

At its peak in 2003, some 10,000 ha in Dorset was in OFS. There remain some 23 OFS Agreements, of which 8-10 are within the Dewlish and Milborne St Andrew groundwater catchments of the Upper Piddle Catchment.

Review of OFS for current and future water quality measures. Research indicates that organically managed soils usually have higher total contents of soil Organic Matter (OM), the main indicator of which is the abundance of earthworms (Stolze *et al*, 2000). Overall there is a positive net impact on soil conservation and organic farming systems often are considered to contribute significantly lower levels of nitrates to watercourses. In recognition of this, in the past Wessex Water Services Ltd offered a subsidy of £40 per hectare per year for 2 years to farmers willing to convert to organic farming in areas where nitrate levels were rising (House of Commons, 2001). Based on an extensive review of the relevant European literature by Stolze *et al* (2001), it has been concluded that organic farming does result in lower or similar nitrate leaching rates than integrated or conventional agriculture. However, although nitrate leaching rates on a per hectare basis may be significantly lower, when related to production units of tonnes of crop or litres of milk, the nitrate leaching rate is similar to or higher than that from conventional farming.

Energy Crops Scheme

Under the continued Energy Crops Scheme (ECS) farmers can receive payments for establishing Short Rotation Coppice (SRC) or miscanthus, as well as up to 50% of establishment costs for the formation of producer groups. SRC requires standard annual nitrogen fertiliser application rates between normal 3-yearly harvest, whereas miscanthus requires no fertiliser following the establishment year as the leaf mulch supplies sufficient nutrients. Details of fertiliser application rates of SRC and miscanthus, practical difficulties of application and their relative nutrient efficiency are presented in the Main Report

Review of ECS for current and future water quality measures. A mature SRC plantation will have a dense, widespread root system and this, combined with a long growing season, enables the crop to efficiently utilise nutrients. Research in the UK, and areas of Scandinavia with similar growing conditions, has shown that the uptake of available nitrogen by SRC is very effective and, consequently, nitrate leaching is much lower than that from fertilised grassland or arable land. Also with both SRC and miscanthus there is no soil disturbance to promote mineralisation. However, nitrate leaching has been recorded in SRC after green cover removal in the land preparation phase during the establishment year where nitrogen has been applied as fertiliser, and also after final removal of the crop. It is therefore important that no nitrogen is applied during the establishment year, when the root system will not have fully developed and would not be able to utilise the additional nutrients. It would appear that both SRC and miscanthus could be of considerable benefit to water quality in areas where this is of major concern, such as groundwater catchments.

Environmental Stewardship Scheme

Defra's Environmental Stewardship (ES) was initiated in England in 2005 and currently has 2 elements: Entry Level Stewardship (ELS) which is itself divided into ELS for conventional farmers and Organic Entry Level Stewardship (OELS) for land of registered Organic status or land 'in conversion' to organic farming, and; Higher Level Stewardship (HLS).

Entry/Organic Entry Level Stewardship. O/ELS is a whole-farm 5-year scheme open to all farmers. By March 2008, 766 ELS Agreements were being implemented in Dorset (634 ELS and 132 OELS) involving some 103,000 ha of agricultural land, equivalent to some 40% of the land area.

Many of the 60 O/ELS options relate to landscape features, such as hedgerows and their management but 15 ELS options are likely to provide benefit for groundwater quality, including both grassland and arable measures with specific, reduced and no inorganic and/or organic fertiliser inputs. These include arable reversion to grassland, over-wintered stubble following a combinable crop or prior to a Spring sown crop, undersown Spring cereals, grass margins in arable fields and the management of maize to avoid erosion. There is a wide range of grassland options including low and very low fertiliser inputs on permanent grassland and rush pasture, as well as non-fertilised grassland margins in otherwise intensively managed enclosures and the buffering of field corners and field margins.

Review of O/ELS for current and future water quality measures recognises that although ELS includes a range of measures that would exert a beneficial effect on groundwater and surface water quality, many options are unlikely to be chosen. Farmers choose to score sufficient points with easily achievable options such as hedge management and 2m field margins in arable. Table 2 provides details on individual O/ELS options and these are described in further detail in the Main Report.

Higher Level Stewardship. HLS has replaced both ESA and CSS and, when currently valid ESA and CSS Agreements expire, the agreement holder can apply for ELS and for a 10-year HLS Agreement. Unlike ELS, HLS Agreements include payments for capital works. The most relevant options for water quality enhancement within HLS are described in Table 2 and in more detail in the Main Report.

Review of HLS for current and future water quality measures notes that limited funding has resulted in only 44 HLS Agreements in Dorset by February 2008, although several more were in the final stages of processing and due to start in 2008.

A variety of land management options available under HLS are of benefit to the improvement of water quality and quantity. These are presented in Table 2 and described in more detail in the Main Report. The options available that could influence groundwater quality include: arable reversion to grassland

for reasons of historical importance, no inorganic or organic fertiliser application where erosion or run-off is the rationale. Direct drilling is an option but only for sites of archaeological importance. These measures would be of benefit to both surface and groundwater quality (Table 2), but are not available on a wider farm basis.

Soil, Nutrient and Manure Management Plans were previouisly included as ELS/HLS options but were subsequently withdrawn in order to obtain EU approval for the Rural Development Programme for England (RDPE). The inclusion of these plans in a different form is currently under review. There is no doubt that adherence to these Management Plans will contribute to more efficient use of nutrients and less run-off and leaching to groundwater.

English Woodland Grant Scheme

Grants from the English Woodland Grant Scheme (EWGS) that superseded the Woodland Grant Scheme (WGS) and Farm Woodland Premium Scheme (FWPS), are paid as part of a contract in which land managers agree to look after the woodlands and undertake approved maintenance, regeneration and planting works to an acceptable standard.

Review of EWGS for current and future water quality measures. With an estimated 45 km^2 of woodland within the Frome, Piddle and Wey catchments, and some 20% of Dorset in woodland, this ground cover is an important feature of the landscape. With an absence of nutrient applications, the N from woodland represents but a small proportion of the total in groundwater. The availability of support to maintain and restore existing woodlands and plantations is of benefit to the environment.

The creation of new woodlands is also of interest to some farmers or other landowners, especially those with field areas of shallow soils or steeper slopes that may not be conducive to productive agriculture. With the landuse changes associated with reforestation, there are major benefits in terms of reducing N leaching and improving groundwater and surface water quality. Silgram (2005) reported that while annual losses from over 600 field-years of data from arable fields averaged 23-75 kg/ha nitrate-N, 85 field-years of measured losses from woodland averaged only 16 kg N/ha per annum. With nitrogen leaching to groundwater from woodland being substantially less than that from arable land, perhaps by as much as a factor of 3, the encouragement of new woodland or orchard planting is therefore of benefit to groundwater quality.

4.2 Schemes and Projects implemented by business and non-profit making organisations

Despite the objectives of the organisations involved, the schemes and projects implemented by non-government organisations are inevitably of a more temporary nature than those of institutional bodies. Whilst this does not detract from their value, such projects can seldom impinge upon the entire farming community, for whom the operation of the farm business is for the longer-term rather than the short-term of most projects. This need for the long-term continuity of support is elaborated below. Non-governmental schemes and their contribution are more fully described in the Main Report and include:

a) Catchment AMP 5: implemented by Wessex Water;

b) Dorset Area Of Outstanding Natural Beauty (AONB) involving:

   i) Chalk and Cheese; and,

   ii) Pastures New.

c) The Dorset Biodiversity Arable Project;

d) Purbeck Keystone Project;

e) Biodiversity Fund, Dorset Biodiversity Partnership;

f) The Dorset Winterbournes Project;

Providing that the multiplicity of projects and schemes on farmer-owned land does not disillusion farmers with a too obvious desire to influence their land management practices, such programmes can only be positive.

4.3 Water Protection measures undertaken or planned within conservation designated areas and effect on groundwater

In Dorset, some 139 Site of Special Scientific Interest (SSSI) are recognised and have legally enforced management programmes associated with the features for which they were designated. The majority of Dorset's SSSIs are of the following habitats: broadleaved semi-natural woodland; flower rich grassland; wetland and rush, reed grazing; heathland; quarries – mainly for geological reasons; moors; marshes and bogs; and rivers including the River Frome from Dorchester to Wareham.

Prior to the introduction of ES in 2005 and recognising that the management by farmers of SSSIs was likely to lead to a reduced farm income due to loss of productivity, it was determined that SSSI managers could be eligible for a Wildlife Enhancement Scheme (WES), designed to 'top-up' existing ESA or CSS payments to cover the full cost, rather than part cost. Existing WES agreements are still valid, although new or renewed WESs are no longer available. Instead, farmers with SSSIs on their land must apply for HLS.

The maintenance of grassland SSSIs in favourable condition is likely to be beneficial for water quality. On a range of grassland, heathland, rush pasture and wetland sites, no nitrogen or other inorganic fertilizers or slurry will be applied, and only light applications of well-rotted FYM permitted after a hay crop. With SSSIs being prioritised at present for HLS and with WES Agreements still in place, there may be little change in management practice that can be undertaken on the SSSI site itself that would further improve water quality.

Sources in Natural England suggest that there are no measures planned for any SSSI that would influence the quality or quantity of groundwater beneath or in the immediate vicinity of the designated site. As discussed above, HLS applications with SSSIs to-date have received priority for entry, so as to further Defra's SSSI Public Service Agreement.

4.4 Water Protection measures not supported under on-going Schemes and Projects

The formal schemes contain a wide range of measures that could be described as both reducing the application of nitrogenous fertiliser, both inorganic and organic, as well as management practices that reduce nitrogen loss to surface and groundwater. Some measures that have yet to be considered for schemes and would be of benefit in reducing groundwater pollution are described below. Complete descriptions are presented in the Main Report with estimated benefits in terms of nitrate leachate reductions described in Table 2 below.

4.4.1 Measures for arable sector

Adoption of Minimum Tillage. Although neither simple nor straightforward techniques, Minimum Tillage (Min-till) and Non-Till by direct-drilling do in certain circumstances and on certain soil types, have definite advantages over traditional cultivation methods. Of importance to groundwater quality, is

that the retention of increased soil organic matter content reduces the leaching of pesticides and nitrogen in some circumstances.

Alternatively Conservation Tillage, which is defined as any tillage system that leaves at least 30% of the soil surface covered with crop residues after planting, may be equally appropriate. This maintains a continuous ground cover during the year thus reducing erosion. Direct drilling is included as an option in HLS, but only for areas of archaeological significance and not for all arable land.

Tractor exhaust gas boost to soil carbon. A possibility for the future is the technique used since 2007 by a group of Canadian farmers and currently being piloted in the UK. This involves the use of a pneumatic drill that diverts cooled tractor exhaust gases such as carbon dioxide into the soil via the airflow, thus increasing soil carbon content and boosting micro-organism content. Savings of fertilizer are apparently substantial and often halved and, although this technique is still in the pilot stage, the indication is that crop yields with such systems, despite the reduced fertilizer application rate, are at least as good as the long term average for conventional equipment and fertiliser rates. It is assumed that nitrogen leaching is reduced as a result of the greater carbon content of the soil, and research evidence indicates that at higher C:N ratios, nitrate is less present in the sub-soil.

This technique is still at an early stage of development and may, even when commercially available, be viable only in large-scale arable units, such as those in East Anglia. Nevertheless, policy makers should remain aware of the opportunities that such techniques might have to offer in terms of reducing fertilizer inputs and subsequent potential leachate, as well as the release of CO_2 into the atmosphere.

Routine sub-soiling of arable land. Tractor weight in excess of 6 tonne is normal and soil compaction and the creation of a hard pan can become an issue on loam and clay soils, often at depths of 30-50 cm below ground level. Under these circumstances, water percolation through the soil profile is hindered and water run-off and soil erosion can result, even on gently sloping ground.

Whilst the impact of such breakdowns in soil structure, particularly in 'tramlines', may not be too damaging for crop yields, its effect on water pollution can be a major consequence, particularly of phosphate and to a lesser extent of nitrate as well. The use of a sub-soiler breaks up the pan with cracks and fissures. This improved soil structure enables water percolation to a normal depth to be resumed and reduced water run-off and soil erosion minimised with consequent improvement potential in water quality. With better crop root growth there is better nutrient uptake and reduced nutrient availability for leaching to groundwater.

Raising organic matter content in arable soils. The absence of a break crop or ley pasture as part of modern-day arable rotations has apparently led to the reduced Organic Matter (OM) content of many if not all soils under arable crops. Ways of enhancing the OM content are described above, and include Min-till, Non-till and Conservation tillage techniques, with Green Manuring being another. For some soil types in certain locations, these techniques may not be appropriate. In addition, if the farm is not a mixed livestock/arable unit, the absence of an on-farm livestock manure source, may make the application of slurry or FYM impractical were the alternative sources too distant to import.

However, were an option in ELS for example to be the use of slurry or FYM on arable land, then this measure might encourage arable farmers to negotiate a source of such manures from neighbouring livestock units, whether cattle, pig or poultry. This would have the dual benefit of reducing the slurry/FYM application rate per ha on the livestock farm, and raising the organic matter content and C:N ratio of the arable soils to which the slurry or FYM had been applied. Providing appropriate

Manure and Nutrient Management Plans were developed and implemented, this would lock up nitrate and reduce the potential of severe nitrate leaching into groundwater.

Precision farming. Soil conditions, type, pH, depth and structure can vary considerably within a single field, together with levels of organic matter and nutrients, both available and unavailable. However, fertiliser application rates are invariably uniform across the field or with variations based on admittedly informed operator opinion rather than factual evidence. Since the mid-1980s, there has been much development work leading to commercial precision farming, which is the process of adjusting husbandry practices across an area of land according to measured spatial variability.

The cost-effectiveness of precision farming is determined by the cost of defining zones within fields, the stability of those zones through time, the difference in treatment between zones in terms of cost, and the responsiveness of the crop in terms of yield and quality to changes in treatment. Cost-effective precision farming is most likely where prior knowledge indicates large heterogeneity and where treatment zones can be predicted, for example from soil type or field history.

It can be anticipated that techniques and equipment designed and capable of matching plant nutrient needs with nutrients available within the soil and therefore that to be applied, will be available in the future. Nevertheless it is important that policy makers should be aware of the opportunities that such techniques might have to offer in terms of applying fertilizer inputs at the level required by the plants and soil in each sub-area of the field, thus minimising the loss of nitrogen into groundwater.

4.4.2 Measures for livestock sector

Extensification payments. Until 2005, the Extensification Payments Scheme offered payments to farmers based on two stocking levels, with higher rates paid for levels under 1.6 Livestock Units (LSU) per ha and lower rates for levels 1.6-2.0 LSU. Area payments based on reducing stocking density and hence grazing intensity, should provide conservation benefits for a range of species.

Although SMR4 NVZs provides a maximum 'whole farm organic manure loading' within the NVZ (Main Report, Appendix 1), there are some areas of Dorset not within NVZs and to which this SMR does not apply, including areas of Friar Waddon and Empool groundwater catchments. With CAP revisions and the introduction of the Single Payment Scheme in 2005, other than Cross Compliance rules regarding the need to avoid overgrazing (GAEC 9) that apply to natural and semi-natural grassland only but not to temporary leys, currently there is little encouragement for farmers to reduce stocking density and therefore minimise the annual inorganic and organic fertiliser application rates.

Reduction in high N feed intakes. Most dairy farmers feed concentrates to milking cows, often more than 2 tonnes/cow/year and containing in excess of 20% protein. Standard milk price payments are based typically upon 4.1% butterfat and 3.3% protein content, with financial increments per 1% of each. It is possible that some farmers in certain situations, particularly where milk is for liquid consumption rather than processing, might be willing to reduce protein feed intake, thus lowering the level of N in slurry or FYM, and the amount of nitrogen when these are applied to grassland or arable, and consequent nitrate levels in groundwater.

Use of FYM instead of slurry. Compared with slurry, FYM has a lower content of water soluble nitrogen and phosphorus as organic compounds, which slowly release N and phosphate during microbial breakdown in the soil. With this higher organic matter content and a greater C:N ratio, the nitrogen in FYM is locked up and less subject to leaching from the soil surface than slurry. However, with big-baled wheat straw having a current high ex-farm value of about £35 per tonne, livestock

farmers might be reluctant to convert from a slurry system, or to retain loose housing utilising straw, unless there were financial incentives available.

A points score in ELS for those land areas upon which only FYM rather than slurry would be applied, might make this a more attractive option for both dairy and other livestock farmers alike.

Use of Slurry separator. Using a slurry separator, slurry at a normal 5-8% dry matter can be passed over a screen to produce a liquid that can be pumped with only low power for 1,500m in a 5cm pipe, and the remaining ±20% dry matter material can be stacked and composted as FYM. Benefits include: better results from grass production with: less contamination of silage; no capping of fields so grass grows more rapidly; a more uniform spread from separated liquid as opposed to slurry; clovers are encouraged by separated liquid, rather than killed by raw slurry; grass response to nitrogen in separated slurry is more rapid and more reliable, with greater yield; less nitrogen loss than with raw slurry applied to the soil surface, and; separated liquid can be spread at a very low cost of operation.

The nutrient analysis of the separated liquid and solids is roughly the same and, as the liquid can be incorporated more readily and frequently than can raw slurry, the window of spreading opportunities is enlarged. This reduces the potential for slurry wash off fields with nitrogen and phosphate run-off into ditches, drains and streams, leading to some pollution of groundwater.

Use of slurry injection techniques. In both conventional and organic systems, slurry can be injected into bare soil, grassland, over-wintered stubble, and Autumn and Spring-sown cereals. A range of soil types can be injected safely, including chalk with flints.

The benefits of injection compared with normal surface spreading of slurry include: reduced inorganic fertiliser use as injected slurry loses less nitrate as ammonia than does soil-applied slurry; reduced 'burn-off' of grassland and clover and increased drought tolerance; odour reduction; improved grass growth; extended annual grazing as cattle graze within one week of injection, and; aeration by slots that also allow increased rainwater percolation into the soil profile as capping is reduced.

Use of High Sugar Grass varieties. Normal grass cultivars contain some 13% sugars, compared to 20% sugars in High Sugar Perennial Ryegrass. Because this extra sugar in high sugar grass 'dilutes' other constituents such as protein, they tend to have lower protein content than normal grasses. However, the Institute of Grassland and Environmental Research (IGER) have shown that livestock perform as well as they do on a normal grass. The protein in the high sugar grass is utilised more efficiently with 30% converted to milk, and even if milk yields are not improved, nitrogen excretion to the environment is reduced with only 26% lost in urine. This compares favourably with normal grass cultivars in which most of the feed protein is excreted in the faeces and some 35% lost in the urine, contributing to the environmental pollution.

On-farm Anaerobic Digestion (AD). At present there is little Government support for AD development, even though it has the potential to reduce livestock manure applications to small or difficult sites and would contribute to national energy supplies. There would also be social benefits in that the digestate is odour free and reduces ammonia emissions to the atmosphere. However, although the pollution potential of digestate has a 60-80% reduction of Biological Oxygen Demand (BOD) compared with the feedstock, it is still high and most of the N:P:K remains in the digestate.

Field drainage deterioration. Selective blocking would reduce water flow into drains through the soil profile, minimising the transfer of pollutants to surface or groundwater, unless the land slope permitted easy surface run-off to occur. Drainage of grazed grassland can apparently result in a 2-3 fold increase in nitrate leaching. However, on heavier soils prone to waterlogging, without field drainage many

arable crops would become uneconomic. Grassland has the greatest potential for implementation of this measure but, even were water run-off and soil erosion not a potential problem, on the heavier soils stock would need to be housed earlier in the Autumn to avoid excessive field poaching.

Since most field drainage systems were installed using government loans or grants for the purpose of raising crop yield potential, few farmers are likely to look favourably upon such a measure, unless land is of already low crop yield potential and for which alternative financial returns from agri-environment schemes are possible. This measure was not a topic within either the On-farm Interviews or Postal Survey.

Nitrification inhibitors. These delay the transformation of ammonium ions into nitrate ions. As ammonium ions are protected from leaching by chemically active clay surfaces, nitrification inhibitors can delay nitrogen leaching until the plant has time to take up the nitrogen. At least 2 compounds are commercially approved for use in the USA and others in Japan. Research in New Zealand and elsewhere continues to identifying chemical processes that slow down or delay the nitrification process, thereby decreasing the possibility that large losses of nitrate will occur before the fertilizer nitrogen is taken up by plants. Inhibitors at typically low application rates of less than 1 kg per ha are applied to grassland or arable land incorporated with inorganic fertiliser or applied directly, and work continues with their incorporation into livestock manures and sewage sludge.

Inhibitors are currently being piloted as a slurry additive in the UK and this measure was not a topic within either the On-farm Interview or Postal Survey.

4.4.3 Other measures

Rationalisation of points scoring within ELS. As already discussed, most farmers can achieve successful entry to ELS from boundary management options concerning hedge management and 2, 4 or 6m buffer strips on cultivated land or grassland. From a diffuse pollution aspect, there could be some value in raising the 'points score' for measures that are likely to reduce the leaching of nitrates into groundwater such as over-winter stubbles and conservation headlands and as a result making them a more attractive proposition for arable farmers. Alternatively, the inclusion of a points categorisation system could ensure a more equitable take up of ELS measures.

On-farm advisory support. Farming is an isolated profession, and keeping up to-date with the latest opportunities and implications of new regulations and rulings is not straightforward. All evidence from on-going catchment-scale projects elsewhere indicates that a long-term approach to the provision of advice regarding water and soil run-off, ideally by the same adviser over many years, is an invaluable component of an effective, efficient and 'farmer-friendly' advisory system.

The England Catchment Sensitive Farming Delivery Initiative (ECSFDI) would appear to be working towards an achievable objective. However, in order to deliver real changes in water quality, a long term commitment in terms of funding and advisers is necessary, the necessity and experience for which are described in the Main Report.

4.5 Secondary Measures and impact on water quality

Only limited literature would appear to be available about the impact of individual measures and none could be found indicating any complementary benefit to be obtained by the multi-use of measures. Derived and extrapolated from various sources, Table 2 presents a quantified estimate of the potential reduction in nitrogen leachate for each of the Secondary Measures described above. Whether the measure has a benefit to surface water is also indicated. Other than complete cessation of fertiliser

application, no single measure alone will provide a complete solution to the problem of nitrate leaching but they could be adopted as useful tools to complement good management practice.

Table 2 Assessment of the effect of implemented scheme options, as well as other measures for the improvement of groundwater quality and diffuse pollution.

Land management options and [scheme]	Payment rate [£/ha/year]	Benefit to surface or groundwater?		Mean reduction of leaching loss in kg Nitrate per ha/year	Comment
		surface water	ground water		
ARABLE MEASURES					
Reversion of arable to permanent grassland [ESA, CSS, HLS]	£210-500	yes	yes	20	Providing poaching minimised and with extensive grazing. In HLS only for historic site or erosion management
Over-wintered stubble followed by a Spring crop or low-input Spring cereal [CSS]	£40-125	yes	yes	10	Weed and volunteer cereal growth absorbs some available N
Over-wintered stubble followed by a Spring/Summer fallow [CSS]	£520	yes	yes	20-30	Assumes no fertiliser application for fallow period
Whole crop cereals followed by over-wintered stubble [ELS]	£230	yes	yes	10	Weed and volunteer cereal growth absorbs available N
Brassica fodder crop followed by over-wintered stubble [ELS]	£90	yes	yes	10	Weed growth absorbs some of available N
Undersown Spring Cereals [ELS]	£200	yes	yes	5-15	Assume cover crop of grass for 3-year ley
Conservation headlands of 6-24m in arable with restricted inputs [ESA, CSS, ELS]	£270-440	yes	yes	1-5	Land taken from production & denitrification
Buffer strips of 2m, 4m or 6m in arable or intensive grassland, and beetle banks [CSS, ELS, HLS]	£100-600	yes	yes	1-5	Land taken from production & denitrification
Routine sub-soiling of arable land	none yet	yes	perhaps	0	Assumes increase in soil permeability with minimal leaching increase
Raising organic matter content in arable soil	none yet	yes	yes	5 – small increase	Could be increase in nitrate leaching from mineralization, but C:N ratio should rise
Minimum tillage/no till [≅HLS]	none yet	yes	yes	0-5	Retains OM. In HLS, direct drilling, but only for archaeological sites.
Field drain deterioration	none yet	yes	yes	10-30	Potentially greater for grassland
Autumn seedbeds left rough	none yet	yes	small if any	0-5	Reduces water/soil run-off but encourages water percolation and perhaps leaching.
Establish a post-harvest cover crop	none yet	yes	yes	10-45	If annual cover crop followed by Spring Cereal crop
Tractor exhaust gas boost to soil carbon	none yet	no	yes	20-30	Dependant upon soil C:N ratio
Precision farming	none yet	some	yes	10-15	Minimises excess N use
GRASSLAND MEASURES					
Permanent grassland with low inputs [ESA, ELS]	£42-85	some	yes	5-10	20% reduction in N applications
Permanent grassland with very low inputs [ELS]	£150	some	yes	10-15	50% reduction in N applications

Table 2 continued - Assessment of the effect of implemented scheme options, as well as other measures for the improvement of groundwater quality and diffuse pollution.

Land management options and [scheme]	Payment rate [£/ha/year]	Benefit to surface or groundwater?		Mean reduction of leaching loss in kg Nitrate per ha/year	Comment
		surface water	ground water		
Managing chalk and limestone grassland with sheep and/or cattle grazing & light applications of well-rotted FYM only [ESA, CSS]	£60	some	yes	5-15	Depends upon previous application rate
Restoration or creation of species-rich, semi-natural grassland [CSS, HLS]	£115-355	some	yes	5-15	Depends upon previous application rate
Livestock removal on grassland to reduce poaching /compaction [HLS]	£40	yes	perhaps	0-1	Seasonal with no input restrictions. Mainly reduced P_2O_5 losses & micro-orgs.
Preventing erosion/run-off from intensive grassland by extensive grazing to minimise soil compaction [HLS]	£280-335	yes	yes	1-5	Depends upon previous stocking density
Livestock extensification payments [similar in ESA]	none yet	yes	yes	10-25 [3-5]	Assumes a 20% reduction in dairy [beef & sheep] stock numbers
Use of FYM instead of slurry	none yet	yes	yes	10-20	Only 10-25% ammonium-N in FYM as, compared with 50-60% in slurries
Reduction in high Protein feed intakes by livestock	none yet	yes	yes	2	Assumes reduction in content of cake from 20 to 16% DCP
Use of slurry injection technique	none yet	yes	yes	5-25	Reduces risk of diffuse pollution as less pressure to spread in high risk periods
Use of High Sugar Grass cultivars	none yet	no	yes	5-10	25% reduction of nitrogen lost in urine
Use of slurry separator	none yet	possible	yes	5-10	Liquid pumped 2km & solid above ground
Export slurry & FYM	none yet	yes	yes	5	2% cattle manures exported
Anaerobic digesters for biogas	none yet	yes	yes	na	Reduced application rates of high dry matter digestate
Field drain deterioration	none yet	possible	yes	10-30	Benefit to grassland exceeds that for arable
Nitrification inhibitors	none yet	yes	yes	potentially substantial	Dependent upon rainfall, soil type and farming system
WOODLAND AND GENERAL					
Woodland restoration maintenance, or creation (< 1 ha) [similar in ESA, HLS]	£100-315	yes	yes	15-25	Assumes less productive land with medium N application rates
Leaving rough field corners with maximum of 1 ha per patch [HLS]	£500	yes	yes	1-5	Land taken from production & denitrification

5 Results: On-farm Interviews and Postal Survey

The following text and data represents a summary of that presented in the Main Report. Text data will most usually be described using numbers of farmers or farmer participants for whom a particular characteristic is the case, such as (n=15) when 15 farmers are understood to have followed a particular course of action. Both On-farm Interviews and Postal Survey methodologies are presented in Section 3 with brief descriptions of the participants and their farms.

5.1 Cross Compliance and Set-aside

5.1.1 Cross Compliance

On-farm Interview. Farmers views and opinions were sought as to the practicalities of conformation to Good Agricultural and Environmental Conditions (GAEC) particularly in relation to those measures that might influence nutrient application and hence groundwater quality and quantity. Nine GAECs were discussed and the results are presented in Table 3. Farmers were asked whether they were implementing the required condition prior to XC initiation, and whether the condition was easy to follow (score 1) or not (score 0). Dependant upon the farming system, not all GAECs apply to all farmers. A brief discussion follows in Section 6 and is more detailed in the Main Report. The rationale for sudden major changes in regulations was also a source of considerable frustration to working farmers.

A majority of farmers (n=14) attended meetings or workshops about Cross Compliance issues that were staged by various bodies both governmental and non-governmental. Surprisingly though, those farmers asked whether any of their farm staff had attended such meetings, mainly responded that they either did not know or that staff had not been involved.

Table 3 Implementation ease or difficulty of Cross Compliance GAECs for water quality for 20 farmers in On-farm Interview

Farmer opinion	GAEC 1 [Soil Protection Review]	GAEC 2A [overwinter stubble]	GAEC 2B [rough soil surface]	GAEC 2C [cover crop]	GAEC 2D [crop sown in 10 days]	GAEC 3 [no vehicles on water logged soil]	GAEC 4 [no crop residue burning]	GAEC 5 [no > productivity of semi-natural land]	GAEC 6 [SSSIs]	GAEC 9 [no overgrazing or supplementary feeding]	GAEC 12 [green crop establishment]	GAEC 14 [hedge and watercourse protection]	Training in XC attended?
nc	6	6	6	8	8	2	2	5	2	4	2	2	--
easy	13	7	6	7	8	9	8	8	2	4	1	17	13 yes
not easy	1	0	0	0	1	3	0	0	0	7	1	1	7 no

[nc = no change from before Cross Compliance; 1= yes & 0= no.]

Note [1]/ Overall 'no problem' is the total of 'no change' or 'no problem' as a percentage of those GAECs that relate to that farm. GAEC 2 is included as 4 separate items [A, B, C and D].

Prior to XC introduction in 2005, a majority of farmers (n=17) were implementing at least one of the 9 GAECs under discussion. On those farms where the specific GAECs applied, most featured as not causing a problem to implement, although there was concern expressed as to why certain individual measures were necessary. Only GAEC 3 and 9 had substantial farmer numbers (n=3 and n=7 respectively) who did not find their implementation easy. Concerns about GAEC 3, No vehicles on waterlogged soil, related to the need to out-winter stock and access to suitable fields that did not

'poach' and that was not always dry. Reactions to the related GAEC 9, No overgrazing or Supplementary feeding was more complex and related to changing weather conditions and the need to be able to be flexible with farm operations.

Overall, XC was considered by farmers to be manageable although by no means cost-neutral to implement (see Main Report). Farmers recognised that the farming community will continue to be subject to these regulations.

There was a perception that greater 'self policing' of guidelines would be advantageous and that there needed to be a recognition by Defra that the apparent lack of flexibility over dates for operations was perhaps the major reaction about problems encountered.

Postal Survey. Only two questions were asked specifically about Cross Compliance; the first related to Post-harvest Management of Land in GAEC 2. The question was whether between harvest and end-February, a crop was ever not drilled within 10 days of a seedbed being established. Of the respondees (n=42) to this question, the majority (n=33) could drill within 10 days and the remainder (n=9) not able to drill within this short window required under XC regulations. No reasons were given as to why this condition could not always be met or how frequently it occurred.

The second question also related to GAEC 2, and concerned the establishment of a cover crop either post-harvest or by undersowing and whether this was part of the farm programme. Of the 44 responding to this question, 61% (n=27) indicated that they did not either use a cover crop or undersow.

A third question asked was related to NVZ regulation compliance and particularly those of the Statutory Management Requirements. Farmers were asked whether they would be willing to shift from Autumn to Spring applications of slurry and FYM. Of the 43 respondees, a 63% majority (n=27) indicated that they would be willing to consider this.

5.1.2 Set-aside

This topic was discussed only during the On-farm Interviews. A majority of farmers (n=17) were required in 2007 to put land under Set-aside totalling 280 ha, but as obligatory Set-aside was amended in 2008 to 0%, all but 2 farmers reduced their Set-aside area. In 2008, Set-aside for the 17 farmers was 108 ha, a reduction of 62% compared with 2007. Those retaining the same areas of Set-aside in 2008 did so because of involvement in Voluntary Set-aside (n=1) and for slurry when grassland application not possible (n=1). Ten farmers had retained no Set-aside at all in 2008.

5.2 Use of inorganic fertiliser and organic manures

5.2.1 Soil analysis routine

On-farm Interview. A large majority of the farmers (n=17) considered that they soil sampled 'regularly', although the most recent occasion for one 'regular' soil-sampling farmer was in 2002. Only one farmer had had Organic Matter content included in soil analyses, and 1 farmer stated and several others merely agreed that the cost of soil analysis was not worthwhile.

Farmers, and particularly those with livestock, indicated that their interest in soil nutrient content was greater than previously. This would appear to have been triggered both by the rapid rise in price of inorganic fertiliser and the activities of WAgriCo and ECSFDI. Indeed, one farmer had not taken a soil sample for 20 years prior to ECSFDI sampling and analysis in 2006, but anticipated continued sampling and analysis in future.

Postal Survey. The number of respondees indicating that they soil sampled 'every year' (n=30) was the same as those that did not (n=30). The specific 'every year' was used for the Postal Survey as distinct from the term 'regularly' used in the On-farm Interviews, as in the latter the farmer's response could be and was clarified in each case.

5.2.2 Nutrient Management Plans

On-farm Interview. A majority of farmers (n=16), although not the same as those who took soil samples regularly, had a Nutrient Management Plan (NMP). Most did not develop the NMP themselves, relying upon an Agronomist, and indeed several were unsure as to the software that was used.

The importance given to the NMP for practical farm business varied considerably between farmers. For some mainly large arable farmers, their NMP was a vital tool that enabled them to optimise crop yield and minimise unnecessary inputs. For others, it was just a routine that they went through and which scarcely impacted upon the fertiliser application rates applied, these farmers preferring to rely upon experience or Fertiliser Recommendations for Agricultural and Horticultural Crops (RB209).

Postal Survey. As with the On-farm Interviews, a majority of farmers (n=33) had a Nutrient Management Plan (NMP). Of those that had NMPs, 21% (n=7) did not soil sample every year, although 10% (n=3) of those that soil sampled annually, did not have an NMP.

5.2.3 Lime application

On-farm Interview. Most farmers recognised the importance to plant nutrient uptake of maintaining a neutral pH and minimising soil acidity to the extent possible. However, only 14 farmers limed regularly and some made no applications (n=4), whilst others were less than regular (n=2). There appeared to be no obvious correlation between lack of regular liming and the main farm enterprise. All farmers were aware of the range of soil types within their management and likely pH variability.

5.2.4 Nitrogen application

On-farm Interview. Non-organic farmers reported substantial differences in inorganic nitrogen application rates in 2007, both for the same crop and between crops. Winter wheat for example, had a mean of 167 kg N per ha (n=13), but ranged from 0 to 240 kg N per ha for conventional farms. At least part of the variation was dependent upon the use of imported chicken manure, which minimised not only the crop nitrogen requirement but also lime requirement as the poultry in question were egg-layers and therefore their manure was of high pH. Other arable crops had a similar range, with that for maize of 25-120 kg N per ha, but averaging 65 kg N per ha (n=9). Arable farmers recognised the variation in soil type and nutrient status across their land and applied fertiliser according to both perceived demand and/or demand quantified by soil analysis. Nitrogen applications to grassland also varied, but rates were surprisingly similar for both grazing and mowing leys, although considerably reduced for permanent pasture.

Those farmers participating in the WAgriCo Primary Measures programme would appear to have larger nitrogen application rates, for reasons that are not obvious. Only for grassland leys for mowing did WAgriCo participants use reduced nitrogen application rates.

5.2.5 Calibration of fertiliser spreader

Following from the inclusion of fertiliser spreader calibration (EGAP2) as a WAgriCo Primary Measure and the large proportion of the On-farm Interview farmers who routinely calibrated their spreaders prior the advent of WAgriCo (n=7 out of 8 interviewed), the Postal Survey farmers were asked whether they calibrated their fertilizer spreader every year. Of the 44 respondees that excluded those registered or converting to Organic Status, a 66% majority (n=29) replied that they did calibrate spreaders annually. However, the quality of calibration is unknown.

5.2.6 Change in fertiliser application rates

On-farm Interview. Farmers were asked whether compared with 2007, they would be changing their fertiliser application rates in 2008 and if so then why and to which crop. As many arable farmers had purchased their fertiliser in July-September 2007 before the current major price rise had occurred, farmers were also asked whether they anticipated changes in fertiliser application rates in 2009.

A majority of farmers (n=13) anticipated using the same application rates in 2008 as in 2007, with only 5 farmers reducing applications. However by 2009, the ratio had changed with those anticipating reductions outnumbering (n=9) those applying the same rate (n=7). Given the current volatile nature of input and output prices and values, management plans may need to be altered in future. There was little difference in farmer attitude to fertiliser application rate change between participants within WAgriCo and those outside the target groundwater catchment areas.

Farmers were less certain as to which crops would have reduced fertiliser applications, with several merely indicating arable (n=3), grassland (n=4), Winter wheat/Oilseed rape (n=1) or Malting barley (n=1). Other than the rise in fertiliser cost, reasons for the reduction in fertiliser application rates included:

a) have been reducing fertiliser application rates over the past 10 years or so in response to poor farmgate price for outputs (n=4);

b) sowing red clover and increasing clover content of leys, both to reduce nitrogen applications and also to reduce protein content of concentrate feed (n=2);

c) not reducing fertiliser, but reseeding leys more frequently (n=1);

d) on silage ground could apply less fertiliser per cut but take more cuts each year (n=1); and,

e) make better use of slurry and manures (n=5).

Postal Survey. Although not asked for specific fertiliser application rates, farmers were asked whether compared with 2007, they would be changing their inorganic fertiliser application rates in 2008 and if so, then why and to which crop. Unlike the On-farm Interviews, farmers were asked also if changes were anticipated in phosphate fertiliser application in 2008 compared with 2007.

The number of farmers anticipating no change in application rates, was almost equalled by farmers anticipating reductions. The increase in price was the major reason given for reducing fertiliser application rates in 2008. Interestingly, a reduction in phosphate applications was triggered for farmers with high P_2O_5 indices in recent soil samples (n=2), whilst an increase for low indices for another farmer (n=1). Farmers (n=20) were less certain as to which crops would have reduced fertiliser

applications of either nitrogen or phosphate, with several merely indicating All arable and grassland (n=3), Arable (n=1), Grassland (n=10), Wheat (n=1), Spring barley (n=3) and Maize (n=2).

5.2.7 Slurry and organic manures

Type of Organic Manure produced

On-farm Interview. Farms produced a range of manure types, including slurry (n=12), dirty water (n=8) and FYM (n=18). Only 2 farm units produced no organic manure on-farm, however both used organic manure extensively as these arable farms imported either sewage sludge or pig slurry.

Postal Survey. Responses about their livestock manure type (n=38) and whether they produced slurry, FYM or both, were 0, 20 and 18 respectively. Some farms produced no livestock manure (n=22).

Import and export of Organic Manure

On-farm Interview. Only 3 farmers had an arrangement with Wessex Water for the spreading of sewage sludge, 7 other farmers imported livestock manures as either cow manure (n=1), poultry (n=4) or pig slurry (n=1). The rationale for organic matter import was invariably as a nutrient source, particularly P_2O_5 and K_2O, but also to enhance the soil organic matter status (n=3). Other farmers indicated that they would be interested in importing either sewage sludge or livestock manures, but so far without success, and 3 livestock farmers indicated that they would like to export livestock manure.

Postal Survey. Although 6 farmers had an arrangement with Wessex Water for the spreading of sewage sludge, 7 other farmers imported livestock manures either as slurry (n=2), both slurry and FYM (n=1) or in addition to sewage sludge (n=3).

46 farmers responded the majority indicating that they would like to import (n=26) sewage sludge or livestock manures and the remainder (n=20) not. Six farmers actively exported livestock manures: slurry (n=2); FYM (n=2), and; both slurry and FYM (n=2).

Slurry storage and process

On-farm Interview. Tanks (n=1) and slatted floor storage capacity (n=1) were the minority, with external lagoons the main slurry storage (n=8), none of which had a roof to exclude dilution with rainwater. Farms were particularly interested in but lacked the investment required in minimising clean water access to slurry storage, either by diverting roof water to natural drainage or roofing passages and yards used by cattle. Few farms (n=6) had slurry separators and these were mainly of the 'weeping wall' type. Slurry storage capacity ranged from 0-5 months, averaging 2 months storage. Several farmers applied dirty water on a daily basis.

Timing of livestock manure application

In both On-farm Interviews and Postal Survey, each farmer was asked for an estimate of the percentage of slurry and FYM applied in each quarter of the year. Information provided was based on general impressions rather than quantitative data, but is indicative of farmer perceptions of current practice.

On-farm Interview. Differences in slurry application timing were apparent between the WAgriCo participants and those outside the WAgriCo Primary Measures Programme (Table 4). It is not impossible that WAgriCo Advisers had encouraged farmers to focus on Spring applications, to the extent permitted by current storage capacity.

Table 4 Timing of slurry and FYM application

Farmers	Manure type	Measure	Proportion applied in specific quarter [%]			
			Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
WAgriCo Area	slurry	range	40-100	0-10	0-10	20-40
		mean	70	5	4	21
	FYM	range	0-100	0-100	0-100	0-5
		mean	38	21	41	1
non-WAgriCo Area	slurry	range	0-80	0-75	0-25	0-50
		mean	37	21	13	27
	FYM	range	0-66	0-100	0-100	0-50
		mean	34	27	42	19

[due to rounding, percentages may not add to 100%]

Postal Survey. A wide range in application timing was apparent between respondees for both slurry and FYM the reasons for which, it being a Postal Survey, are not known. Compared with the On-farm Interviews, slurry was more evenly spread across the year, with a lower peak in the January to March period whilst although similar, there was still a peak of application in July-September, corresponding to that from the On-farm Interviews.

Crop target for livestock manure

On-farm Interview. Farmers were asked the crops to which they applied slurry and FYM and the proportion of each respectively. No statistical correlations have been drawn between farm enterprise mix and proportional applications, but farmer estimates are presented in Table 5.

With livestock manures being produced upon livestock farms, the greatest proportion is applied to either grassland or maize, with lesser proportions to combinable crops. The differences apparent in Table 5 between WAgriCo participants and other farmers are perhaps a result of small sample size.

Table 5 Crop target for slurry and FYM application

Farmers	Manure type	Measure	Proportion applied to specific crop [%]			
			grassland	maize	combinables	other
WAgriCo	slurry	range	0-80%	20-50%	0-50%	0
		mean	43%	38%	20%	0
	FYM	range	0-100%	0-100%	0-100%	0-10%
		mean	17%	50%	32%	2%
non-WAgriCo	slurry	range	0-100%	10-100%	25-100%	0-10%
		mean	52%	26%	22%	0
	FYM	range	0-100%	10-80%	0-100%	0
		mean	35%	28%	37%	0

[due to rounding, percentages may not add to 100%]

Postal Survey. Most slurry and FYM was applied to grassland, although less to maize than for farms in the On-farm Interviews. The range of proportions applied varied substantially, as expected from the information from the On-farm Interview farmers.

Recognition of slurry value

A recurrent feature in the On-farm Interviews and to a lesser extent from the Postal Survey, was the recognition by most farmers of the value of slurry and FYM, whether home-farm produced or imported. This recognition would appear to have been of relatively recent development, triggered by both the rapid rise in inorganic fertiliser price and the advisory activities of WAgriCo and ECSFDI. However, and although not asked as a specific question, few farmers in the On-farm Interviews appeared aware of the nutrient content of their slurry or FYM and only 2 farmers routinely had slurry nutrient analysis undertaken. None of the farmers asked directly (n=6) were able to indicate an even approximate financial value of the nutrients in a 10 tonne spreader tanker of undiluted slurry leaving their farmyard. When informed that, at the then current inorganic fertiliser price equivalent, this value would range from £75-£90 per 10 tonne load, farmers were surprised at the high value.

Several farmers (n=5) indicated that although they were able to accurately apply a required rate per ha of solid inorganic fertiliser, this was far less practical for livestock manures, particularly slurries.

Soil organic matter enhancement

Although several conventional arable farmers indicated in the On-farm Interviews that they had imported livestock manures and applied them to arable crops so as to increase soil organic matter content, no farmer had specifically requested soil analysis for that purpose. Similarly, although those farmers utilising minimum tillage, no tillage and/or direct drill techniques indicated that an achieved benefit was the enhancement of soil OM, there were no quantified measures of increase, merely general statements regarding increases in earthworm numbers and improvements in soil structure.

5.3 Water Protection Measures in Schemes and other programmes

5.3.1 Government-supported Schemes

During On-farm Interviews, farmers were asked whether they had or have had an agreement for a Defra or Forestry Commission scheme. Only a single farmer had not participated in one or more scheme.

Only 8% of Postal Survey respondees (n=5) had not participated in a scheme. Some 74% of respondees had an O/ELS (n=46), and there were 4 HLS Agreements. The results presented focuses upon the On-farm Interviews, unless stated otherwise.

Energy Crops Scheme (ECS). A minority (n=3) had or still were involved in ECS but with the cultivation of Oilseed rape on Set-aside rather than Short-Rotation Coppice (SRC) or miscanthus. Of those asked why they had not grown SRC or miscanthus (n=17) the most frequent response was that they had neither the time nor land to become involved or that there was no easily accessible market for output. The inference is that the effort of developing resources and facilities has not been recognised as financially worthwhile, even for arable farmers in the past when farmgate cereal prices were low. Until accessible markets are developed, Gross Margins for SRC and miscanthus increase relative to combinable crops, and miscanthus establishment costs are supported more completely under the ECS, a rise in energy crop production with associated reductions in N-fertiliser use with subsequent benefits to groundwater quality, would appear unlikely in Dorset.

Organic Farming Scheme (OFS). The Organic Registered farmers (n=2) in the On-farm Interviews both converted with OFS and are now implementing OELS. Both farmers stated categorically that they could not have financed the initial conversion cost from conventional to organic farming without the 'front-end loading' premiums of conversion aid top-up payments.

However, one conventional farmer was under the misapprehension that OELS had no conversion aid top-up payments and that he could not therefore afford conversion to organic status.

A large proportion (n=12) of the Postal Survey respondees (19%) were either registered organic or in the process of conversion. Of those, 9 (75%) indicated that they had converted using OFS and that they would not have been able to convert without the support of this scheme.

South Wessex Downs Environmentally Sensitive Area (SWD ESA). Of those eligible for the ESA (n=5), 3 had had Agreements all of which had either expired or been terminated by the farmer concerned. Agreements discussed were strongly oriented towards Low Input Permanent Grassland (Tier 1, 2A) and Downland Turf Management (Tier 1, 3), although 1 farmer included Permanent Grass Enhancement (Tier 2, Option 4) and Small Woodland Management and generation. Asked if the management of this land within the ESA Agreement would have been different had there been no Agreement, the main response was that nitrogen fertiliser rates would have been increased, although 1 farmer said that there would have been no change as the Downland and Permanent Grassland was steep sloped and not particularly responsive to inorganic fertiliser.

Overall, the ESA Agreements discussed focussed on grassland rather than arable areas. From the limited number of respondents with ESA Agreements, groundwater benefits have been limited, with little interest in Conservation Headlands which do not appear to fit within most arable farm business plans. Nevertheless, the inclusion of Downland and Permanent Grassland Tiers has encouraged the retention of these areas, often in undulating landscapes with low inorganic fertiliser inputs.

Countryside Stewardship Scheme (CSS). Of those farmers eligible for CSS (n=15), 7 reported having existing (n=4) or expired (n=3) Agreements. Of those 3 with expired Agreements only 1 had managed to gain a HLS Agreement, and then apparently only because the farm contains a Site of Special Scientific Interest (SSSI) and a Site of Nature Conservation Interest (SNCI). For this farmer, the measures included within CSS and HLS were predominantly the same, focussing upon the Maintenance and restoration of species-rich semi-natural grassland or Downland, although under HLS some margins in both arable and grassland have been added.

Overall, farmers have chosen those CSS measures that 'fitted in' to their own farming system and specific interests. The farmer ideal was to achieve an agreement without major changes in existing land management practice. Nevertheless, agreement holders both past and current, were concerned restrictions to farming practice imposed by the Agreement and most (n=4) would be doubtful of re-entering such a scheme unless adequate payments were assured.

Entry and Organic Entry Level Stewardship (ELS & OELS). A substantial majority of the farmers participating (n=17) were implementing ELS (n=15) and/or OELS (n=3). With 2 exceptions, the bulk of ELS/OELS points for those within these schemes (n=17) were scored by Hedge Management options. Second choice options were either 2, 4 or 6m field margins in arable crops or permanent grass with low or very low inputs. Clearly, farmers had taken the opportunity to score the necessary points by choosing those measures that: fit their farming system; are as cost-neutral as possible; and are personally desirable by them.

Almost three-quarters of Postal Survey farmers (n=46) were already implementing ELS or OELS agreements, and the remainder were asked whether they planned to apply for ELS if they did not have an agreement already and a majority (n=10) replied that they would. Those that indicated a lack of interest in ELS (n=7) gave various reasons: most land on short-term rental (n=1); only interested in HLS (n=1); too small and not enough points (n=2); too much bother and paperwork (n=2), and; too long to explain (n=1).

Higher Level Stewardship. Apart from those farmers with current ESA or CSS Agreements (n=4), only 1 farmer of 16 had achieved an HLS Agreement to-date. Farmers were asked whether they would be applying for HLS and if not then why not. Broadly, reasons related to a perception by most farmers (n=11) that their application would not be successful and are shown in Table 6.

Table 6 Reasons for not applying for Higher Level Stewardship.

Reason for not applying for HLS	Number of farmers
Still have an ESA or CSS Agreement	4
Considering, but don't know enough yet	3
Whole thing is too complex to understand	1
Need to be flexible on farm	1
Defra has no money for HLS; it's a waste of time applying Have no SSSI, so will not get in	10

A major feature surrounding the topic of HLS, in both the On-farm Interviews and Postal Survey, was the perception of complexity and a general lack of understanding about how one applied and the nature of the application process. Most would like face-to-face on-farm visits to talk about ELS/HLS in relation to their farm and not just in general terms.

The convolution and complexity of HLS was a major stumbling block; with 6 documents totalling 536 pages for an OELS/HLS Application and 5 documents of 377 pages for ELS/HLS.

The single HLS Agreement Holder had a mixed arable and beef holding with a SSSI, and had been in CSS until 2005. Interestingly, the Agreement Holder had not heard of the HLS measures for livestock removal on grassland with or without fertiliser (HJ7 and HJ8), about which he indicated considerable interest during the discussion. This finding would appear to confirm the concerns expressed about the quantity of documentation for ELS/HLS, and the difficulty that farmers would appear to have in absorbing this information.

In the Postal Survey, farmers were asked whether they had considered HLS and if they had not then why not. Most farmers responded (n=51) and a majority (n=38) had considered HLS. As with the On-farm Interviews, the perception of HLS was that the application process and implementation involved a high level of complexity of both the application process and implementation. The two reasons most frequently quoted were the lack of funding for HLS and the difficulty of getting in.

Woodland Schemes. Most On-farm Interview farmers were responsible for some woodland (n=17) with a range of 0.5 to 36 ha, and an average of 6 ha. Although no farmers held agreements with the English Woodland Grant Scheme, 6 farmers had taken advantage of its predecessor, the Woodland Grant Scheme, either for new planting (n=3) or restoration management (n=3).

Including those in receipt of grant from WGS (n=3), a substantial number of the 20 farmers involved (n=8) had planted new woodland areas in the past 25 years, totalling some 7 ha. A majority of farmers (n=16) had considered further woodland planting. It would appear that, although farmers may be

interested in planting woodland areas either for personal satisfaction or for reasons of encouraging wild and/or game birds, a lack of surplus farm labour is a constraint.

5.3.2 Schemes and Projects implemented by business or non-profit making organisations

Farmers were asked about 6 Projects operating within Dorset and whether they had either heard of them, had contact with them and if so, the nature of that contact. Few if any of the projects described in Section 4 were known by the farmer participants and individual contacts had been limited.

5.3.3 Water Protection Measures undertaken or planned within conservation designated areas and effect on groundwater

Three farmers managed land that included one or more Sites of Special Scientific Interest (SSSI). None had been in receipt of Wildlife Enhancement Scheme (WES) support, new applications for which were discontinued with the initiation of ELS and HLS in 2005.

From the On-farm Interviews, the coastal grazing and Frome bank part-SSSIs were in the Countryside Stewardship Scheme and the former is still valid. A CSS Agreement on the latter expired and was immediately replaced with the only HLS Agreement currently in operation amongst the 20 farmers.

5.3.4 Other Water Protection Measures not supported under on-going Schemes and Projects

Each of the secondary measures not included within schemes and discussed in Section 4 were briefly described to each farmer in the On-farm Interviews and Postal Survey. On-farm Interview opinions were requested as to whether a secondary measure might be an attractive measure from a practical farming perspective, the reason why it would be liked or not, and what the farmer would expect to be paid to implement the measure described is given in Table 7. Their potential benefits to groundwater are estimated in Table 2 which identifies these measures by having 'none yet' in the column describing annual payment rates.

Table 7 On-farm Interview: opinion of Secondary Measures not included in schemes

Secondary Measure	Already implemented on-farm?	Measure liked or not[1/]	Reason for like or dislike	Payment required [£/ha]
Over-wintered stubble followed by a Spring-sown crop	8	12:4:4	too dry for spring sowing (n=2) not fit farm or too dry (n=1)	25-400 (n=7) mean = 159
Adoption of Minimum Tillage or No Till	6	10:6:1	weed problems with Min-Till (n=2)	25-50 (n=5) mean = 39
Tractor exhaust gas boost to soil carbon.	0	4:15:0	sounds good but need details (n=19)	na
Conservation headlands of 6-24m wide of cereals managed without fertilizer.	2	6:4:8	weed problems (n=3) yield very low (n=2)	125-750 & Income Foregone + £25 (n=5) mean = 400
Routine sub-soiling of arable land.	11	14:3:2	no need (n=2) only where needed (n=11)	50 (n=1)
Raising organic matter content in arable soils.	0	8:3:2	no OM in soils sample already straw chopping none available (n=1)	na
Precision farming.	4 (some only)	6:0:5	still 3 years away (n=1)	"a lot" (n=1)
Autumn seedbeds left rough	6	9:0:5	na	na

Table 7 On-farm Interview: opinion of Secondary Measures not included in schemes

Secondary Measure	Already implemented on-farm?	Measure liked or not[1/]	Reason for like or dislike	Payment required [£/ha]
Establish post-harvest cover crop	11	13:2:0	na	na
Extensification payments.	2	12:3:1	very useful (n=3) take beef/dairy out (n=2)	25-150 (n=2) 1000/LSU lower a lot/v.high (n=2)
Reduction in high N feed intakes.	1	2:5:5	reluctant to reduce yield (n=3)	≡ ±230 (n=1)
Use of FYM instead of slurry.	3	5:4:4	change from cubicles to loose housing (n=1)	anything (n=1) £5,500 p.a. (n=1) investment cost of loose housing (n=1)
Use of Slurry separator.	7	7:4:3	using 'weeping wall' (n=6)	na
Use of Slurry injection techniques.	1	5:3:6	soil too stony (n=3) not enough storage for contractor (n=1)	na
Use of High Sugar Grass varieties.	2	8:4:2	problem with clovers (n=1)	na
Export slurry & FYM	2	4:0:0	where export to? (n=2)	na
On-farm anaerobic digestion (AD).	1	na	thinking about it (n=1)	na

Note [1/] presented as yes:possibly:no

Clear messages were received with the responses to the queries, the first being that many or most of the secondary measures could be implemented satisfactorily on their farm. However, on few if any farms could all the measures be implemented either practically or from a valid business perspective. For example, there are areas of soils that are perceived to be too stony for Min-Till or Non-Till, or too shallow for Spring sown cereals without the risk of drought and yield loss of developing crops and therefore only appropriate for Autumn sowing.

A second recognition by farmers themselves is that many are not fully aware of the implications of some secondary measures, and would need to see in-field demonstrations on soils similar to their own. An example of this is that of sub-soiling where some thought that they ought to do more but felt restricted by the high contractor cost or uncertainty of the cost:benefit ratio of sub-soiling in their situation. More practical demonstrations involving, in this example, soil pits and in-field lysimeters were suggested as being worthwhile.

In the Postal Survey, farmers were asked whether they had yet adopted any of a list of 21 Secondary Measures or might in future and, if not, then why not (Main Report, Appendix 4). These included measures in closed and current schemes as well as measures as yet not within any scheme or regulation. Many were already being implemented, although the extent, nature of and reason for implementation was not always clear. About one-third of total farmer respondees indicated a willingness to consider implementing some or all of the secondary measures that were presented to them. Of particular interest to farmers were: woodland creation, management and restoration; leaving rough corners and management of permanent pasture, downland or species-rich grassland with limited or no inputs.

5.4 Advisory services and delivery mechanisms

Of the 20 farmers involved in the On-farm Interviews, a majority (n= ± 12) hired consultants, most usually those of an agronomist or livestock nutrition specialist. When discussing soils and the issues surrounding their management, a frequent comment concerned the relative absence of understanding by the specialist hired of 'how soils work' and 'how they can be most cost-effectively managed'.

This sub-Section presents what farmers stated about the current advisory services, not necessarily what they were asked in the On-farm Interviews, and concludes with that which several believe to be a desirable future service. Information from the Postal Survey is presented where appropriate; otherwise this can be viewed in the Main Report, Section 6.

5.4.1 England Catchment Sensitive Farming Delivery Initiative (ECSFDI)

On-farm Interview. The majority (n=16) of farmers had had contact with ECSFDI and 12 had been visited on-farm by the ECSFDI Adviser. The reasons for the visits are presented in the Main Report in which farmer perception of its value is included. Post-Interview, there was no checking upon the reason for the visit, and farmer recollection is the only way of categorizing each visit.

Despite the equal number of opinions as to the usefulness or otherwise of farm visits, the farmers' general opinion of ECSFDI was positive. As with much advisory work, it was often an incidental comment or suggestion from the ECSFDI Adviser that was most valued, rather than the original purpose of the visit. Farmer statements demonstrate that on-farm visits in particular have been valued:

Several farmers (n=3) commented upon the similarity of objectives of ECSFDI and WAgriCo and the land management practices that they advised farmers to consider.

Postal Survey. Of the 57 respondees to the question as to whether they had had any contact with ECSFDI, 46% (n=26) indicated that there had been contact. This included general meeting or workshop (n=7), farm visit by an ECSFDI Adviser (n=14), and telephone contact about stocking rates and fertiliser inputs (n=1). Two visits had led to applications for ELS and HLS, and there had been farm visits for the assessment of ECSFDI capital grant opportunities (n=4) of which only 1 appeared to have been successful.

5.5 Understanding of groundwater issues

During the On-farm Interviews, farmers (n=20) were asked whether groundwater was important and why, what the major pollutants might be and why nitrate in groundwater might be a problem. The responses of each farmer were then given a score of 1-10 on a purely subjective basis. Scores ranged from 0-9 with a mean of 5.4. Surprisingly, farmers within the WAgriCo Primary Measures programme scored only marginally greater than those outside: at 5.6 and 5.2 respectively. The most significant finding was the lack of understanding about the importance of groundwater both nationally and particularly in Dorset, and that nitrate was a major pollutant.

5.6 Project and Adviser continuity

Keeping up to-date with the latest opportunities and implications of new regulations and rulings is not always straightforward for farmers. Evidence from past and current catchment-scale projects elsewhere, indicates that a long-term approach to the provision of advice regarding water and soil run-off, ideally by the same adviser over many years, is an invaluable component of an effective, efficient and 'farmer-friendly' advisory system.

5.7 Information transfer to farmers

From the On-farm Interviews, it would appear as though farmers adopt fewer measures when less information aware, or adopt them without a full understanding as to why they should be adopted. Technology push issues concern the effectiveness of knowledge transfer and the adaptability of specific technologies, and the flexibility of weather and farming circumstances to encompass such measures within a farm business.

Documentation is often thick and heavy and in language that does not make 'easy reading' and can often be interpreted in different ways.

When shown to several farmers, it was agreed that Defra's (2002) Guidelines to Farmers on NVZs – England, which has a 1 page Summary of NVZ Rules on page 2, with simplified and clarified language would be ideal for laminating and distributing to them for hanging up in their office space. Such simple techniques not only enable farmers to remain aware of what is required, but reinforce such regulations with the farm staff, few of whom have had any exposure to the meetings and training sessions at which the regulations have been discussed.

Internet websites can be an important method of information transfer, but not all farmers have either access to them or are of the generation to have grown up with computers as part of their culture.

Meetings and workshops are routine and frequent but, like all other professions, individual farmers have a wide range of interest in such public events, ranging from enthusiasm to a total unwillingness to attend.

On-farm advisory visits would appear as the information transfer and advisory option of choice by farmers. So much technological advance and new regulations must be interpreted within the context of an individual farm; its topography, enterprise mix, elevation and soil type. A majority of farmers would value greater explanation about new regulations and techniques that can themselves assist in the achievement of new regulatory objectives.

5.8 Advice and guidance

Asked in the Postal Survey whether there were any visits, guidance or training that they would like, there were requests (n=19) but a majority replied negatively (n=30). Requests varied, although the use of manures, nutrient budget calculations (n=5) and Defra-supported grant schemes featured prominently and are shown in Main Report, Table 30. The most frequent proposal would appear to be for the development of application rates for inorganic and organic fertiliser and their application, although general discussions on-farm would be welcomed. Clearly this is a topic area that is of immediate importance to farmers and perhaps likely so to remain for the immediate future.

6 Summary, discussion and conclusions

Given the opportunity and the assurance of confidentiality in the On-farm Interviews and Postal Survey, farmers were willing freely to discuss issues of land management, crop agronomy, regulation compliance, farm business and farming politics.

This Review was undertaken during a period of change in the world food markets that has led to a retail food price inflation of some 6.5% over the year to January 2008. However, despite the 30-35% farmgate price increase for liquid milk, all sub-sectors, whether dairy, beef, sheep, pig, poultry or arable are not apparently realising substantial rises in Gross Margin because of input cost rises. These major input cost and farmgate price changes, whether merely temporary or part of a longer term trend, have

already had an influence upon cropping patterns and farmers expect these to continue. The key message heard at many of the On-farm Interviews can be summarised as 'the need to be able to take a flexible approach to land management, and not to be tied down to practices that are either impractical, restrictive and preventing the taking of opportunities as they arise, or forcing us farmers into a long term programme with predetermined dates for operations that may bear no resemblance to weather conditions'.

6.1 Secondary Measures and their adoption

The Part 1 review presents a wide range of secondary measures that can contribute to reducing the leaching of nitrate through the soil profile into groundwater aquifers and contamination of surface water. However, of the 34 secondary measures described in Section 4, Table 2, only 13 are currently available within ES and of those only 7 are within HLS, 2 of which are conditional upon the land being of historic or archaeological importance.

On-farm Interview farmers were asked about their views on the secondary measures identified in Part 1 and a majority indicated either a liking for most measures or a willingness at least to consider them. The Postal Survey produced a majority either already implementing a particular Secondary Measure or willing to consider it, but for only 8 of the 21 measures presented. The reason for this difference may involve the far greater range in farm size and number of small units of respondees in the Postal Survey than within the On-farm Interviews, indicating a greater proportion of holdings with non-farm enterprises being necessary to derive an income, as well as labour constraints.

None of these individual measures alone is appropriate to all farming systems, soil types, land slopes, weather conditions, livestock densities and cropping patterns. On each farm it would be necessary to implement a range of measures that suit that farm situation, allowing measures to complement each other and enhance groundwater quality.

Overall however, it appears that all the secondary measures described above would be considered and taken up by a proportion of farmers provided that good advice was given on implementation, payments, reason for implementation. But not all farmers would take up all measures offered and not every measure would be adopted by a large proportion of farmers. Take up and implementation within an area would be dependant upon the range of farm size and enterprise mix, soil type and slope, methods used currently and investment in those, a range of other personal and farm business based criteria and, most importantly, the payment inducement available.

Reasons for unwillingness to implement often involved a lack of full comprehension of the agronomic or environmental rationale for a particular measure. Clearly, there is a need for greater clarity of explanation to land managers about why certain measures are appropriate for specific locations and the timing of implementation. This is further reinforcement of the need for an advisory service dedicated to providing skilled guidance on land management issues and being able to provide field-supported evidence that measures are effective in achieving desired objectives on a continuous basis.

6.2 Defra Regulations

The greatest criticism of Cross Compliance GAEC Measures was that farmers do not work by dates, as they need to be flexible to cope with changing weather conditions. However, most farmers had little problem conforming either because they were doing it already or it did not apply anyway. It needs to be made very clear in documentation relating to NVZs and specified in simple terms, the reasons why farmers are required to undertake certain measures.

Concern was expressed about a 'general lack of understanding' by Defra of the implications of each regulation change for particular farms. A repeated message from farmers during the On-farm Interviews concerned the difficulty that they had in keeping up-to-date with the changing regulations and particularly the reasons for their introduction. For example during the On-farm Interviews, few farmers were fully aware of the reasons why groundwater is important especially in Dorset and nitrate in groundwater is a potential problem, and this despite the activities of ECSFDI and WAgriCo, and the Statutory Management Requirement for XC prescribing a maximum level of nitrogen application per ha per year on their farm.

A majority of On-Farm Interview farmers had some or all of their land in NVZs, but would appear to have had no feedback from Defra or EA since NVZs were introduced in 2002, as to the benefits that have been recorded within the locality of each farm's immediate area of operation.

6.3 Defra-supported schemes

The early years of ELS have been a learning process and the end of each ELS agreement (5 years) will be welcomed by those agreement holders who have found that certain measures have not fitted well into their system for practical and/or financial reasons.

Although not always understanding the process and methodologies involved, a majority of farmers would appear to support the concept of agri-environment schemes such as the ESA, CSS, ELS and HLS. However, farmers suggest that a balance needs to be developed between a requirement to adopt measures that benefit wildlife and the environment, and the need to have sustainable food production.

Based upon both On-farm Interviews and the Postal Survey, it would appear that HLS is not currently well received by the farming community. The high level of complexity in this successor to the simple and effective ESA and CSS schemes is perceived to be too restrictive; with priority to farms either containing a SSSI or within a favoured area under the targeting system. It would appear that the HLS Application procedure requires simplification and farmer assurance that the scheme is available to a greater number and wider range of applicants.

6.4 Application of inorganic fertiliser and livestock manures

The range of inorganic nitrogen application rates between farms in the On-farm Interviews appeared wide, even allowing for the variable use of livestock and other organic manures, soil type and past cropping history. There would appear to be a trend for arable farmers to manage crops by quantitative measurement which livestock farmers tend not to do for grassland.

However, the conventional farming culture during the past 60 years of regarding slurry and FYM as waste products would appear to be in the process of change, encouraged by WAgriCo and ECSFDI Advisers. But many farmers, perhaps a majority, appear still to be unaware of the reasons why certain fertiliser or land management practices might be more nutrient efficient than others. Although not permitted by EU organic institutions to apply sewage sludge, Organic Registered farms have had to learn the value of organic manures produced upon their own holdings, and conventional farmers could perhaps benefit from their experiences.

Of particular note was the wide range between farms in the proportion of total slurry and FYM applications in each quarter of the year. Although preferring to apply slurry in spring, farmers indicated

that they were restricted by storage capacity and the need to start the closed application period with empty lagoons or tanks.

Livestock farmers would like to make better use of livestock manures on grassland during the season but, apart from application immediately after a silage cut, cannot apply to grazing ground due to the extended and impractical time interval of 4-5 weeks from application until grass can be grazed. An alternative is the application of diluted or undiluted slurry, using a slurry injector. This equipment is still used mainly by contractors rather than owned and operated by individual farms because of costs. Nevertheless, the injection of slurry below ground level enables grazing to take place within 10-14 days and, when small models become available for farmer use, may enable better use of slurry onto grazing ground and reduced applications rates of inorganic fertiliser.

6.4.1 Slurry storage

Slurry storage was mainly in uncovered lagoons, with slurry diluted routinely with rainwater and often farm building roof water as well. This increases the storage capacity necessary to avoid the application or export of slurry during the closed period under NVZ regulations. Although farmers were aware of the necessity of increasing storage capacity and effectiveness by restricting the access of clean water, years of poor financial returns has restricted this development. In Dorset, farmers are also hampered by the difficulty of lagoon construction in a chalk sub-soil that may restrict storage without percolation into underground aquifers, and therefore may have to invest in above-ground metal tanks and stores.

Particularly within the dairy sub-sector, slurry storage is adequate at best and lacking capacity at worst, even under current closed periods for spreading in NVZ Regulations. As slurry stores will need to be empty at the start of the closed period and then full by the end of the closed period, farmers have suggested that slurry applications will remain seasonalised in Autumn and Spring. A routine and regular application throughout the year, however, might be more beneficial for groundwater quality.

6.4.2 Determination of nutrient application rate

From the interviews and questionnaire, there would appear to have been a recent increase in the routine testing of samples for soil nutrient status. This could be due to a number of factors including the cost of inorganic fertiliser, encouragement from ECSFDI or WAgriCo or as part of NVZ compliance. However, few farmers include soil Organic Matter content in their analysis, due partly to cost or recognition of a need. A majority of farmers had Nutrient Management Plans. This topic was barely touched in the Postal Survey, although it was apparent that assistance with the development of application rates for inorganic and organic fertiliser and their application in an on-farm scenario was the need most frequently expressed by respondees.

Efficient use of slurry and manures is dependent not only upon the nutrient content per m^3 or tonne, timing of application, but also upon the application rate of m^3 or tonnes per ha. Many farmers indicated that this was an estimate only and could vary depending upon application equipment and field slope and shape. It would appear that this topic area would benefit from a more detailed investigation.

6.4.3 The value of slurry and livestock manure

The majority of farmers in On-farm Interviews and Postal Survey had an increasing awareness of the value of slurry from livestock and sewage sludge. However, of the 20 On-farm Interview farmers only one actually analysed the nutrient content of his slurry, and few knew the nutrient value of each tanker load of slurry that left the yard. Organic farmers would appear to have a better understanding of the value of organic manures, simply because this is their only source of applied nutrients. Those

converting to organic status must learn to manage without inorganic fertiliser and it would seem that conventional farmers could learn much from organic farmers.

With shortage of farm labour and a general movement towards use of contractors, equipment such as slurry injectors are now available to apply slurry below the ground surface and with some models, at a pre-determined application rate. Given the availability of a contractor service at reasonable cost, such technology could be adopted enthusiastically by many farmers.

6.4.4 Livestock manure export/import

A feature of responses to both the On-farm Interviews and Postal Survey was the substantial number of farms onto which slurry and/or FYM was imported and spread, and the large number of farmers who would be interested in importing organic matter and nutrients in this form. Particularly for commercial pig units, large and intensive dairy units and poultry producers, this export is likely to be one of the few ways, other than the introduction of anaerobic digesters, for regulations to be met.

6.5 Schemes and wider benefits

Support for maintaining and restoring wildlife, historic habitat and the landscape has been available in Dorset through the South Wessex Downs ESA and Countryside Stewardship Scheme since 1993 and 1991 respectively. A minority of the On-farm Interview farmers were attracted to these schemes. Woodland management, restoration or new planting, although presenting a desirable outcome for many farmers, would appear to be luxury events for spare time only. For farmers with limited labour resources, to plant woodland there would need to be good and easily accessible grant support.

Only since the initiation of Environmental Stewardship (ES) has a move into agri-environment schemes proved an attractive option to the farmers contacted. Many On-farm Interview farmers had undertaken ELS agreements, although most gained entry largely on the basis of boundary management rather than land management options. Although complicating the ELS application procedure, categorisation of ELS measures into measure-types or objectives with a maximum permissible point score from each category, would not appear to unduly affect those farmers with whom this was discussed However, even those with ELS Agreements are uncertain as to the purpose of certain measures and many would appreciate face-to-face farm visits by an ES specialist to talk about changes and options on their farm.

Although it might prove difficult to persuade applicants for the current ELS to choose many of the discussed secondary measures described above, the review of ES currently being undertaken and due to be announced in 2010, may enable measures that will enhance groundwater quality to become a more attractive option to applicants. With ELS being a 5-year scheme only, there are opportunities for an Advisory Service to encourage both those farmers entering ELS and those renewing existing agreements to modify their chosen options in favour of measures that will benefit water quality. Options known to benefit water quality could be prioritised by increasing their ‘score’.

Most farmers were cynical about HLS. This is unfortunate, particularly for those whose current ESA or CSS agreements have been completed and for which no follow-on scheme is currently feasible. Several such farmers inferred that the benefit to landscape, wildlife and historic sites gained in their previous 10-year agreement had been wasted. There is logic for a wider prioritisation of HLS agreements in future to include those groundwater catchments where there is a danger of extracted water approaching the permitted maximum nitrate content. In Dorset for example, the current prioritisation area for HLS excludes a large proportion, perhaps as much as one-half or 50%, of the WAgriCo-targeted

groundwater catchment areas beneath which public water supplies are obtained. So many farmer applicants in these groundwater catchment areas do not receive any priority for HLS and the potential adoption of measures to benefit groundwater quality and quantity.

6.6 Information transfer and advisory support

6.6.1 Interpretation by farmers of documents and schemes

The substantial paper load of farmers was a repeated concern voiced during this study. Finding the time to read and absorb this data and information was a constraint. The size and bureaucratic language of many of the documents puts many farmers off. In addition, there is a need for a clear and concise summary of actions required and implications for a farm with a particular enterprise mix. Suggestions included using packs of simpler and shorter notes with bullet points identifying major features and in simple, clear and unambiguous language.

The general lack of understanding by farmers of ELS and HLS is indicative; even without application forms there being 6 documents of 377 pages and, if OELS is included, 7 documents of 536 pages. Such complexity has not helped to engage farmers 'with a sense of ownership' of the scheme. The trend of a general lack of understanding of the regulations and requirements by farmers was apparent, although there were no questions targeted at this problem. The problem of increasing paper work was a major concern to the Postal Survey's often smaller farms than those in On-farm Interviews.

6.6.2 Routine advice and guidance

Although some farmers use the Internet and attend routine meetings when appropriate, the understanding of regulations and schemes would appear to be determined largely by 'word of mouth' and the documentation described above. The initiation of ECSFDI and WAgriCo in April 2006 and October 2005 respectively, and access to on-farm advisers would appear to have had a positive and beneficial initial impact on those farmers with whom they have come into contact.

Motivated at least partially by the rising cost of inorganic fertiliser, farmers have learned to value the nutrients within organic manures, whether cattle or pig slurry, FYM from various livestock enterprises or sewage sludge. Some farmers have received farm visits from experienced advisers and, in general, had appreciated these as a medium to discuss issues on a 1:1 basis.

However, the extent to which measures to benefit surface and groundwater quality and quantity have been adopted on a permanent basis as a result of these visits remains to be assessed. Farmers have businesses to operate and are unlikely to change farming patterns unless the measure to which change takes place is 'cost-neutral' at worst, and ideally of financial benefit to the farm business. ECSFDI and WAgriCo have been active but with the latter being completed, there is no certainty that farmers will continue to implement land management measures that reduce business flexibility, are not cost-neutral and for which no financial inducements are immediately available.

Several farmers indicated that ECSFDI and WAgriCo actually were just starting and, as there were perceptions of uncertainty over future support for ECSFDI, to stop now was not rational. Whilst it was recognised that WAgriCo was a 3-year pilot research programme closing in September 2008, there remained a need for continuity of advice and guidance and on-farm rather than, or as well as, in workshops. There was a level of disappointment apparent with those farmers with whom discussions were held whether in the On-farm Interviews or at the WAgriCo Workshop in May 2008, about this

'slow-down' in advisory services. Farmers asked whether they would be willing to pay for such advice in the same way that they hired agronomists for general crop management, gave a varied response.

ECSFDI would appear to be working towards an achievable objective and is valued, but CSFOs seldom visit farmers and the advice is given by contractors, whose staff are not necessarily long-term and constant. Without contact continuity, farmers are unlikely to value such a support system or to approach field staff directly when they need technical guidance and support. Perhaps better to consider support for a small group of advisers, each allocated to a particular river catchment or group of catchments so they can become thoroughly familiar with the prevailing farming conditions and systems in the area, and can themselves become an essential element of the agricultural scene.

Conventional farmers would appear to have much to learn from organic farmers who have no choice but to manage their home-produced or imported organic manure effectively. Even when registered organic, there is still a 'long learning curve'. The Soil Association has indicated that it is willing to support and encourage visits by conventional farmers to Organic Registered holdings not to encourage conversion, but to enable conventional farmers to gain from the experience of those who have just had 'to make do' with such as livestock manures and legumes to enhance soil fertility.

ECSFDI and WAgriCo have been able to provide a source of advice welcomed by farmers on a wide range of topics. Particularly valued by farmers have been on-farm visits, since it is much easier for a farmer to relate regulations, issues and opportunities to his own farm situation when discussions take place on that farm and face-to-face with an adviser. Several farmers stated that there was a shortage of soil and land management expertise and experience.

Installation of nitrate removal capability at groundwater abstraction locations would involve Water Companies in considerable capital and recurrent expenditure. In England and Wales during the period 2005-10, Water Companies will spend over £288 million including capital investment and £6 million per annum operating expenditure at 75 separate sources used for drinking water, to reduce high nitrate levels caused by diffuse pollution. Nitrate removal plants, as well as being costly to build and maintain, are also energy intensive and will add to the water industry's growing carbon footprint.

In certain situations, particularly perhaps in areas where a large proportion of public water supply is derived from groundwater sources such as Dorset, it would appear logical to consider long-term support for advisers who can routinely visit, talk to and encourage farmers. There can then be methods developed that fulfil the requirements of Water Companies to conform to EU Nitrate maxima in the public water supply, whilst enabling farmers to best contribute to global food supplies at a time when sustainable productivity is uncertain.

Alternatively, the views of On-farm Interview farmers might be considered that land management for the minimisation of diffuse pollution, both water run-off and leaching to groundwater, should be dealt with by ECSFDI Advisers, rather than focussing upon water run-off and soil erosion. This implies that ECSFDI priority catchments should include those groundwater catchments from which drinking water is extracted, as well as an external margin to take account of surface water entry to aquifers through subsoil fissures.

7 Recommendations

Based upon the discussions with and responses from farmers described above, the following recommendations are proposed:

7.1 Secondary Measures

a) Defra to include additional measures in ELS/HLS specifically for the benefit of groundwater quality and quantity but without compromising other ELS/HLS objectives;

b) Within Schemes, Defra to indicate clearly and succinctly the purpose and benefit(s) of each measure that farmers are invited to adopt;

c) Defra and the Environment Agency to consult with farmers over ways to encourage the import and export of slurry and FYM between farm holdings;

7.2 Agri-environment Schemes and Defra support

d) Simplify the documentation and application process for HLS;

e) HLS Priority Areas to be modified to include priority Groundwater Catchment areas.

f) Based upon recent experience, farmers perceive HLS as an exclusive, inaccessible scheme. Defra-Natural England should attempt to address this perception by removing geographic targeting and reducing the emphasis on SSSIs;

g) Include flexibility over dates in regulations and Schemes dependent upon weather and other conditions; make it easier to option a derogation from prescriptions;

h) Pilot a system whereby a group of farmers monitors and polices their own conformation of regulations and/or Scheme conditions;

i) Defra to take action at a high level to persuade EU Organic Regulators to approve the use of Sewage Sludge to Organic Farms in UK and elsewhere;

j) With livestock manures in some locations perhaps contributing to nitrate levels in groundwater approaching or exceeding the maximum permitted threshold, alternative uses of such manures should be promoted and encouraged by Government agencies, so as to reduce the volumes that must be spread onto land. This would include anaerobic digestion and biogas production for which there is little support at present;

7.3 Advisory and information transfer

k) As part of its remit, ECSFDI to advise on all water issues relating to agriculture including groundwater. A greater awareness of groundwater issues is needed, and CSFOs should be trained on understanding groundwater quality issues and land management practice;

l) Water companies to take responsibility for providing ongoing advisory support within defined groundwater catchment areas from which public water supplies are extracted. This support would be for both capital grants and an Advisory Team that would be skilled in soil and nutrient management, but also familiar with the agri-environment schemes to which farmers could apply. This Advisory Team would provide farm visits, general talks, development of demonstration locations, and cooperation with other interested agencies and institutions. This

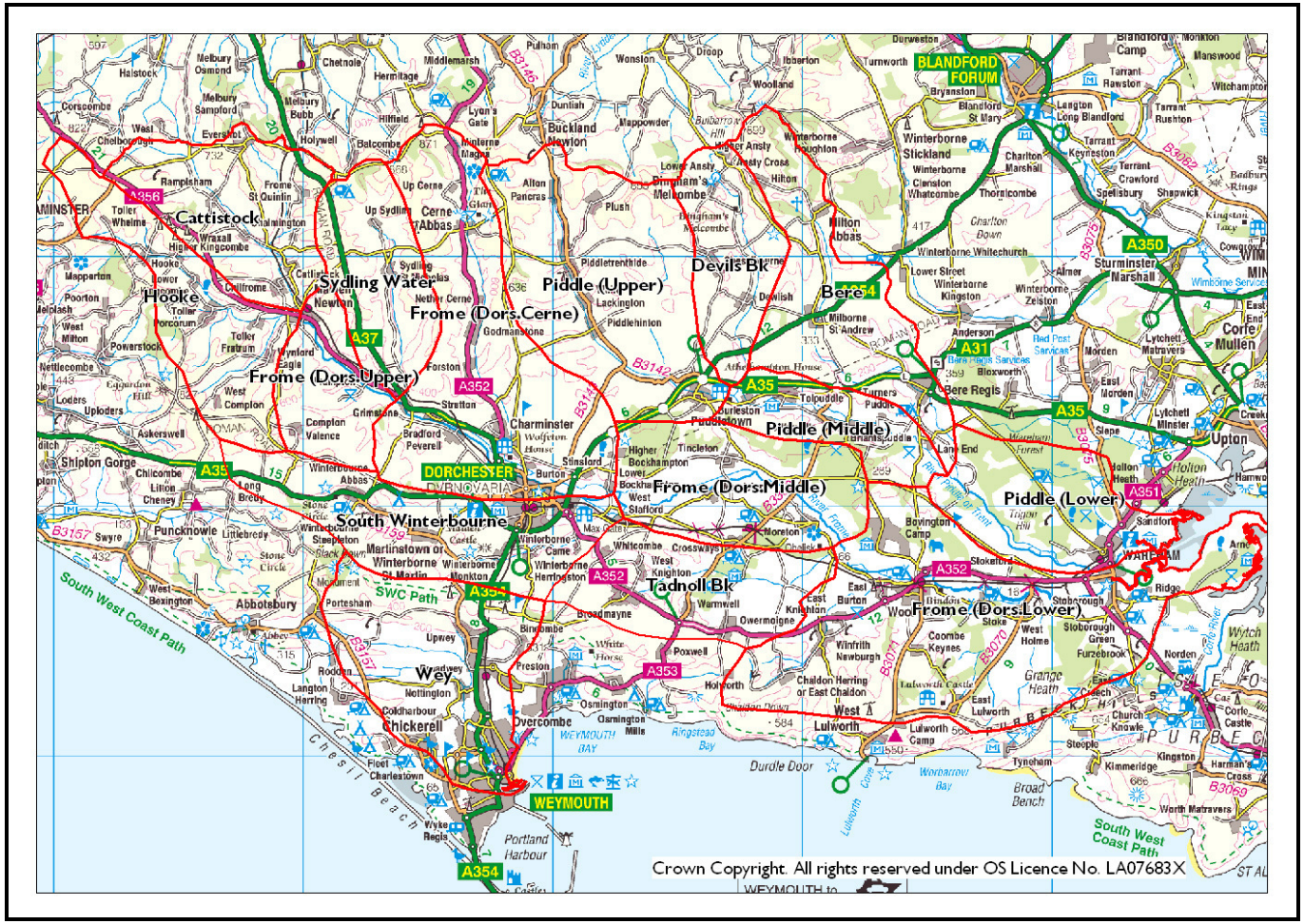
could, at least in part, be paid for by future reductions in capital investment and costs associated with denitrification plant at groundwater abstraction and distribution plant;

m) Conventional farmers could gain from a better understanding of how organic farmers manage to farm without inorganic fertiliser. Advisory groups to participate with charitable organisations involved with organic farmers, and promote events on organic farms, not with the intention of organic conversion but for conventional farmers to hear how those without access to inorganic fertiliser manage their crop nutrition and production;

n) Publications from Defra and other Government agencies should provide the details of what is required, where it is required and why it is required, in simple documents that can be summarised succinctly on a single side of A4 at the beginning of the document. Prior to distribution to the farming community, such documents should be reviewed by a 'farmer document liaison group', not to approve the regulation or scheme concept but to advise the document producers as to whether the document is clear, understandable and easily readable and any changes that need to be made;

o) Farmers are being told 'what to do', but seldom 'why they must do it' (see n) above) and even less are they being 'shown that it is working'. Farmers should be provided with succinct and easily understandable results of the land management measures that they are being required to undertake. For example, the awareness of farmers in Dorset should be raised about the nitrate levels in groundwater in their immediate area and changes that have occurred since NVZs started. This could be undertaken by Water Companies who monitor such data routinely;

Map 1 Frome, Piddle and Wey River Catchments in Dorset[1]



[1] Environment Agency

Map 2 Borehole Catchment Areas for WAgriCo Primary Measures