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recycling to agricultural land in Wales**

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1 Introduction

1.1 Agriculture in Wales

- In 2021, more than 90% of the land area of Wales was classified as agricultural land (1.8 million ha on farm holdings and 180,000 ha of common rough grazing) (Welsh Government, 2021). In Wales agriculture is dominated by grassland (permanent pasture and sole-rights rough grazing) which accounts for 78% (1.4 million ha) of the total area on farms with significant variation in type (e.g., improved, natural or semi-natural) and management (e.g., stocking rate or cutting regime). In comparison, tillage accounts for 14% (0.25 million ha) of the area, 7% is woodland (0.12 million ha) and the remaining 1% 'other' land on farms (Welsh Government, 2021). Of the 250,000 ha of tilled land in 2021, 62% (c.156,000 ha) was grass under 5 years old and 38% (94,000 ha) was in arable and horticulture production (more than 50% of which was cereal crops).
- The interaction between climate and soil type influences the productivity of agricultural land. Local climate is strongly influenced by topography, aspect and altitudinal gradients in temperature and rainfall that lead to microclimatic variations. Of the total land area of Wales, 60% is more than 150 m above sea level, and 27% is more than 300 m above sea level (Russell *et al.*, 2011), where the climate will limit the potential for agricultural crop production. In addition, acid soils and impeded drainage limit tillage and grassland intensification over large parts of Wales. As a result, around 75% of land is classified as Agricultural Land Classification (ALC) classes 3b, 4 and 5 (i.e., mainly unsuitable for arable cropping). Similarly, around 80% of the agricultural land in Wales has been designated under the Less Favoured Area (LFA) Directive (EU Directive 75/268/EEC of 28 April 1975) (Welsh Government, 2018). LFA land is characterised by challenging climatic limitations and shallow, stony and/or peaty soils with limited agricultural and forestry potential and below average economic returns (Armstrong, 2016). Consequently, large areas of agricultural land in Wales are not suitable or available for applications of organic materials.

1.2 Organic materials

- Maintaining an appropriate level of soil fertility by the careful use of manufactured fertilisers (produced by an industrial process), organic materials (fertiliser derived from animal, plant or human sources including livestock manure) and lime will help to maximise the profitability of agricultural production. However, nutrients lost from agricultural land can be an important cause of air and water pollution unless carefully managed. Nutrient losses from fertilisers or manures can be minimised by matching applications to crop requirements and applying at the correct time and in the right place (e.g., to reduce the risk of runoff into surface waters)
- Appropriately managed use of organic materials for agricultural benefit or ecological improvement is acknowledged as the Best Practical Environmental Option (BPEO) in most circumstances (Cundill *et al.*, 2012). The benefits of using organic materials in place of manufactured fertilisers include reduced fertiliser costs, the addition of organic matter to soil which can improve soil structure, workability, resilience to drought and/or waterlogging and increased carbon storage. However, it is important that the application of organic materials only takes place when soil and weather conditions are appropriate and when the nutrients supplied can be utilised by the crop and reduce the risks of environment, soil, water or air pollution. Legislation and codes of practice are in place to control application rates, timings and location of organic material application to reduce their environmental impact.
- To realise the benefits of organic materials there must be land that is both suitable and accessible for applications by machinery. Thus, the sustainability of recycling organic materials to land in Wales is dependent on the size and distribution of the available agricultural landbank at both a national and local level. Not all the 1.8 million ha of agricultural land in Wales is suitable for

recycling organic materials due to climatic, physical and practical constraints (e.g., steep slopes or proximity to water), and legislative restrictions. For example, upland rough grazing will generally be unsuitable for organic material applications due to steep slopes and low nutrient requirements. In comparison, arable production usually takes place on land with fewer climatic and physical constraints and crops have a greater requirement for nutrients than extensive grasslands.

2 Objectives

- The overall objective of this project is to establish the distribution and size of the landbank in Wales available for recycling organic materials both at national and local scales. The work will be delivered in 2 work packages (WP). Work package 1 (this report) has identified the legislative, physical, land, soil, management, seasonal and climatic barriers to the application of organic materials to land in Wales. Work package 2 will quantify the available landbank for organic materials in Wales, using the ALLOWANCE (Agricultural Land – A National Capacity Estimator) tool (Nicholson *et al.*, 2012).
- This work package 1 report has collated organic material datasets from Natural Resources Wales (NRW), Welsh Government and other external sources (e.g., Dŵr Cymru Welsh Water or Renewable Energy Assurance Limited (REAL). In addition, relevant information on the legislative (e.g., Water Resource (Control of Agricultural Pollution) (Wales) Regulations 2020), physical (e.g., no spreading to slopes >12°), best practice (e.g., Code of Good Agricultural Practice (COGAP) and other controls (e.g., designated areas such as Sites of Special Scientific Interest (SSSIs)) on organic materials to lands are described.
- The data collated in WP1 will be used to update the appropriate datasets in the ALLOWANCE tool, which will be used in WP2 to identify the extent and distribution of the landbank for organic materials for the benefit of agricultural land in Wales.
- This report explores factors that control the application of organic materials which have been considered under eight broad categories:
 - o Organic material type and regulations for recycling to land
 - o Legislation
 - o Climate and season
 - o Site (e.g., soil or slope)
 - o Cropping and crop nutrient demand
 - o Designated sites
 - o Voluntary or elective schemes

3 Organic material types

- Organic materials contain major plant nutrients (e.g., nitrogen, phosphate, potash, magnesium and sulphur), which are all essential for plant growth. They are also a valuable source of organic matter, which can improve soil physical, chemical and biological properties such as water holding capacity, workability, structural stability, water infiltration rate, nutrient supply, biological activity etc. However, when the nutrient application rate exceeds soil and crop demand, or the materials are applied where there is rapid connectivity to water courses, or when soil and weather conditions are inappropriate there is increased risk of nutrient losses to the environment. To reduce this risk legislative and good practice guidance for organic material applications to land aims to limit nitrogen and phosphorus losses from agriculture.
- According to the British Survey of Fertiliser Practice (BSFP) in 2020 around 65% of farms in Great Britain used organic materials on at least one field on the farm. In 2020, organic manure was

applied to 25% of the area of tillage crops, 32% of the area of grass five years old and over and 51% for grass under five years old. Most cattle manure and slurry was applied to grassland, reflecting the practice of utilising the manure on the farm on which it is produced. Note that the BSFP does not give any Welsh specific statistics for organic material applications to agricultural land.

- Most of the organic materials spread to agricultural land in Wales are livestock manures, with 8.4 million tonnes of manures and slurries produced by housed stock (i.e., excluding excreta produced at grazing) (Smith and Williams, 2016). Other organic materials used in Wales include 515,000-670,000 tonnes of waste spread under a permit or exemption (Welsh Government, 2014), c.57,000 tonnes of PAS 100 compost and c.252,000 tonnes of certified digestate (REAL, 2021) and 38,000 tonnes of biosolids on a dry weight basis (equating to 152,000 tonnes fresh weight assuming a dry matter of 25%) (DCWW, 2018). These data suggest that that in Wales, livestock manure accounts for 89%, permitted waste 5%, PAS 100 compost 1%, PAS 110 digestate 3% and biosolids 2% of organic materials applied to agricultural land, respectively. Note that the most up to date values available will be used in WP2 landbank calculations.
- The Waste Framework Directive (2008/98/EC) defines 'waste' as "any substance or object which the holder discards or intends or is required to discard". Livestock manure, straw and other non-hazardous agricultural or forestry material used in farming, forestry through "processes or methods which do not harm the environment or endanger human health" are excluded from the scope of the Directive. Therefore, most of the organic material (by quantity) recovered to land is not classified as 'waste'. However, some types of organic materials that are spread to land in Wales are classified as 'waste' and must be recovered to land in accordance with waste management controls. For compost and digestate, where the material is compliant with a quality protocol it is no longer regarded as a waste and can be recovered to land without the need for waste management controls. See Section 5 for more details.

3.1 Livestock manures

- For Wales, slurry is specifically defined in The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 as "liquid or semi-liquid matter composed of - (i) excreta produced by livestock (other than poultry) while in a yard or building (including that held in wood chip corrals); or (ii) a mixture wholly or mainly consisting of livestock excreta, livestock bedding, rainwater and washings from a building or yard used by livestock of a consistency that allows it to be pumped or discharged by gravity at any stage in the handling process" (Welsh Government, 2021a). Livestock manure is not defined in the Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021. However, Agriculture and Horticulture Development Board's (AHDB) guidance in the Nutrient Management Guide (RB209) defines livestock manure as "dung and urine excreted by livestock or a mixture of litter, dung and urine excreted by livestock, even in processed organic form". It includes farmyard manure (FYM) (excreta that is mixed with straw bedding material that can be stacked in a heap without slumping), slurry, poultry manure (excreta produced by poultry, including bedding material that is mixed with excreta), separated manures and granular or pelletised manures (AHDB, 2020). As noted above, livestock manure makes up the majority (almost 90%) of organic materials spread to land in Wales.
- In June 2021, there was c.21 million agricultural livestock in Wales comprising of 1.1 million cattle (dairy plus beef), 9.5 million sheep, 27,000 pigs and 10.3 million poultry (Welsh Government, 2021). Most of the handled manure (i.e., excreta from housed stock) is from cattle; using 2010 data, Smith and Williams, (2016) reported that 93% of the handled manure (7.8 million tonnes) was from cattle. Given the similar number of cattle reported in June 2010 (1.14 million) and June 2021 (1.13 million) handled manure from cattle in 2021 is expected to be in line with the 2010

value of 7.8 million tonnes. In 2021 (using the same per head manure output as Smith and Williams, 2016) an indicative estimate of total handled manure in Wales is 8.5 million tonnes (compared to 8.4 million tonnes in 2010). Note that although poultry numbers in Wales have increased from 7,570,700 in 2010 to 10,352,300 in 2021 this will have little overall effect on total handled manure to land because the excreta output of poultry is much less than that of cattle.

- For WP2 the livestock manure output in Wales (based on data from the June 2021 Agricultural Census (Welsh Government, 2021)) will be calculated using manure nitrogen output (kg/head/year) based on livestock type, manure production, nitrogen content and adjustments for occupancy. The proportion of manure that is a) handled and b) solid is also calculated for each livestock type.

Table 1. Livestock numbers in Wales (June 2021 and June 2020) and manure production (2010)

Livestock type	Number ¹		Manure production (2010) ² million tonnes	
	June 2021	June 2010	Slurry	FYM/Solid
Dairy				
<1 year	83,100	63,500	2.12 ³	1.32 ³
1-2 years	74,100	60,100		
≥2 years no calf	35,900	52,900		
≥2 years with calf	255,400	221,300		
Beef				
<1 year	118,300	105,800	0.59 ³	3.77 ³
1-2 years	93,300	91,600		
≥2 years no calf	39,400	56,200		
≥2 years with calf	159,500	185,800		
Male cattle				
<1 year	142,100	143,200		
1-2 years	94,800	106,900		
≥2 years	32,700	50,800		
Total cattle	1,128,600	1,138,100	2.71	5.09
Sheep				
Ewes for breeding	4,373,100	3,876,100		
Ewes for cull	253,500	233,500		
Rams for service	100,300	90,200		
Other sheep (≥1 year)	89,800	106,300		
Lambs (<1 year)	4,647,700	3,938,100		
Total sheep	9,464,300	8,244,200		0.39
Pigs				
Breeding	3,000	4,500		
Fattening	24,200	22,500		
Total pigs	27,200	27,000	0.04	
Poultry				
Chickens (layers)	3,148,500	1,289,200		
Chickens (broilers)	6,537,800	5,850,500		
Chickens (breeding)	471,400	224,100		
Turkey	100,100	58,500		
Other birds	94,500	148,400		
Total poultry	10,352,300	7,570,700		0.20 ⁴
			2.75	5.68
Total manure (slurry + FYM)			8.43	

¹Livestock numbers from Survey of agriculture and horticulture June 2010 and June 2021.

²Manure production handled as slurry and FYM/solids for Wales for 2010 from Smith and Williams, 2016

³Slurry and FYM production for cattle includes production from both male and female cattle. Smith and Williams (2016) split manure production data by enterprise type (i.e., dairy and beef) but not by livestock age/gender.

⁴Poultry manure production from all types of birds. Note all poultry manure is classed as solid manure (dry matter typically ≥20%).

3.2 Biosolids

- Sewage sludge (i.e., 'biosolids') is produced through the treatment of urban wastewater at wastewater treatment works and can be in cake, granular/pellet or liquid forms. Solid materials (e.g., digested cake, lime stabilised cake) are the most common products in the UK; all biosolids supplied for application to agricultural land by Welsh Water are solid materials (c.24% dry solids)¹ which have been subject to treatment processes to control microbial pathogens.
- Sewage sludge applied to non-agricultural land and agricultural land "used for the production of non-food crops not grown in short rotation with food crops" is applied to land for agricultural benefit under the Environmental Permitting Regulations (EPR) (SI, 2016). Specifically, Standard Rules SR2010 No6 v5.0 "Mobile plant for landspreading of sewage sludge (land treatment resulting in benefit)" (NRW, 2016). Otherwise, where applications are made to agricultural land (land growing commercial food crops, including for stock rearing purposes), permits are not required, and sludge is applied according to "The Sludge (Use in Agriculture)" Regulations 1989 (SI, 1989) (see Section 5.4 for more details).
- In 2018, Dŵr Cymru Welsh Water (DCWW) predicted that 38,000 tonnes of biosolids on a dry matter basis (equating to 152,000 tonnes fresh weight assuming a dry matter of 25%) would be available for spreading in Wales in 2020 (DCWW, 2018).

3.3 Water treatment cake

- Water treatment cake (sludge) is the residue resulting from the treatment of raw water to produce potable water in water treatment works. The cake is composed of the impurities removed and precipitated from the water, together with the residues of any treatment chemicals used. Typical processes include centrifuging, coagulation (using iron hydroxide or aluminium sulphate), filtration, dewatering and thickening.
- In Wales, water treatment cake may be spread to agricultural land for agricultural benefit/ecological improvement under the EPR (2016), specifically Standard rules SR2010 No4 v6.1 Mobile plant for landspreading (land treatment resulting in benefit to agriculture or ecological improvement) (NRW, 2016).

3.4 Compost

- Natural Resources Wales (NRW) define composting as the "managed biological decomposition of biodegradable waste, under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat and that result in compost" (NRW, 2017). Green compost is solely derived from green waste from domestic gardens, municipal parks and recreational areas, whereas green/food compost contains a mixture of garden and food waste. Both green and green/food compost are derived from feedstock material that has been collected separately from other waste streams.
- Where compost meets the standards of both PAS 100 (BSI, 2011) (see section 5.3 for more details) and the Compost Quality Protocol (WRAP and Environment Agency, 2012) it is no longer a waste and can be recovered to land according to the Code of Good Agricultural Practice (COGAP) Wales (Welsh Assembly Government, 2011) and Water Resource (Control of Agricultural Pollution) (Wales) Regulations 2021 (WSI, 2021) (subsequently abbreviated to COAPR 2021 in this report). See Section 5.1 for a more detailed description of the COAPR 2021. In addition, the Compost QP also states that compost must be applied in accordance with cross compliance requirements,

¹Dŵr Cymru Welsh Water. Bioresources and contract information (Excel spreadsheet)

guidance in the Nutrient Management Guide (RB209) (AHDB, 2020), the Code of Good Practice for the Agricultural Use of Sewage Sludge (for metal addition rates) and following guidance on the application of animal by-products.

- Compost that does not meet the requirements of the PAS 100 and the compost QP may be applied to agricultural land under the Environmental Permitting Regulations (EPR) (SI, 2016) in compliance with SR2010 No4 v6.1 – see section 5.5 for more details. Alternatively, small-scale composting (80 tonnes of on-farm waste at a time or 60 tonnes if using off-farm waste) can be carried out on-farm (processing manure, crop and green waste) under a T23 exemption (from EPR)². The resulting compost can be spread for agricultural benefit under the U10 exemption (NRW, 2017).

3.5 Anaerobic digestate

- In contrast to compost, digestate is typically a nutrient rich substance produced by anaerobic digestion (AD) of biodegradable organic materials for biomethane production (AHDB, 2020). The digestate may be separated into liquid and fibre fractions before application to land. Biomethane production uses a range of feedstocks including domestic and commercial/industrial food ‘wastes’, livestock manures and crops (e.g., maize, grass). Digestate is considered a waste unless it meets the criteria for end of waste. Where digestate meets the standards of PAS 110 (BSI, 2014) and the Digestate Quality Protocol (WRAP and Environment Agency, 2014). (see section 5.3) it is no longer considered a waste and can be recovered to land according to COGAP and COAPR 2021. In addition, the Digestate QP states that digestate must be applied in accordance with cross compliance requirements, guidance in the Nutrient Management Guide (RB209) (AHDB, 2020), the Code of Good Practice for the Agricultural Use of Sewage Sludge (for metal addition rates) and following guidance on the application of animal by-products.
- Digestate that does not meet PAS 110 standards may be applied to land under EPR in compliance with SR2010 No4 v6.1. Alternatively, small-scale digesters (up to 1250 m³) processing manure and crops on-farm can operate under a T24 exemption (from EPR)³. The resulting digestate can be spread for agricultural benefit under the U10 exemption (NRW, 2017).

3.6 Other non-farm wastes

- Other waste may be recovered to land where the agricultural or ecological benefit has been confirmed via an application to NRW for an EPR (SR2010 No4 v6.1) or bespoke permit. A range of non-farm wastes can be recovered to agricultural land for agricultural or ecological benefit under SR2010 No4 v6.1. These are detailed in Tables 2.2A and 2.2B of SR2010 No4 v6.1⁴ (see Table 3 and 4, below). The mobile plant shall be for land treatment activities on notified agricultural or non-agricultural land in England and Wales which result in benefit to agriculture or ecological improvement. The operator must submit a deployment form to Natural Resources Wales, prior to the activity commencing.

² Natural Resources Wales. Register or renew your waste exemption

For full details of the T23 exemption see T23 waste exemption: aerobic composting and associated prior treatment. NRW, note that although the page states the exemptions apply to England only, they are the same in Wales.

³ Natural Resources Wales. Register or renew your waste exemption

For full details of the T24 exemptions see T24 waste exemption: anaerobic digestion at premises used for agriculture and burning resulting biogas. NRW note that although the page states the exemptions apply to England only, they are the same in Wales.

⁴ Standard rules SR2010 No 4. Mobile plant for landspreading

- According to data supplied by NRW around 100 mobile plant deployments were issued in Wales in 2020 to recover c.755,000 tonnes of materials to land. However, note that the amount of material applied to land may have been less than the amount stated on the permit, which represents the maximum amount of material that can be applied under that deployment. More than twenty types of organic materials were applied under a permit in 2020 (Table 2). Considering the tonnages of materials indicated on the deployment almost half (49%) of the materials applied under a mobile plant deployment were sludges from water clarification (31% of total tonnage) and sludge from on-site effluent treatment: dairy products industry (18%).

3.6.1 *Paper crumble (sludge) and paper sludge ash*

- Paper crumble is the residue from the preparation of recycled paper prior to its re-use in the paper production process, or from the processing of virgin fibre from a variety of fibre sources, such as wood or cotton. It contains short cellulose fibres which are not suitable for use in paper production, printing inks and mineral components such as kaolin, talc and calcium carbonate. Paper sludge ash is the residue from the incineration of paper sludge. De-inked paper sludge and de-inked paper pulp from paper recycling and paper sludge ash can be recycled to land under EPR in compliance with SR2010 No4 v6.1.

3.6.2 *Food and drink processing waste*

- This category includes a wide range of materials all of which are categorised as waste and applied under EPR. Only the specific waste types listed in Tables 2.2A (see Table 3 below) and 2.2B (Table 4 below) of SR2010 No4 v6.1 can be recycled under this SR; other waste types will require a bespoke permit (NRW, 2016).
- The Animal By-Products (Enforcement)(Wales) Regulations 2014 (WSI, 2014) controls the risks to human and animal health from the handling, treatment, storage and disposal of animal by-products (ABP). Where waste applied to land includes the recovery to land of ABP, then Animal By-Product Regulations controls may also apply. Certain ABP materials may be spread directly to land without treatment (i.e., manure, digestive tract content separated from the digestive tract, milk, milk-based products and colostrum/colostrum products). Grazing (or feeding cut herbage) of pigs is banned for 8 weeks and by all other livestock for 3 weeks following the spreading of ABP materials (except for those that can be applied to land directly) (WSI, 2014; Welsh Government, 2019).

3.6.3 *Other waste*

- Other waste may be recovered to land where the agricultural or ecological benefit has been confirmed via an application to NRW for an EPR (SR2010 No4 v6.1) or bespoke permit. Waste spread to land in certain circumstances for specific purposes (e.g., lime deficiency) might include poultry litter ash, small quantities of bottom ash from the combustion of biomass or pig and poultry carcasses, fly ash from peat and untreated wood, waste from wood processing and gypsum. Note that ash is not considered as an organic material as it typically has little or no remaining organic matter. Consequently, ashes are outside of the scope of this report, which focuses on the available landbank for organic materials.

Table 2. Waste types recovered to land under a mobile plant deployment in Wales in 2020 and % of total accounted for by each waste type (blue shading indicates the five most common waste types by permitted tonnage).

Waste code	Description of waste type	% of total
02 01 Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing		
02 01 06	animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site	1.8
02 01 99	wastes not otherwise specified	0.1
02 02 Wastes from the preparation and processing of meat, fish & other foods of animal origin		
02 02 01	sludges from washing and cleaning	5.4
02 02 02:	animal-tissue waste	0.1
02 02 04	sludges from on-site effluent treatment	6.7
02 03 Wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation & processing; conserve production; yeast & yeast extract production, molasses preparation & fermentation		
02 03 01	sludges from washing, cleaning, peeling, centrifuging and separation	2.4
02 03 04	materials unsuitable for consumption or processing	0.2
02 03 05	sludges from on-site effluent treatment	4.7
02 05 Wastes from the dairy products industry		
02 05 01	materials unsuitable for consumption or processing	4.5
02 05 02	sludges from on-site effluent treatment	17.5
02 07 Wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea & cocoa)		
02 07 01	wastes from washing, cleaning and mechanical reduction of raw materials	2.5
02 07 02	wastes from spirits distillation	2.7
02 07 05	sludges from on-site effluent treatment	4.2
03 03 Wastes from pulp, paper and cardboard production and processing		
03 03 05	de-inking sludges from paper recycling	0.4
03 03 10	fibre rejects, fibre-, filler- and coating-sludges from mechanical separation	0.2
07 07 Wastes from the MFSU of fine chemicals and chemical products not otherwise specified		
07 07 12	sludges from on-site effluent treatment other than those mentioned in 07 07 11	0.2
17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil		
17 05 06	dredging spoil other than those mentioned in 17 05 05	1.4
19 02 wastes from physico/chemical treatments of waste		
19 02 03	premixed wastes composed only of non-hazardous wastes	2.5
19 02 04:	premixed wastes composed of at least one hazardous waste	0.1
19 05 wastes from aerobic treatment of solid wastes		
19 05 99:	wastes not otherwise specified	0.9
19 06 Wastes from anaerobic treatment of waste		
19 06 05:	liquor from anaerobic treatment of animal and vegetable waste	1.2
19 06 06	digestate from anaerobic treatment of animal and vegetable waste	6.2
19 09 wastes from the preparation of water intended for human consumption or water for industrial use		
19 09 02	sludges from water clarification	31.3

Table 3. Standard rules SR2010 No 4 mobile plant for landspreading Table 2.2A Waste types (list A wastes) (Source: NRW, 2016).

Waste Code	Description of waste type
01	WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING AND PHYSICAL CHEMICAL TREATMENT OF MINERALS
01 01	wastes from mineral excavation
01 01 02	chalk only
01 04	wastes from physical and chemical processing of non-metalliferous minerals
01 04 08	chalk only
02	WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATION AND PROCESSING
02 01	wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing
02 01 01	soils from washing and cleaning fruit and vegetables only
02 01 03	plant-tissue waste
02 01 06	farmyard manure and slurry, horse manure and soiled bedding made from plant tissue only
02 01 99	milk from agricultural premises only
02 01 99	untreated wash waters from cleaning fruit and vegetables on farm only
02 02	wastes from the preparation and processing of meat, fish and other foods of animal origin
02 02 02	shellfish shells from which the soft tissue or flesh has been removed only
02 03	wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation
02 03 05	effluent from the on-site treatment of wash waters from cleaning fruit and vegetables on farm only
02 03 99	soils from cleaning and washing fruit and vegetables only
02 03 99	untreated wash waters from cleaning fruit and vegetables on farm only
02 04	wastes from sugar processing
04 01	soil from cleaning and washing beet
03	WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS AND FURNITURE, PULP, PAPER AND CARDBOARD
03 01	wastes from wood processing and the production of panels and furniture
03 01 01	waste bark and cork
03 01 05	untreated sawdust and wood shavings other than those mentioned in 03 01 04 only
03 03	wastes from pulp, paper and cardboard production and processing
03 03 01	waste bark and wood, pulp from virgin timber
04	WASTES FROM THE LEATHER, FUR AND TEXTILE INDUSTRIES
04 02	waste from the textile industry
04 02 10	organic matter from natural products only
17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 05	soils (excluding excavated soils from contaminated sites), stones and dredgings
17 05 04	topsoil, peat, subsoil and stones only other than those mentioned in 17 05 03
19	WASTE FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTEWATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE
19 05	wastes from the aerobic treatment of waste
19 05 03	compost derived from biodegradable waste listed in this table only
20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS
20 02	garden and park wastes (including cemetery waste)
20 02 01	seaweed only
20 02 02	soils and stones

Table 4. Standard rules SR2010 No 4 mobile plant for landspreading Table 2.2B Waste types (list B wastes) (Source: NRW, 2016).

02	WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATION AND PROCESSING
02 01	wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing
02 01 99	slurry and manure and soiled bedding from any premises except abattoirs, soiled biodegradable bedding not made from plant tissue, soiled bedding desiccants only
02 01 99	spent mushroom compost
02 02	wastes from the preparation and processing of meat, fish and other foods of animal origin
02 02 01	untreated wash waters and sludges from washing and cleaning from abattoirs, poultry preparation plants, rendering plants or fish preparation plants only
02 02 01	wash waters and sludges from secondary food processing or the cook chill sector
02 02 02	egg shells from hatcheries, processing plants and similar premises
02 02 02	cooked shellfish shell which is not completely free of flesh
02 02 02	blood and gut contents from abattoirs, poultry preparation plants, rendering plant or fish preparation plants only
02 02 04	sludges from on-site effluent treatment plant from abattoirs, poultry preparation plants, rendering plants or fish preparation plants only
02 02 99	slurry and manure and soiled bedding from abattoirs including soiled biodegradable bedding not made from plant tissue and soiled bedding desiccants only
02 02 99	wash waters from animal by-product handling and processing plants that meet the wastewater treatment requirements in the ABPR
02 02 99	processed animal by-product material from rendering plants
02 02 99	catering waste
02 03	wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation
02 03 01	sludges from washing and cleaning produced during food preparation and processing only
02 03 01	wash waters and sludges from secondary food processing or the cook chill sector
02 03 01	sludges from washing, cleaning, peeling, centrifuging and separation
02 03 02	wastes from preserving agents
02 03 03	wastes from solvent extraction
02 03 04	biodegradable materials unsuitable for consumption or processing only
02 03 05	sludges from on-site effluent treatment
02 03 99	biodegradable wastes not otherwise specified from the processing of such materials including those from secondary food processing or the cook-chill sector
02 04	wastes from sugar processing
02 04 02	off-specification calcium carbonate
02 04 03	sludges from on-site effluent treatment
02 04 99	biodegradable wastes not otherwise specified derived from the processing of sugar
02 05	wastes from the dairy products industry
02 05 01	biodegradable materials unsuitable for consumption or processing
05 02	sludges from on-site effluent treatment
02 05 99	biodegradable wastes not otherwise specified derived from the processing of dairy products
02 06	wastes from the baking and confectionery industry
02 06 01	biodegradable materials unsuitable for consumption or processing
02 06 02	wastes from preserving agents
02 06 03	sludges from on-site effluent treatment
02 06 99	biodegradable wastes not otherwise specified from the processing of materials used in baking and confectionery
02 07	wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea and cocoa)
02 07 01	wastes from washing, cleaning and mechanical reduction of raw materials
02 07 02	wastes from spirits distillation

02 07 03	wastes from chemical treatment
02 07 04	materials unsuitable for consumption or processing
02 07 05	sludges from on-site effluent treatment
02 07 99	biodegradable wastes not otherwise specified from the processing of the raw materials used in the production of such beverages only
03	WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS AND FURNITURE, PULP, PAPER AND CARDBOARD
03 01	wastes from wood processing and the production of panels and furniture
03 01 05	untreated sawdust, shavings, cuttings, wood, particle board and biodegradable veneer other than those in 03 01 04
03 03	wastes from pulp, paper and cardboard production and processing
03 03 05	de-inked paper sludge and de-inked paper pulp from paper recycling only
03 03 09	lime mud waste
03 03 10	fibre rejects and sludges including mineral based fillers and coatings only
03 03 11	sludges from on-site effluent treatment other than those mentioned in 03 03 10
04	WASTES FROM THE LEATHER, FUR AND TEXTILE INDUSTRIES
04 01	wastes from the leather and fur industry
04 01 07	sludges from on-site effluent treatment free of chromium
04 02	wastes from the textile industry
04 02 15	biodegradable wastes from finishing other than those containing organic solvents only
04 02 20	sludges from on-site effluent treatment other than those mentioned in 04 02 19
04 02 21	wastes from unprocessed biodegradable textile fibres only
04 02 22	wastes from processed biodegradable textile fibres only
05	WASTES FROM PETROLEUM REFINING, NATURAL GAS PURIFICATION AND PYROLYTIC TREATMENT OF COAL
05 01	wastes from petroleum refining
05 01 10	activated sludges from on-site oil refinery biological effluent treatment plants other than those mentioned in 05 01 09
07	WASTES FROM ORGANIC CHEMICAL PROCESSES
07 07	wastes from the manufacture, formulation, supply and use of fine chemicals and chemical products not otherwise specified
07 07 12	sludges from on-site biological effluent treatment plant at chemical manufacturing sites other than those mentioned in 07 01 11 only
10	WASTE FROM THERMAL PROCESSES
10 01	waste from power stations and other combustion plants
10 01 01	poultry litter ash, paper sludge ash and ash from wood chip boilers only
10 01 01	meat and bone meal ash
10 01 05	flue gas gypsum (solid) only
10 01 07	flue gas gypsum (sludge) only
10 13	wastes from manufacture of cement, lime and plaster and articles and products made from them
10 13 04	wastes from calcinations and hydration of lime
10 13 12	cement kiln dusts and by-pass dust only
10 13 13	cement kiln dusts and by-pass dust other than those mentioned in 10 13 12 only
10 13 99	gypsum only
16	WASTES NOT OTHERWISE SPECIFIED IN THE LIST
16 03	off-specification batches and unused products
16 03 06	out of date and out of specification beverages only
16 10	aqueous liquid wastes destined for off-site treatment
16 10 02	wash waters from animal by-product intermediate plants that meet the wastewater treatment requirements in the ABPR
17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 05	soils (excluding excavated soils from contaminated sites), stones and dredgings
17 05 06	dredging spoil other than those mentioned in 17 05 05

19	WASTE FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTEWATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE
19 01	wastes from incineration and pyrolysis of waste
19 01 12	ash from the incineration of pig and poultry carcasses at premises used for agriculture only
19 01 18	biochar manufactured from untreated wood, bark, and cork from the furniture manufacturing and wood processing industries (including untreated sawdust, wood shavings, and wood cuttings, except from particle board)
19 01 18	biochar manufactured from untreated wood and plant matter from agriculture, horticulture and forestry, or from vegetable waste from food preparation and processing
19 02	wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)
19 02 03	cement kiln dust and by-pass dust from cement kilns conditioned with water only
19 02 04	cement kiln dust and by-pass dust from cement kilns conditioned with water only
19 05	wastes from the aerobic treatment of waste
19 05 03	compost from source segregated biodegradable waste only
19 05 03	compost from source segregated biodegradable waste and sludges from treatment of urban wastewater only
19 05 99	liquor and digestate from aerobic treatment of source segregated biodegradable waste only
19 06	wastes from anaerobic treatment of waste
19 06 05	liquor from anaerobic treatment of source segregated biodegradable waste
19 06 06	whole digestate and fibre digestate from anaerobic treatment of source segregated biodegradable waste
19 06 06	whole digestate and fibre digestate from anaerobic treatment of source segregated biodegradable waste and sludges from treatment of urban wastewater only
19 09	wastes from the preparation of water intended for human consumption or water for industrial use
19 09 02	sludges from water clarification
19 12	wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
19 12 12	recycled gypsum from plasterboard
20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS
20 02	garden and park wastes (including cemetery waste)
20 02 01	plant tissue waste from parks only

4 Waste management

- The Waste Framework Directive (2008/98/EC) defined ‘waste’ as “any substance or object which the holder discards or intends or is required to discard” (Table 5). Key provisions of the Waste Framework Directive were the introduction of the legal concept of the definition of waste and when material could cease to be a waste. The Framework also included the creation of a waste hierarchy, recycling targets of 50% for household waste by 2020 and permitting of any establishment or undertaking that recovered or disposed of waste. The Landfill Directive set a target for the reduction of biodegradable municipal waste landfilled in 2020 to 35% of that produced in 1995. It also set out requirements for waste permitting.
- ‘The recycling rate in Wales (i.e., the percentage of local authority municipal waste that is reused, recycled or composted) has increased considerably during the last two decades from around 5% in the late 1990s to 65% in 2020-2021 (Welsh Government, 2021b). A third of all material collected for reuse/recycling/composting in 2019-20 was classified as ‘organic’ material (33%) and included food, green (garden) and other compostable waste.
- The increase in waste reuse/recycling in Wales reflected both EU and national policy which changed the way that waste was managed. Up until January 2020 when the UK left the EU, waste management in Wales was subject to EU legislation. The two most important pieces of legislation

controlling the use of organic wastes were the Waste Framework Directive (2008/98/EC) and the Landfill Directive (1993/31/EC). The Waste (Wales) (Miscellaneous Amendments) (EU Exit) Regulations 2019 (WSI, 2019) set out any changes to the WFD for Wales now that the transition period has ended.

Table 5. Terminology used in the Waste Framework Directive waste hierarchy.

Term	WFD definition
Prevention	Measures taken before a substance, material or product has become waste, that reduce: (a) the quantity of waste, including through the re-use of products or the extension of the life span of products. (b) the adverse impacts of the generated waste on the environment and human health. (c) the content of hazardous substances in materials and products.
Re-use	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.
recovery	Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.
recycling	Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.
Disposal	Any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy

- English and Welsh law was updated on 1 October 2020 to include changes to the Waste Framework Directive (WFD) made in 2018. This was done through the Waste (Circular Economy) (Amendment) Regulations 2020 (SI, 2020). An important focus for the WFD was to promote better use of resources by encouraging the use of waste for beneficial purposes. As a result, recovery of waste (where waste was used in place of primary resources) was encouraged over recycling or disposal. Note that under the WFD the application of organic materials “resulting in benefit to agriculture or ecological improvement” is classified as “recovery”.
- In 2014 the Welsh Government published “Towards Zero Waste. One Wales: One Planet. Food manufacture, service and retail sector plan” (TZW) (Welsh Government, 2014). It set out a waste hierarchy (from the best to the worst option) of prevention, preparation for reuse, anaerobic digestion with digestate applied to land, composting of segregated food waste with compost applied to land, other recovery and disposal. TZW acknowledged the importance of recycling organic matter back into the soil in the form of compost and digestate.
- More recently (2021), the Welsh Government published “Beyond Recycling” which set out the steps that the government would take towards a circular economy (Figure 1) (Welsh Government, 2021c). A circular economy aims to keep resources and materials in use for as long as possible and represents a move away from the traditional linear economy (based on a manufacture, use, dispose principle). Key targets of Beyond Recycling are reduction in waste (26%, 33% and 62%

reductions by 2025, 2030 and 2050 respectively⁵), zero waste to landfill by 2025, reduction in avoidable food waste (50% by 2025 and 60% by 2030), 70% recycling by 2025 and zero waste by 2050.

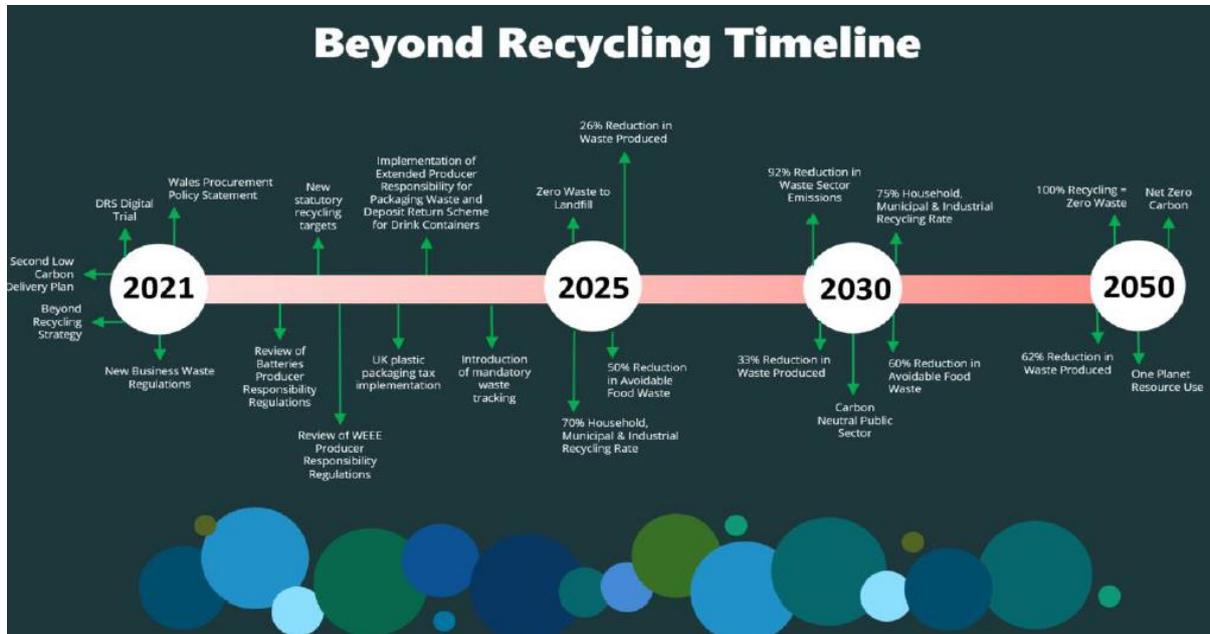


Figure 1. Beyond Recycling timeline 2021 to 2050. Source: Welsh Government, 2021c

5 Regulatory regime for organic materials

- A regulatory regime exists to manage the process of applying organic material to land, to prevent environmental harm and to ensure materials are only applied where there is either agricultural benefit or ecological improvement. The approach taken to control organic materials which are spread to agricultural land is determined by whether the material is classified as a waste. Where materials are classified as a waste, application to land is controlled by the Environmental Permitting (England and Wales) Regulations 2016 (No. 1154) (SI, 2016). However, as noted earlier, livestock manures and slurry make up 90% of the organic materials applied to land in Wales. Livestock manures and slurry are not defined as waste if they are spread for agricultural benefit and in accordance with COGAP Wales (Welsh Assembly Government, 2011) and Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 (WSI, 2021).
- Where Quality Protocol frameworks are followed some waste materials can be reclassified as products if they meet standards for feedstock, processing and quality of material (e.g., limits on physical, chemical and microbial contaminants). Waste quality protocols (QPs) are end of waste frameworks that set out the requirements for compliance for certain wastes (including compost and digestate) that industry can volunteer to follow to achieve product status. Compliance with these criteria is voluntary and is considered sufficient to ensure that the fully recovered product may be used without the need for waste management controls⁶. In addition, sewage sludge (biosolids) is not regulated as a waste when it is used in agriculture and the requirements for land

⁵ All waste reduction targets are set against a 2006-2007 baseline.

⁶ NRW. Meeting the end of waste test.

application set out in the Sludge (Use in Agriculture) Regulations (1989) are fulfilled. In the regulations, “agriculture” is defined as “the growing of all types of commercial food crops, including for stock-rearing purposes. Where an activity fails to meet the requirement of these regulations (application on non-agricultural land or agricultural land used in the production of non-food crops not grown in short-term rotation with food crops), sludge may be applied under waste management regulations (i.e., SRP SR2010 No6 v5.0 mobile plant for landspreading of sewage sludge (resulting in benefit)).

- However, note that for all organic materials (including manures/slurry) where application rates exceed crop requirements or organic materials are not spread for agricultural/ecological benefit this will be classified as ‘disposal’ and all materials will be subject to waste controls.
- Relevant regulatory controls for organic materials are detailed in the following sections.

5.1 Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021

- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 (WSI, 2021) have been introduced to reduce or prevent losses of pollutants from agriculture to the environment by setting rules for certain farming practices including limits on nitrogen loading from livestock manures, nutrient management planning and the application of organic materials⁷. More widely they also include requirements for silage storage, slurry and solid manure containment, temporary field heaps for solid manure, the storage period and storage capacity for organic manures; records must also be kept demonstrating compliance with storage requirements. The regulations apply to the application of all organic materials.
- The regulations came into force on 1 April 2021 but are subject to a transition period up to 1 August 2024 at which point the full requirements of the regulations will be in force. The new regulations will replace the existing NVZ regulations but there will be minimal changes to requirements and practices in these areas. The transition periods will not generally apply to farms within NVZs which must be fully compliant with the regulations from 1 April 2021. The requirements for the land application of organic materials are outlined below along with the date on which the requirements come into force.

5.1.1 Requirements from 1 April 2021 for spreading organic manures

- Organic materials must not be spread on land if there is significant risk of pollution, considering the slope of the land, particularly if the slope of the land is more than 12° (20%), ground cover, proximity to surface water, weather conditions, soil type and the presence of land drains. Also, organic materials must not be spread if the soil is waterlogged, flooded or snow covered, is frozen or has been frozen for more than 12 hours in the previous 24 hours. Or within 50 metres of a borehole, spring or well or within 10 metres of surface water (6 metres if precision spreading).

5.1.2 Requirements from 1 January 2023

- From 1 January 2023 nitrogen limits will apply to 1) the whole holding and 2) individual hectares. The whole holding limit will be 170 kg/ha from all livestock manure including direct excreta from animals on the land and the land spreading of handled manure for any calendar year. For any individual hectare the limit will be 250 kg N for the spreading of organic manure for any 12-month rolling period.

⁷ Follow this link for a summary of the Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 and the associated timeline.

- Other requirements not directly relating to landspreading include risk maps, controlled spreading, storage of manure other than slurry (in a vessel, covered building, on an impermeable surface or in a temporary field site), nitrogen management plans, maximum nitrogen limits by crop type, record keeping (risk maps, nutrient management plans, etc.).

5.1.3 Requirements from 1 August 2024

- Closed periods for land spreading organic manures with high readily available nitrogen content ($\geq 30\%$ available N, i.e., poultry manure, cattle/pig slurry as well as other manures subject to analysis, e.g., digestate) will come into force from 1 August 2024. The start/end, and duration of, the closed period depends on the soil type and cropping (Table 6).

Table 6. Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 closed period for organic materials with high readily available N

Soil type	Grassland	Tillage land
Sandy or shallow soil	1 September to 31 December	1 August to 31 December*
All other soils	15 October to 15 January	1 October to 31 January

*Spreading high RAN material is allowed on sandy or shallow soils on tillage land between 1 August and 15 September inclusive provided that the crop is sown on or before 15 September.

- Exemptions to the closed period apply where crops are sown on or before 15 September on tillage land with sandy or shallow soil (as defined in COAPR, 2021). In this situation high readily available N (RAN) materials are permitted from 1 August to 15 September (inclusive). There are also exemptions for registered organic producers who can spread organic manure with high RAN at any times on crops specified by the regulations or to any crop with written justification from an advisor who is a member of Fertiliser Advisers Certification and Training Scheme (FACTS). However, the land which is spread with the organic manure must not receive more than 150 kg total N per hectare between the start of the closed period and the end of February.
- From the end of the closed period until the end of February the maximum amount of slurry that may be spread at any one time is 30 m³/ha and the maximum amount of poultry manure that may be spread at any one time is 8 tonnes/ hectare. Other regulatory requirements must also be met.

5.2 Cross compliance

- Cross Compliance sets out the important regulatory baseline standards that all farmers must meet to receive Common Agricultural Policy payments including Basic Payment Scheme or Rural Development land-based schemes (e.g., Glastir) support in Wales (Welsh Government, 2021d). The Verifiable Standards set out in detail the obligations of a farmer who receives payments under Cross Compliance and the Basic Payment Schemes. These are classified as either 'Statutory Management Requirements (SMR) or 'Good Agricultural and Environmental Condition (GAEC).

5.2.1 Statutory Management Requirement 1: water protection

- Statutory Management Requirement (SMR) 1 sets out requirements for water protection; in essence, this requires compliance with the COAPR 2021.

5.2.2 *Good agricultural and environmental conditions (GAEC) 1: Water establishment of buffer strips*

- The aim of GAEC 1 is to protect surface water from pollution by fertiliser and plant protection products by creating buffer strips. The rules for the landspreading of organic manures mirror those in the COAPR, i.e., no spreading within 6 metres of the surface of surface water if using precision equipment, no spreading with 10 metres of the surface of surface water and no spreading of organic manures within 50 metres of a borehole, spring or well.
- The only exception to this is for livestock manure (other than slurry and poultry manure) which may be spread within 10 metres of surface water if it is spread on land managed for breeding wader birds or as a species-rich semi natural grassland and the land is notified as a Site of Special Scientific Interest or is under an agri-environment commitment and permission has been granted by Natural Resources Wales or the Welsh Government as appropriate. Landspreading can take place between 1 June and 31 October inclusive, and the total annual amount must not exceed 12.5 tonnes per hectare (Welsh Government, 2021d).

5.3 *Certified compost and digestate*

- Compost or digestate which is produced in accordance with the relevant QP (WRAP and Environment Agency, 2012; 2014) is assessed for compliance with PAS 100 (compost) (BSI, 2011) or PAS 110 (digestate) (BSI, 2014) by an approved certification body. The certification body specify requirements for the process of composting or digestion, the selection of input materials, the minimum quality of materials and the storage, labelling and traceability of products. PAS 100 and PAS 110 accreditation is only given to composts and digestates from systems using source segregated biowastes and/or biodegradable non-waste material feedstock.
- The PAS criteria ensure that if Codes of Good Practice are followed when spreading the materials, the impacts on the environment are minimised and the benefits in terms of crop available nutrient supply and organic inputs are maximised. Good practice requires all potential environmental issues such as soil and crop nutrient requirements, impacts on soil function, potential for water pollution, etc. to be considered when applying the materials.
- Note that the Environment Agency and Natural Resources Wales have recently reviewed the compost and digestate QPs, which will be republished as resources frameworks (subject to appropriate updates). Initial reports on the current AD and Compost QPs have been published; they concluded that the revision of several key areas was required for both the compost and digestate QPs. The revision process is currently underway⁸. While a QP is being revised industry can still use it until either a new resource framework is agreed, or the revision concludes without resolution and the QP is withdrawn. Once a new resources framework has been published, it can be used to achieve end of waste.

⁸ Environment Agency. Waste quality protocols review

5.4 Sewage sludge regulations

- Regulatory control of sewage sludge (or biosolids) applications to agricultural land is under the Sludge (Use in Agriculture) Regulations (1989) (SI, 1989). Sewage sludge is not regulated as a waste when it is used in agriculture and the requirements set out in the Sludge (Use in Agriculture) Regulations (1989) are fulfilled. In the regulations, “agriculture” is defined as “the growing of all types of commercial food crops, including for stock-rearing purposes”.
- The regulations are supported by a Code of Practice (Defra and Environment Agency, 2018) which embodies best practice guidance on sludge recycling to land, including maximum permitted soil heavy metal concentrations and sludge application rates (Tables 7 and 8). The key difference between the 1989 Sludge Regulations (SI, 1989) and the Sewage Sludge in Agriculture: Code of Practice for England, Wales and Northern Ireland (Defra and Environment Agency, 2018) is that the limits for soil zinc are lower in accordance with the recommendations of an Independent Scientific Committee Review of the “Soil Fertility Aspects of Potentially Toxic Elements” (MAFF, 1993). The Code of Practice also recommends maximum soil limits for chromium (Cr), molybdenum (Mo), selenium (Se), arsenic (As) and fluoride (F).

Table 7. Maximum permissible concentrations of potentially toxic elements (PTE) in soil after application of sewage sludge and maximum annual rates of addition to arable soils (sampled at 15 or 25 cm depths). Source: Defra and Environment Agency, 2018.

PTE	Maximum permissible concentration of PTE in soil (mg/kg dry soils)				Maximum permissible average annual rate of PTE addition over a 10-year period (kg/ha)
	pH 5 - <5.5	pH 5.5 - <6.0	pH 6.0 - 7.0	pH >7.0	
Zinc	200	200	200	300	15
Copper	80	100	135	200	7.5
Nickel	50	60	75	110	3
	For pH 5 and above				
Cadmium	3				0.15
Lead	300				15
Mercury	1				0.1
Chromium	400				15
Molybdenum	4				0.2
Selenium	3				0.15
Arsenic	50				0.7
Fluoride	500				20

Table 8. Maximum permissible concentrations of potentially toxic elements (PTE) in soil under grass after application of sewage sludge when samples taken to a depth of 7.5 cm. Source: Defra and Environment Agency, 2018.

PTE	Maximum permissible concentration of PTE in soil (mg/kg dry soils)				Maximum permissible average annual rate of PTE addition over a 10-year period (kg/ha)
	pH 5 - <5.5	pH 5.5 - <6.0	pH 6.0 - 7.0	pH >7.0	
Zinc	200	200	200	300	15
Copper	130	170	225	330	7.5
Nickel	80	100	125	180	3
	For pH 5 and above				
Cadmium	3				0.15
Lead	300				15
Mercury	1.5				0.1
Chromium	600				15
Molybdenum	4				0.2
Selenium	5				0.15
Arsenic	50				0.7
Fluoride	500				20

- Except for applications to grassland no limits have been set for potentially toxic elements (PTE) concentrations in sludge used in agriculture. Sludge to be surface applied to grassland should not have concentrations of lead or fluoride greater than 1200 and 1000 mg/kg dry solids, respectively.
- In addition to the legislation, a voluntary agreement, the “Safe Sludge Matrix”, has been in place throughout the UK since 1999 (ADAS, 2001), Table 9. The Matrix requires strict controls on the microbiological quality of sludge and that no harvest/grazing intervals are adopted following biosolids application to agricultural land. It Matrix provides a robust multiple barrier approach for all stakeholders – farmers, food retailers, food processors and consumers – although it has no direct impact on heavy metal additions to soils.
- Additional safeguards for the protection of soils, the wider environment, human and animal health are set out in a voluntary industry led standard, the Biosolids Assurance Scheme (BAS, 2020). BAS, which currently covers almost 100% of biosolids recycled to agricultural land in the UK, provides rigorous controls on source materials, effective treatment, transport, storage and application to land.
- The UKAS accredited scheme is based on regulations and best practice, is overseen by a Technical Advisory Committee comprised of stakeholders and industry experts and is audited by a third-party Certification Body to demonstrate that members of the Scheme are conforming to its requirements. The BAS Standard is based on legislative (e.g., Sludge (Use in Agriculture) Regulations, EPR etc) and good practice standards for biosolids (e.g., Safe Sludge Matrix, COGAP etc.).

Table 9. The Safe Sludge Matrix minimum acceptable level of sludge treatment for crop groups and harvest intervals/no grazing periods. Source: ADAS, 2001.

THE SAFE SLUDGE MATRIX			
CROP GROUP	UNTREATED SLUDGES	CONVENTIONALLY TREATED SLUDGES	ENHANCED TREATED SLUDGES
FRUIT	X	X	✓
SALADS	X	X (30 month harvest interval applies)	✓
VEGETABLES	X	X (12 month harvest interval applies)	✓
HORTICULTURE	X	X	✓
COMBINABLE & ANIMAL FEED CROPS	X	✓	✓
- GRAZED GRASS & FORAGE	X	X (Deep injected or ploughed down only)	✓
- HARVESTED	X	✓ (No grazing in season of application)	✓

NOTE : ✓ All applications must comply with the Sludge (Use in Agriculture) Regulations and DETR Code of Practice for Agricultural Use of Sewage Sludge (to be revised during 2001).
 X Applications not allowed (except where stated conditions apply)

5.5 Environmental permitting regulations

- Where materials are classified as a waste, application to land is controlled by the Environmental Permitting (England and Wales) Regulations 2016 (No. 1154) (SI, 2016). As part of the regulations Standard Rules have been developed which consist of a set of requirements common to the type of facility or activity they are regulating. They are suitable for activities where the generic risks are well understood, assessed and mitigated (Defra and Welsh Government 2020). Standard Rule SR2010 No4 v6.1 'Mobile plant⁹ for land spreading' (land treatment resulting in benefit to agriculture or ecological improvement) is used for spreading specific organic materials to land (Natural Resources Wales, 2016).
- SR2010 No4 v6.1 only permits, storage of waste pending application and subsequent land treatment resulting in benefit to agricultural land or ecological improvement. A deployment form must be submitted to Natural Resources Wales, at least 25 days prior to the land treatment activity commencing. This requires site specific information and control measures to be provided and agreed prior to the use of any mobile plant under Standard Rules.

⁹ The permit requires the that the machinery used to carry out the landspreading is mobile (by road, rail or water) (Natural Resources Wales, 2014). For landspreading of wastes the machinery is typically tractors, spreaders etc.

- For most wastes the application limit is 250 t/ha (except soil for washing and cleaning sugar beet where it is 1,500 t/ha and dredging spoil from inland water where it is 5000 t/ha). Landspreading of waste is not permitted within 10 metres of any watercourse or Groundwater Source Protection Zone (SPZ) 1; or if a SPZ has not been defined then within 50 metres of any well spring or borehole used for the supply of water for human consumption including from a private water supply or supplies. In addition, any wastes controlled by the Animal By-Products Regulations must be treated and handled in accordance with any requirements imposed by those Regulations. There are also specific regulations for high readily available nitrogen (RAN) materials relating to application rates (<50 m³/ha) and nutrient applications (≤250 kg N/ha).
- For organic materials outside of the scope of SR2010 No4 v6.1 a bespoke permit will be required.

5.5.1 U10 waste exemption: spreading waste to benefit agricultural land

- In addition, some types of waste (specified in Table 10) can be spread on agricultural land under a waste exemption (i.e., it is exempt from needing an Environmental Permit). A U10 exemption allows the spreading of specific waste on agricultural land to replace manufactured fertilisers or virgin materials (such as lime) to improve or maintain the physical, chemical and biological properties of the soil to grow crops. The exemption does not apply to the spreading of wastes that do not benefit the land, spreading waste on non-agricultural land or spreading waste that is not listed in Table 10, even if it would provide benefit.
- Under a U10 exemption, waste must be spread under the same restrictions that apply to permitted waste, i.e., at least 10 metres from a watercourse and 50 metres from a spring, well or borehole. Also, waste must not be spread if the land is waterlogged, frozen or covered in snow, has been frozen for 12 hours or more in the 24 hours before spreading. The specific regulations for certain materials are detailed as a footnote to Table 10, below.

Table 10. Types and quantities of wastes that can be used under a U10 waste exemption (Source: www.gov.uk¹⁰)

Waste Code	Types of waste	Quantity (t/ha/year)	Storage (t)	Conditions
010102, 010408, 170504	Chalk only	50	200	A
020101	Sludge from cleaning fruit and vegetables on farm only	50	200	A
020199, 020399	Untreated water from cleaning fruit and vegetables on farm only	100	200	A, F
020305	Effluent from treating water used to clean fruit and vegetables on farm only	100	200	A, F
020401, 020399	Soil from cleaning fruit and vegetables only	50	200	A
100101	Ash from wood chip boilers burning plant tissue and untreated wood only. Registered and operating under a U4 exemption	1	10	
170506	Dredging spoil, not containing any dangerous substances, from creating or maintaining habitats, ditches or ponds in parks, gardens, fields and forests only	150	1250	C
020199	Used compost from growing mushrooms only	50	500	A
190599	Compost produced only from the limited list of waste and in the proportion stated in the T23 exemption or worm compost from T26 exemption only	50	500	A
190604	Digestate produced only from the limited range of waste and conditions allowed under T24 and T25 exemptions only	50	200	A
190812	Biobed or biofilter material produced from treatment registered and operated under T32 exemption only	50	200	A, D
020199	Milk from agricultural premises only	50 m ³ of diluted milk/ha in any 24-hour period		A, B, E
Key to conditions				
A	The place where waste that is stored or land which is to be spread must be at least 10 metres from a watercourse and 50 metres from a spring, well or borehole			
B	Before spreading, the waste must be diluted with at least an equal amount of water or slurry, and waste must only be spread on the land once in any 4-week period			
C	The waste must be spread next to the place it was dredged from			
D	The waste must be stored at least 12 months before it is spread			
E	The waste must not be stored longer than 24 hours before it is spread			
F	The waste must be spread at the place where it is produced			

¹⁰ U10 waste exemption: spreading waste to benefit agricultural land.

6 Good practice guidance

- In addition, to the good practice that is enforced under legislation, there is also good practice guidance in relation to the management and application of organic materials. Overarching published guidance on good practice is contained in the Code of Good Agricultural Practice for the Protection of Water, Soil and Air for Wales (Welsh Assembly Government, 2011)¹¹. More specifically there is also published good practice guidance available for several organic materials including digestate/compost, 'Digestate and compost use in Agriculture' (WRAP, 2016), biosolids 'Code of practice for agriculture use of sewage sludge' (Defra and Environment Agency, 2018) and paper sludge, 'Code of good practice for land spreading paper mill sludges (CPI, 2015).

6.1 *Code of Good Agricultural Practice for the Protection of Water, Soil and Air for Wales COGAP*

- The 'Code of Good Agricultural Practice for the Protection of Water, Soil and Air for Wales' (Welsh Assembly Government, 2011) provides advice and guidance for farmers and land managers to minimise the risks of causing pollution. COGAP guidance include the production of soil, manure and nutrient management plans to assess current resources, matching resources to requirements and planning future requirements. The manure and nutrient management plans are most relevant for controlling nutrient load to agriculture. The manure management plan identifies when and where to apply manure. It is based on a maximum field application rate of 250 kg N/ha and identifies areas where spreading should not take place (based on slope, proximity to water etc.).
- Importantly, the manure management guidance recommends that land managers should not accept biosolids, composts or other organic materials "if it will make it difficult to spread manures safely or to meet any restrictions".
- The nutrient management plan identifies the appropriate application rate. It recommends the assessment of crop nutrient requirement using a recognised fertiliser recommendation system such as RB209 (AHDB, 2020). Also, that the crop available N supplied by organic materials should be accounted for before applying fertiliser.

6.2 *Code of good agricultural practice guidance on reducing ammonia losses from agriculture in Wales*

- The guidance in the 'Code of good agricultural practice guidance on reducing ammonia losses from agriculture in Wales' (Welsh Government, 2019a) provides further guidance on best practice for ammonia mitigation for land managers. This includes guidance on the use of low emission spreading equipment (e.g., shallow injection, trailing shoe and trailing hose applicators).

6.3 *Digestate and compost*

- 'Digestate and compost use in agriculture' (WRAP, 2016) recommends that the good practice guidance in COGAP is followed when applying compost and digestate. The guidance is aimed at PAS 100 compost and PAS 110 digestate (i.e., material that has end of waste status). However, the guidance also notes that where materials are not certified an "environmental permit or waste management license exemption" would be required for landspreading.
- In common with other materials with a high readily available N content digestate application should not be made within 10 metres of any ditch, pond or surface water or within 50 metres of

¹¹ Code of good agricultural practice.

any spring, well, borehole of reservoir that supplies water for human consumption, or on very steep slopes where runoff is a high risk throughout the year.

6.4 Biosolids

- Sewage sludge in agriculture: code of practice for England, Wales and Northern Ireland details where and when sewage sludge can be applied (also Section 5.4 Sewage sludge regulations, above). Additional safeguards for the protection of soils, the wider environment, human and animal health are also set out in BAS (BAS, 2020) which provides rigorous controls on source materials, effective treatment, transport, storage and application to land.

6.5 Paper sludge

- Paper sludge is spread under an environmental permit and as such will be subject to the general recommendations and restriction in that permit. The Confederation of Paper Industries (CPI, 2015) “Code of good practice for land spreading paper mill sludges” brings together guidance on relevant legislation and COGAP guidance. Although note that the guidance predates the COAPR 2021; any landspreading of paper sludge must comply with COAPR 2021.

7 Climate and season

- Seasonal and climatic factors should determine when organic materials should be applied. To ensure that applications are agronomically beneficial and to prevent environmental impact (e.g., damage to soil structure or nutrient leaching) organic manures should be applied when crops or grass can make efficient use of nitrogen and when soil is both workable and trafficable. Spring applications often make best use of nitrogen in organic materials due to crop uptake. Applications to soils that are wet will increase the risks of phosphorus and microbial pathogen losses to water and soil compaction. General guidance for minimising losses to water states that materials should not be applied after heavy rain, when heavy rain is forecast, when the soil is waterlogged or wetter than its workable range, when the soil is frozen, or snow covered (Crooks and Litterick, 2020).
- These seasonal and climatic factors are acknowledged by COGAP Wales which lists them in Section 5.2.4. Applying Livestock Manures and Dirty Water as conditions under which manure applications should not be applied. In addition, the COAPR 2021 state that “fertiliser must not be spread if the soil is waterlogged, flooded or snow covered, is frozen or has been frozen for more than 12 hours in the previous 24 hours”. Note that this includes organic materials. Closed periods in the COAPR 2021 constrain the timings of applications of organic manures with high readily available nitrogen ($\geq 30\%$ available N) such as livestock slurries, poultry manures and anaerobic digestate (Table 11). The closed period is designed to minimise the risk of autumn/winter nitrate leaching losses when there is limited crop demand for nitrogen. In addition, from the end of the closed period until the end of February slurry applications are limited to 30 m³ and poultry manure to 8 t/ha in any one application (there must also be at least three weeks between each spreading). However, note these requirements do not come into force until 1 August 2024 except for areas of Wales that were previously designated as NVZ in 2013.

Table 11. Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 closed period for organic materials with high readily available N

Soil type	Grassland	Tillage land
Sandy or shallow soil	1 September to 31 December	1 August to 31 December*
All other soils	15 October to 15 January	1 October to 31 January

*Spreading high RAN material is allowed on sandy or shallow soils on tillage land between 1 August and 15 September inclusive provided that the crop is sown on or before 15 September.

- Regulations for the spreading of waste materials (e.g., SR2010 No4 v6.1) also recognise the importance of climatic conditions and prohibit the application of waste to land that has been frozen for 12 hours or more in the preceding 24 hours or if the land is waterlogged, frozen or snow covered.

8 Site

- Soil type and soil properties are important factors to determine the appropriate application timing for organic materials to maximise benefits and minimise risk.

8.1 Soil type

- The only national controls relating to soil type are for sandy or shallow soils under the COAPR 2021, Table 11 (above). The COAPR 2021 prohibit the spreading of organic manures with high RAN to sandy and shallow soil (as defined by COAPR) between the 1 September and 31 December for grassland and 1 August to 31 December for tillage land. This acknowledges the greater risk of nitrate leaching on sandy/shallow soils than on other soils. However, where tillage soils have a crop sown before 15 September application is permitted between 1 August and 15 September (the crop will take up N and reduce the potential of leaching losses). Note this closed period regulation does not come into force across the whole of Wales until 1 August 2024 but currently applies only to land formally in NVZs. The closed periods for other soil types starts later but is extended by 2 weeks (grassland) to 1 month (tillage land).

8.2 Soil phosphorus (P)

- There are no specific regulatory limits on the application of P to agricultural land. However, EPRs require that the materials spread result in benefit to agriculture or ecological improvement. NRW guidance “How to comply with your landspreading permit” states that “If phosphate is to be applied at index 3 or above, the operator should: explain why the increased levels are appropriate for the receiving land and, address the increased risks from the application in the risk assessment within the benefit statement” (NRW, 2017).
- Good practice guidance on P applications is included in COGAP which notes that “Phosphorus in manures should be the limiting factors - when you use nitrogen and other nutrients in manures, and the soil phosphorus index is already 3 or above, you should not apply more phosphorus than will be removed by the crops in the rotation”. Also, The Sludge Use in Agriculture Regulations require that “sludge shall be used in such a way that account is taken of the nutrient needs of the plants and that the quality of the soil and of the surface and ground water is not impaired”. In addition, to comply with the Biosolids Assurance Scheme biosolids applications must follow guidance in the Biosolids Nutrient Management Matrix (Table 12), which is used to complement and not replace nutrient management planning for nitrogen and phosphate.
- Information on soil phosphorus content is available from the Representative Soil Sampling Survey and the National Soils Inventory, which are both comprehensive at a national scale (around 830

points in Wales) but maybe considered out of date (with data available from between 1969-2003 and 1983-1995, respectively). However, although the datasets are old, they are the best spatial point datasets available with comprehensive coverage at the national scale. In comparison, Glastir Monitoring and Evaluation Programme data is more current (2013-2016) but only has around 140 unique datapoints for soil P. There is also very limited data available from the Countryside Survey for 2019 (from <10 sites in Wales).

- Data on soil P balances for the UK show that soil nutrient balances (inputs-outputs) have decreased from 13.4 kg P/ha in 1990 to 5.4 kg P/ha in 2019 (the same figures for England are 12.7 kg P/ha to 3.3 kg P/ha) (Defra, 2021). Note, that soil P balance data for Wales is not available, although soil P decreases in Wales have been previously reported in improved grassland from 40.8 mg P/kg in 1998 to 21.5 mg/kg in 2007 (Emmett *et al.*, 2010).
- The lack of current data on a national scale indicates the clear need for more publicly available data on soil P for Wales.

Table 12. Biosolids nutrient management matrix (Source: BAS, 2020).

Soil P Index	Maximum application of lime treated biosolids ^a	Maximum potential application of all other biosolids types
0/1/2	250 kg/ha total N in any 12-month period	250 kg/ha total N in any 12-month period
3	250 kg/ha total N in any 12-month period. Application 1 year in 4 on sandy soils and 1 year in 2 on all other soils	250 kg/ha total N in any 12-month period Application 1 year in 2 on sandy soils ^b
4	250 kg/ha total N in any 12-month period Application 1 year in 5 on sandy soils and 1 year in 3 on all other soils	250 kg/ha total N in any 12-month period Application 1 year in 4 on sandy soils ^c and 1 year in 3 on all other soils
≥5	No application	No application

^a Lime addition >5.5% weight/weight on a dry weight basis. ^b Composted biosolids can be applied annually and ^ccan be applied 1 year in 2.

8.3 Soil pH

- Soil pH is a measure of soil acidity or alkalinity. pH varies according to soil type and the optimum requirement for crops differs; guidance in AHDB’s Nutrient Management Guide suggests that soil pH is maintained at pH 6.0 for grass and 6.5 for arable crops. Regulatory control on pH is in the Sludge (Use in Agriculture) Regulations (SI, 1989) which prohibit the application of biosolids where the soil pH is <5. This reflects the influence pH has on the availability of metals in soils (with most metals being more available for crop uptake on acid soils). In addition, NRW guidance on “How to comply with your landspreading permit” notes that “metal containing waste and sewage sludge should never be applied to soils below pH 5.0 and only to soils below 5.5 with ‘properly qualified advice’” (NRW, 2017).

8.4 Soil metal concentrations

- Livestock manures can contain potentially toxic elements, especially copper and zinc. The COGAP includes trigger values for soil copper (80 mg/kg at pH 5.0 to 5.5 and 100 mg/kg at pH .5.5) and zinc (200 mg/kg) at which advice should be sought when applying manures.

- Regulatory control of soil metal content is included in the Sludge (Use in Agriculture) Regulations. Soil concentration limits are in place for six metals, zinc, copper, nickel, cadmium, lead, mercury; where concentrations are above these limit values sludge cannot be applied. These limits vary for different pH values for Zn, Cu and Ni and in some cases differ between grassland soils and those used for arable cropping (see Section 5.4). Recommended limits are also in place for soil chromium, molybdenum, selenium, arsenic and fluoride in the Code of Good Practice for Sewage Sludge. There is also a maximum permissible annual rate of metal addition over a 10-year period.
- In addition, NRW guidance on “How to comply with your landspreading permit” states that waste application rates must not exceed the limits set in The Sludge (Use in Agriculture) Regulations 1989 and Code of Practice for Agricultural Use of Sewage Sludge. The guidance also notes that waste applications which apply metals to the soil at greater levels than those described in the sludge regulations should be justified in the certificate of benefit written by a ‘suitably qualified person’” (NRW, 2017).
- Although not a regulatory control, the QPs for compost and digestate also recommend that these materials are applied in accordance with Sludge (Use in Agriculture) Regulations for soil metal limits and 10-year loading rates.
- Data on soil metal concentrations are available from the Representative Soil Sampling Survey and the National Soils Inventory, which are both comprehensive at a national scale (around 830 points in Wales). As noted above these may be considered out of date (with data available from between 1969-2003 and 1983-1995, respectively). However, although the datasets are old, they are the most up to date spatial point dataset available with comprehensive coverage at the national scale. The geochemical processes that affect the bedrock geology are one of the key factors influencing the natural concentrations of heavy metals in soils (Alloway, 2012, Crispo *et al*, 2021). Consequently, the RSSS/NSI data although dated is still likely to be indicative of current metal concentrations.

8.5 Slopes

- Slope is an important factor determining whether organic materials can be applied safely. The slope of land affects its suitability for agricultural production through the restrictions steeper slopes impose on mechanisation of crop management and on their vulnerability to soil erosion and surface runoff.
- The application of organic materials to steeply sloping land will pose a higher risk of nutrient losses to water via surface runoff than from material applied to flat or gently sloped land. Defra (2021) states that slopes $\geq 7^\circ$ may have high runoff risk, between 3° and 7° may have moderate runoff risk and $< 3^\circ$ may have lower runoff risk¹².
- Good practice guidance in the COGAP for Wales states that livestock manures and dirty water should not be applied on steep slopes where there is a high risk of run-off throughout the year (Welsh Assembly Government, 2011). However, note that ‘steep’ is not defined in the COGAP guidance. In comparison the legislative requirements of the COAPR 2021 state that “fertiliser must not be spread on land if there is significant risk of pollution, considering the slope of the land, particularly if the slope of the land is more than 12° (20%)” (WSI, 2021). Also, NRW guidance states that wastes should not be applied “on steep slopes where run-off is a high risk” (NRW, 2017).

¹² Sustainable Farming Incentive. Assess risks relating to soil.

8.6 Proximity to watercourses

- Proximity to water bodies should determine where organic materials should be applied and it is recognised as an important control over the application of materials to land (Crooks and Litterick, 2020). As noted earlier, The COAPR 2021 and EPRs prohibit organic material application within 10 metres of any surface water or within 50 metres of a borehole, spring or well. In addition, EPR also prohibit applications within groundwater source protection zone 1.
- Proximity to watercourses (and conduits for water, e.g., land drains or runoff pathways) controls the potential connectivity between the organic manure applications and the water. Nutrients from surface applied organic material applications can runoff into watercourses and pass through the soil to drains during rain events and when snow melts and can also leach through the soil and into groundwater over time. In general, the level of inherent risk of losses following organic material applications will be less significant if fields are not close or well connected to a waterbody. However, manure type, soil condition, type and nutrient content, slope, and crop will also influence the risk of nutrient loss following land spreading of organic materials.
- No spread buffer zones or strips that are managed correctly can help prevent nutrient loss from fields by absorbing or filtering out nutrients before they reach a water course, pond, land drain or groundwater. They also reduce the risk of pollutant transfer from areas where there is good hydrological connectivity between fields and watercourses.
- Several key pieces of legislation are in place to enforce good practice, including the COAPR 2021, Cross Compliance GAEC and EPRs (and U10 waste exemptions), whilst COGAP Wales provides non-legislative guidance. To help prevent nutrient losses to water from organic material applications legislation does not permit applications of organic materials within 10 m of surface water and 50 m from boreholes, springs or wells.

8.7 Source protection zones (SPZ)

- Groundwater is a vital resource, providing base flow to springs, rivers and wetlands and supplies up to 10% of drinking water in Wales¹³. In rural areas, groundwater may be the only viable water source for isolated properties. Groundwater is vulnerable to pollution, and once polluted it can be difficult and expensive to clean up. Consequently, NRW aim to prevent damage and pollution to groundwater using Source Protection Zones (SPZs).
- SPZs indicate those areas where groundwater supplies are at risk from potentially polluting activities and accidental releases of pollutants. SPZs are primarily a policy tool used to control activities close to water supplies intended for human consumption. SPZs are not statutory and are mainly for guidance but they do relate to distances and zones defined in legislation where certain activities are restricted (EA, 2019). Three SPZs are typically defined for groundwater sources (well, boreholes and springs for potable uses for public drinking water supplies) (Figure 2):
 - o SPZ1. Inner Protection Zone is defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
 - o SPZ2. Outer Protection Zone is defined by a 400-day travel time from any point below the water table to the source. This zone has a minimum radius of 250 m or 500 m dependent on abstraction size
 - o SPZ3. Source Catchment Protection Zone. This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point.

¹³ NRW. How we can all help protect groundwater in Wales.

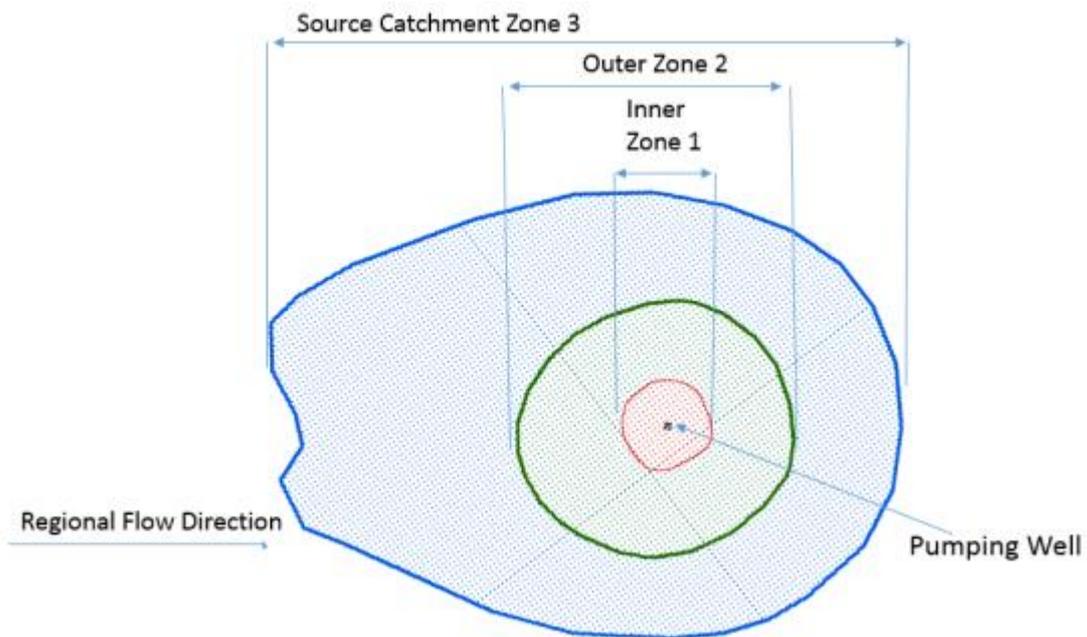


Figure 2. Source Protection Zone subdivisions (Source: Environment Agency, 2019)

- The SPZ1 zone is used to control a range of activities that could pose a risk to groundwater, the main purpose of the zone is to reduce the risk of pollution from rapidly degrading chemicals and some pathogens. In comparison, SPZ2 is designed to minimise the risks from slowly degrading pollutants.
- NRW do not support the spreading of biosolids or liquid waste within a SPZ1 or within 50 metres of any borehole, well or spring. Applications within a SPZ1 are not permitted under a mobile plant for land spreading permit (SR2010 no4 v6.1) (NRW, 2016).

9 Groundwater vulnerability zones

- Groundwater vulnerability maps have been created by NRW and the Environment Agency based on data from the British Geological Survey, the UK Centre for Ecology and Hydrology and the National Soil Resources Institute. The maps provide an assessment of the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within a one-kilometre square grid. The groundwater vulnerability for principal (providing significant quantities of water) and secondary (modest amounts of water which supports supplies at a local rather than strategic level) aquifers is expressed from high to low.
 - o High: areas that can easily transmit pollution to groundwater. They are characterised by free draining sandy and shallow soils with a high risk of leaching and the absence of low-permeability superficial deposits.
 - o Medium: areas that offer some groundwater protection. Intermediate between high and low vulnerability.

- o Low: areas that provide the greatest protection to groundwater from pollution. They are likely to be characterised by slowly permeable soils and/or the presence of low-permeability superficial deposits.
- The maps were designed as a high-level screening tool to indicate whether an activity (e.g., land spreading of organic materials) is in an area of high vulnerability.

10 Cropping and crop nutrient requirement

- Organic materials are important sources of major plant nutrients N, P, K, Mg and S as well as trace elements. It is important that applications are managed to meet and not exceed soil and crop requirements to minimise the risks of nutrient losses to the environment.
- Guidance in COGAP (Welsh Assembly Government, 2011) states that organic materials other than livestock manures produced on farm should only be applied to land where there remains a crop requirement for nutrients after accounting for livestock manures produced on farm.
- Note that as detailed in Section 5.1, from 1 January 2023 the COAPR 2021 includes legislative nitrogen limits which will apply to 1) the whole holding and 2) individual hectares. The whole holding limit will be 170 kg N/ha for any calendar year from all livestock manure (i.e., both directly excreted and spread manure). For any individual hectare the limit will be 250 kg N for the spreading of organic manure for any 12-month rolling period. Maximum N limits permitted to be spread for specified crops will also apply. Also note that total application rates under EPR legislation should not exceed 250 kg N/ha.
- COGAP guidance also includes a maximum field application rate of 250 kg total N/ha/year.

10.1 Nutrient planning

- Effective nutrient management planning involves applying nutrients (either fertiliser or organic manures) based on soil and crop requirement. This approach ensures that nutrients are utilised efficiently on farm and only used when and where necessary. Optimal supply of all major and minor nutrients as well as maintaining optimum soil pH and soil structural condition are necessary to ensure that crops utilise nitrogen effectively and minimise the amount soil N available for conversion to N₂O or at risk of nitrate leaching.
- Information from the Wales Farm Practice Survey in 2012 (the most up to date information available) suggested that 43% of farmers had a soil nutrient plan (Anthony *et al.*, 2012). In comparison, in 2021, 56% of holdings in England had a nutrient management plan and 71% had a manure management plan (Defra, 2021). The difference may reflect the more extensive grazing grassland systems in Wales, where a nutrient management plan is less applicable. Defra (2021) noted that 21% of LFA grazing livestock farms and 18% of lowland grazing farms indicated that a nutrient management plan was not applicable to their farm compared to 4% of cereal farms, 4% of general cropping and 1% of dairy farms.
- There are four key stages of nutrient planning which should be followed to maximise nutrient use efficiency and minimise the potential risk of nutrient losses to the environment: 1) quantify crop requirement, 2) quantify soil nutrient supply and pH, 3) quantify the crop available nutrient supply from any organic material applications and 4) account for the nutrients supplied by organic materials when planning manufactured fertiliser additions (Williams *et al.*, 2019). These are discussed in more detail below.
 1. *Quantifying crop nutrient requirement*: AHDB's Nutrient Management Guide (RB209) is recognised as the industry standard fertiliser recommendation system for supporting nutrient management planning in Wales. It provides comprehensive guidance on the nutrients required for economic optimum crop production. Fertiliser requirements are

controlled by many factors including crop type, previous cropping history, fate of crop residues soil type and over winter rainfall.

2. *Quantifying soil nutrient supply and pH:* In most situations soil nitrogen supply can be assessed following methodology in RB209 (AHDB, 2020) which is based on information relating to soil type, typical over winter rainfall (to assess leaching losses), nitrogen released from crop residues and previous fertiliser N and manure use. In circumstances where previous management has been atypical, soil sampling to 90 cm may be more effective to quantify the soil nitrogen supply on arable fields. Topsoil (0-15 cm on tillage and 0-7.5 cm on grass) analysis is recognised as the most effective method of quantifying soil pH status and extractable phosphorus, potassium and magnesium contents. Soil pH, phosphate, potash and magnesium are usually managed for a rotation rather than an individual crop, so soil analysis is recommended every 3-5 years.
3. *Quantifying the nutrient supply from organic materials:* Understanding the nutrient content of organic materials and quantifying application rates are crucial for making best use of nutrients. The nutrient content of organic materials will depend on several factors. For livestock manures the main determining factors include livestock type, feeding regime, diet, the amount of rainwater dilution that occurs during storage and the amount of bedding used. For digestates and composts the source of the feedstock material and for biosolids the treatment processes are important factors. Typical figures for the nutrient content of organic materials are available in AHDB's Nutrient Management Guide (2020). However, laboratory analysis can give a more accurate assessment of the nutrient content of organic materials from a specific source.
4. *Accounting for manure nutrients when planning manufactured fertiliser applications:* Crop available nutrient supply from contrasting manure application timings and methods can be calculated by using the MANNER-NPK decision support tool or by reference to AHDB's Nutrient Management Guide. It is essential that the nutrients supplied by the manures are accounted for when calculating manufactured fertiliser application rates to ensure that crop nutrient requirements are not exceeded and the risks of nutrient losses to the environment are not increased. The approach of integrating fertiliser and manure nutrients to provide optimum levels for plant growth is also used in computer based nutrient management systems such as PLANET (www.planet4farmers.co.uk) and other software tools produced by commercial software companies such as FarmPlan and Muddyboots.

11 Designated sites

- Designated areas (Areas of Outstanding Natural Beauty (AONBs), National Parks, Special Protection Areas (SPA), Special Areas of Conservation (SAC), Ramsar sites, Sites of Special Scientific Interest (SSSIs) and National Nature Reserves (NNR)) cover c.30% of Wales; without the landscape scale sites (AONBs and National Parks) 10.6% of the land area of Wales is designated (i.e., as a SPA, SAC, Ramsar site, SSSI or NNR (JNCC, 2021)¹⁴). Statutory nature conservation designations in Wales include 21 SPAs, more than ninety SACs and ten Ramsar sites¹⁵. SPAs were designated under the EU Birds Directive (Council Directive 2009/147/EC) and are the most important areas in Europe for rare and migratory birds. SACs were designated under the EU Habitats Directive (Directive 92/43/EEC) and are the most important areas in Europe for habitats and non-bird species listed in the Directive as being of European importance. Post Brexit the EU

¹⁴ JNCC. Protected areas.

¹⁵ NRW. Sites protected by European and international law.

Birds and Habitats Directives have been superseded by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, which created a national site network on land and at sea (SI, 2019). Finally, ten Ramsar sites were designated under the convention of the same name and are the most important areas for wildfowl and/or wetland ecosystems. All Ramsar sites are also SSSIs (Noebels *et al.*, 2021).

- National statutory designations are divided into two categories: those for protecting landscapes; and those for protecting habitats and wildlife. Landscape designations include AONB and National Parks. Wildlife and habitat designations are: 1. SSSIs which are areas protected under the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2002) which contain wildlife or geological or land features that are of special importance¹⁶, 2. NNRs are nationally important natural and semi-natural terrestrial (or coastal) ecosystems and 3. Local Nature Reserves (LNR) are locally important natural and semi-natural terrestrial (or coastal) ecosystems. Wales has more than 1000 SSSIs¹⁷ (Figure 3) 76 NNR¹⁸ and 62 LNR¹⁹. The SSSI designation protects the site in law, whereas the NNR or LNR is a legal declaration by the owner or occupier of the site of their intention to manage the site for nature conservation.
- SSSIs provide statutory designation of the protection of a site and require landowners to manage their land to conserve its special features. SSSIs are identified by NRW. As noted above, NNRs, Ramsar sites, SPAs and SACs are typically also SSSIs.
- Designated areas in Wales which are not managed for agricultural production will have a range of differing levels of protection and land management controls applied to them. Specific controls on organic material applications (and other management practices) on designated sites are likely to be bespoke and will relate to the protection of the habitats and species present. For example, all SSSI sites have a management statement which sets out why a site is special and how it should be managed. Each SSSI has a list of Operations Likely to cause Damage (OLDs) or Potentially Damaging Operations (PDOs); these may refer to applications of fertilisers or manures. Activities that are included in the OLD/PDO are not prohibited but require prior consent to be issued from NRW. For organic manures permission may be given to apply in a certain way, at specific times of the year or on specific parts of the SSSI.

¹⁶ NRW. Fact sheets for areas of interest.

¹⁷ NRW. Types of protected areas of land and sea.

¹⁸ NRW. National Nature Reserves.

¹⁹ NRW. Local green spaces.

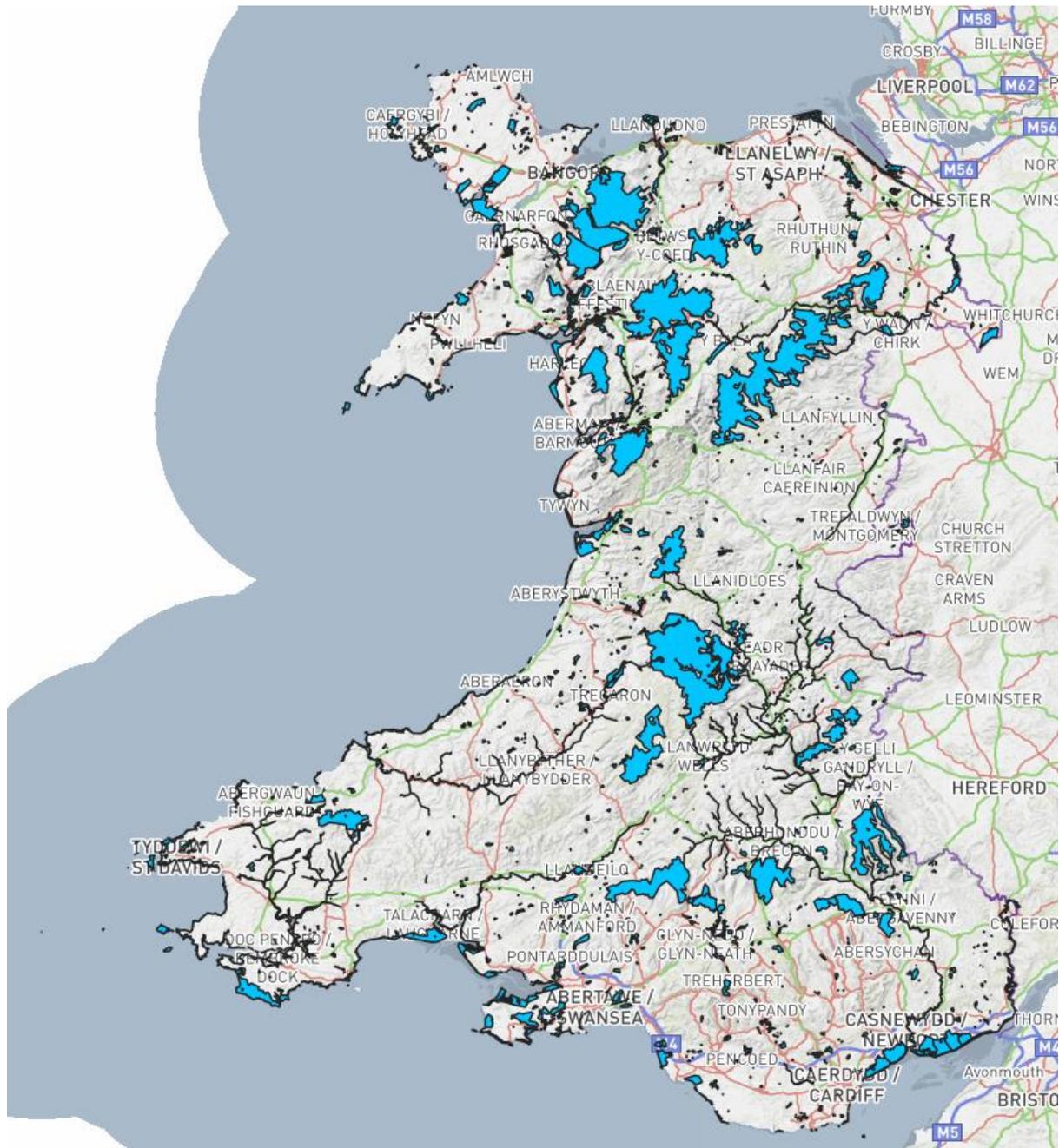


Figure 3. Sites of Special Scientific Interest (Source: <https://datamap.gov.wales>)

12 Voluntary or elective schemes

12.1 Glastir

- Agri-environment schemes such as Glastir provide a means of paying land managers to maintain or enhance the natural environment with the aim of minimising agriculture's impact on the environment. Glastir pays for the delivery of specific environmental goods and services to help combat climate change, improve water management and maintain and enhance biodiversity. It is also designed to deliver measurable outcomes at both a farm and landscape scale in a cost-effective manner. Glastir has several component schemes: Advanced, Commons, Entry, Organic, Small Grants, Woodland Creation, Woodland Management and Woodland Restoration. Glastir Entry and Glastir Advanced are most relevant for this report.
- Over 1.3 m hectares of Welsh agricultural land is included in the Glastir scheme²⁰. In 2020, £38.6 million was spent on Glastir payments, 29% (£11.1 million) on Glastir Advanced, 43% (£16.6 million) on Glastir Entry, 14% (£5.3 million) on Glastir Commons, 9% (£3.6 million) on Glastir Organic and 5% (£2 million) on Glastir Woodland and Small Grants (Welsh Government, 2021e).
- Glastir Entry is comprised of three main components, 1) cross compliance, 2) the whole farm code (WFC) and 3) management options. The first two components are compulsory requirements. Glastir WFC is a set of compulsory requirements for land management and is split into a) rules applicable for all land and b) rules applicable for habitat land. Rules that are applicable to all land include the requirement to record application of all fertilisers and no applications of livestock manures are permitted when soil is waterlogged or frozen. Additional rules apply to habitat land which is defined as both 1) any vegetation, which has a composition of <25% sown agricultural species as per EIA regulations and 2) ALL land included under habitat maintenance, reversion, establishment or creation prescriptions in previous agri-environment agreements. In these areas there must be no application of slurry, FYM, sewage sludge or other off and on-farm wastes. Although note that FYM can be spread when permitted by a specific Glastir habitat option.
- Glastir Advanced is intended to deliver significant improvements to the environmental status of a range of habitats. Glastir Advanced comprises of four main components, 1) cross compliance, 2) the WFC, 3) management options and 4) advanced capital works. As for Glastir Entry, the first two components are compulsory requirements.
- Several Glastir Entry and Advanced options prohibit or limit organic fertiliser additions (Table 13).

²⁰ Welsh Government press release. Substantial funding made available as key agricultural schemes extended.

Table 13. Glastir Entry and Advanced options that limit or exclude the application of organic fertilisers¹.

Option	Name
No organic fertiliser (including FYM)	
7a	Create a streamside corridor on improved land on one side of a watercourse.
7b	Create a streamside corridor on improved land on both sides of a watercourse.
8	Continued management of existing streamside corridor.
9a	Create a streamside corridor on improved land on one side with tree planting.
15a	Grazed permanent pasture with no inputs.
15c	Grazed permanent pasture with no inputs and mixed grazing.
19a	Management of lowland marshy grassland
19b	Management of lowland marshy grassland with mixed grazing.
20a	Management of coastal and lowland heath.
20b	Management of coastal and lowland heath with mixed grazing.
21a	Management of grazed saltmarsh.
21b	Management of grazed saltmarsh with mixed grazing.
25	Management of sand dunes
25b	Management of sand dunes with mixed grazing
26a	Fixed Rough grass margin on arable land.
26b	Rotational Rough Grass Margin.
27	Fallow crop margin
33	Establish a wildlife cover crop on improved land and arable land.
34a	Unharvested cereal headland.
34b	Unfertilised and unsprayed cereal headland
36	Buffering existing unfenced in field ponds
40	Woodland stock exclusion
41a	Grazing management of open country
41b	Grazing management of open country with mixed grazing
Nitrogen from FYM must not exceed 100 Kg N/hectare/calendar year.	
15b	Grazed permanent pasture with low inputs.
15d	Grazed permanent pasture with low inputs and mixed grazing.
FYM can be applied every other year	
22	Maintenance of existing hay meadow
124	Lowland unimproved neutral grassland: hay meadow
166	Hay meadow management for curlew (nesting)
Restricted organic manure applications	
159	Grassland managed with no inputs between 15 October and 31 January
163	Unsprayed Spring Sown Barley Crop for Corn Bunting (Nesting and Feeding)
170	Uncropped Fallow Plot for Lapwing (Nesting)
No slurry	
164	Grassland Management for Curlew (Nesting and Chick Feeding)
167	Grassland Management for Golden Plover (Feeding)
171	Grassland Management for Ring Ouzel (Feeding)

¹Any option on habitat land is restricted under the whole farm code which does not allow the application of slurry, inorganic fertilisers, basic slag, calcified seaweed, sewage sludge, wastepaper sludge or other off and on-farm wastes. Also, farmyard manure can only be spread where permitted by a specific Glastir habitat option.

12.2 Organic farming regulations

- In 2019 around 5% of agricultural land in Wales was certified as organic (in-conversion: 1,800 ha; fully organic: 82,600 ha) 2019 (Defra, 2020). This includes land registered under Glastir Organic which must be registered with an organic certification scheme. The UK organic certification schemes contain clearly defined rules on using organic materials as fertilisers and soil conditioners. The certification bodies operating in Wales are: Organic Farmers and Growers, Organic Food Federation, Soil Association Certification Ltd, Biodynamic Association Certification and Quality Welsh Food Certification Ltd.
- The rules with which organic farmers and growers must comply are based on the European Regulation (EC) No 834/2007 defining the aims, objectives and principles of organic production. After a long revision process, the new organic regulation (EU) 2018/848 was published in June 2018. It will apply from 1 January 2022.
- Each certification body publishes its own set of rules (Organic Standards) which, although based on the EU regulation, may be stricter than the minimum EU standards. Generally, no artificial fertilisers are permitted in organic farming, and there are defined lists of organic and mineral fertilisers permitted under the various certification schemes. For example, materials which are permitted typically include farmyard manure (after composting), slurry (after controlled fermentation and/or dilution), compost or digestate (feedstock: source segregated household waste or vegetable matter), blood meal, bone meal, seaweed and seaweed product, fish and meat meal, dairy products, fur, wool and hair. Organic farmers are not permitted to use biosolids due to concerns about the addition of organic contaminants, pathogenic micro-organisms and heavy metals to the soil, and more recently microplastics, with resulting long-term consequences (Soil Association, 2021).
- Soil or tissue analysis may be required to demonstrate the need for the application of supplementary nutrient sources (e.g., Soil Association, 2021).
- Organic standards do not allow manure applications more than crop nitrogen requirements. For example, Soil Association Standard 2.5.6 states that “the total amount of manure you can apply to your organic land, averaged over the whole area, must not be more than 170 kg of nitrogen per hectare per year” (Soil Association, 2021). Manure applications must be managed to avoid pollution. For example, Organic Farmers and Growers Standard 7.5.20 states that “the application of manure and fertilisers within 10 m of ditches and watercourses and within 50 m of wells and boreholes must be avoided”. In addition, “to prevent excessive run-off the spreading of manure or slurry on frozen ground or on saturated ground must be avoided” (Organic Farmers and Growers, 2013). Similarly, the producer manual for the Welsh Organic Scheme states that the “application of manures and slurries must only be made when and where there is no risk of the pollution of ground water or watercourses”. Specifically, that “no application may be made within 10 metres of a watercourse or 50 metres of a domestic water supply source. Waterlogged and frozen ground must be avoided” (QWFC, 2014).

12.3 Assurance schemes

- Assured crops and livestock are produced according to documented quality management systems in accordance with scheme standards, which aim to produce safe food whilst minimising impact on humans, animals and the environment. There are often requirements within the schemes for fertiliser and nutrient management.
- Rules vary depending on assurance schemes. Some may prohibit use of named materials (e.g., untreated sewage sludges and off-specification composts and digestates). Almost all assurance

schemes require farmers to prove compliance with legislation and good agricultural and environmental practice in relation to use of organic fertilisers and soil conditioners (Crookes and Litterick, 2020).

- The rules for the main farm assurance schemes in Wales, which are those managed by Quality Welsh Food Certification (websites: Quality Welsh Food Certification. Farm Assured Welsh Livestock) and the UK wide Assured Food Standards (Red Tractor Certified Standards) are available on public websites.

12.3.1 Farm Assured Welsh Livestock scheme

- Welsh Lamb and Beef Producers Ltd (WLBP) is a cooperative owned by over 7,500 Welsh farmers²¹. WLBP aims to strengthen consumer confidence by providing assurance of farm standards through the Farm Assured Welsh Livestock Beef and Lamb Scheme (FAWL).
- FAWL standards include requirements for the use and storage of organic manures, designed to protect livestock and subsequent consumers from infection by potentially harmful pathogens. The guidance also acknowledges the necessity to consider consumer perception and maintain their confidence in Welsh farm produce. The standards also refer to the protection of the environment and the importance of ensuring that the farm environment, water, soil and air are not impaired or polluted by the farming practice. Protection of natural habitat areas and awareness of the carbon emissions from farm output are also part of the standards.
- Specific guidance for organic materials includes the requirement for a manure management plan; a nutrient management plan is also recommended to minimise the over-use and loss of nutrients applied to land. Manures must be applied in accordance with COGAP or COAPR 2021 regulations. Slurry may only be applied when the crop or grass is actively growing (or ploughed in within 24 hours to fertilise a subsequent crop and minimise nutrient loss). Solid manures should be composted before application to avoid ammonium losses and to reduce odour. There is no specific guidance on application rates. However, FAWL members must have and implement a manure management plan to demonstrate a commitment to minimising the risk of pollution and complying with the Code of Good Agricultural Practice. Note that compliance with COGAP would limit manure application rate to 250 kg N/ha. Manure, slurry, compost, digestate and sewage sludge/biosolids are included in the guidance (Table 14).
- Sewage sludge may only be applied to farmland if applied as per the Sludge Use in Agriculture Regulations 1989 and all aspects of the Code of Practice for the Agricultural Use of Sewage Sludge are complied with.

²¹ Farm Assured Welsh Livestock.

Table 14. Farm Assured Welsh Livestock Scheme (FAWL) guidance on manure, compost, digestate and compost applications to arable and grassland (Source: FAWL, 2018).

	Manure and slurry		Compost and digestate		Treated sewage sludge	
	<i>Application</i>	<i>Grazing or harvest interval</i>	<i>Including ABP</i>	<i>Excluding ABP</i>	<i>Conventional</i>	<i>Enhanced</i>
Combinable and animal feed crop	Before or after drilling	N/A	Before or after drilling	Before or after drilling	Before or after drilling	Before or after drilling
Grazed grass and forage	Recommend spring applications & the use of rapid incorporation techniques	Min 4 week no graze interval. Recommend 8 week no graze for adult stock and 6 months for younger stock	No graze interval of 3 weeks	No graze interval of 3 weeks	No graze interval of 3 weeks AND Sludge must be deep injected or ploughed	No graze interval of 3 weeks
Harvested grass and forage		No harvest interval of 4 weeks.	No graze interval of 3 weeks	No graze interval of 3 weeks	No graze interval of 3 weeks	No graze interval of 3 weeks

12.3.2 Red Tractor assurance

- Red Tractor is an entire food-chain assurance scheme which sets standards based on science, evidence, best practice and legislation that cover animal welfare, food safety, traceability and environmental protection. There are Red Tractor standards for beef and lamb, dairy, pigs, poultry, crops and fresh produce. All acknowledge that manufactured fertilisers, organic manures and other soil amendments must be applied in a manner that minimises the risk of contamination or pollution (Tables 15-17). Also, that any materials, including waste materials, that are applied to land must have agricultural benefit.
- The standards also require nutrient management or manure management plans to be established and implemented. Fertiliser rates must be based on a calculation of the nutrient requirements of the crop and on regular analysis of nutrient levels in soil, plant or nutrient solution. In addition, proper account should be taken of the nutrient content of organic manures.
- Applications of fertilisers and organic manures should be planned to meet but not exceed soil and crop nutrient needs; timing of nutrient applications must also be matched to meet crop demand.

12.3.3 Other

- In addition to the farm assurance scheme rules, some produce, and commodity buyers have additional rules and prohibitions on the application of off-farm wastes and products, many of which are not easily referenced (Crookes and Litterick, 2020).

Table 15. Red Tractor fresh produce standards (from November 2021) (Source: Red Tractor, 2021)

	Category	Digestate (PAS 110 & pasteurised)	Digestate ¹	Compost ²	Sewage sludge		Land used for grazing ³
			Raw manure/slurry	Treated manure/slurry	Conventional	Enhanced	
Fresh produce	1	Must be applied before drilling/planting	Not within 12 months of drilling/planting	Any time before drilling/planting	Not within 30 months of harvest	Not within 10 months of harvest	Not within 12 months of drilling planting
	2		Not within 12 months of drilling/planting And At least 6 months before drilling/planting				Not within 12 months of harvest and at least 6 months before drilling/ planting
	3		Any time before drilling/planting		Not within 12 months of harvest		Any time before drilling/planting

¹ PAS 110 not pasteurised or digestate that is not assured.

² PAS 100 and non-assured compost. Green or green/food compost.

³ Immediate prior use as grazing land

Table 16. Red Tractor Combinable crops and sugar beet standards (from November 2021) (Source: Red Tractor, 2021a)

	Manure and slurry	Compost and digestate		Biosolids	
		Including ABP	Excluding ABP	Conventional	Enhanced
Combinable crops	May be applied before and after drilling/planting				

Table 17. Red Tractor dairy, pig, beef/sheep and chicken standards (from November 2021) (Source: Red Tractor, 2021b,c,d,e)

	Manure and slurry		Compost and digestate		Treated sewage sludge	
	<i>Application</i>	<i>Grazing or harvest interval</i>	<i>Including ABP</i>	<i>Excluding ABP</i>	<i>Conventional</i>	<i>Enhanced</i>
Grazed grass and forage	Recommend spring applications & the use of rapid incorporation techniques	Min 4 week no graze interval. Recommended 8 week no graze for adult stock and 6 months for younger stock	No graze interval of 2 months for pigs and 3 weeks for other livestock	No graze interval of 3 weeks	No grazing in season of application Or No graze interval of 3 weeks when sludge is deep injected or ploughed	No graze interval of 3 weeks
Harvested grass and forage		No harvest interval of 4 weeks.	No harvest interval of 2 months for pigs and 3 weeks for other livestock	No harvest interval of 3 weeks	No harvest interval of 3 weeks	No harvest interval of 3 weeks

13 Summary

- In 2021, more than 90% of the land area of Wales was classified as agricultural land (1.8 million ha on farm holdings and 180,000 ha of common rough grazing) (Welsh Government, 2021). In Wales agriculture is dominated by grassland (permanent pasture and sole-rights rough grazing) which accounts for 78% (1.4 million ha) of the total area on farms.
- To realise the benefits of organic materials there must be land that is both suitable and accessible for applications by machinery. Thus, the sustainability of recycling organic materials to land in Wales is dependent on the size and distribution of the available agricultural landbank at both a national and local level. Not all the 1.8 million ha of agricultural land in Wales is suitable for recycling organic materials due to climatic, physical and practical constraints (e.g., steep slopes or proximity to water), and legislative restrictions.
- Most of the organic materials spread to land in Wales are livestock manures (c.90%); other important organic materials are compost, digestate, biosolids and permitted wastes (i.e., those spread to land under Environmental Permit).

13.1 Regulatory restrictions

13.1.1 *The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021*

- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 (WSI, 2021) have been introduced to reduce or prevent losses of pollutants from agriculture to the environment by setting rules for certain farming practices including limits on nitrogen loading from livestock manures, nutrient management planning and the application of organic materials.
- The legally binding regulations came into force on 1 April 2021 but are subject to a transition period up to 1 August 2024 at which point the full requirements of the regulations will be in force. However, the transition periods do not apply to land in an area previously designated as a Nitrate Vulnerable Zone (NVZ) which must be fully compliant from 1 April 2021.

13.1.2 *Environmental Permitting (England and Wales) Regulations 2016 (No. 1154)*

- A regulatory regime exists to manage the process of applying organic material to land, to prevent environmental harm and to ensure materials are only applied where there is either agricultural benefit or ecological improvement. The approach taken to control organic materials which are spread to agricultural land is determined by whether the material is classified as a waste.
- Livestock manures and slurry are not defined as waste if they are spread for agricultural benefit and in accordance with COGAP Wales (Welsh Assembly Government, 2011) and Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 (WSI, 2021).
- Where materials are classified as a waste, application to land is controlled by the Environmental Permitting (England and Wales) Regulations 2016 (No. 1154) (SI, 2016). As part of the regulations Standard Rules have been developed which consist of a set of requirements common to the type of facility or activity they are regulating. They are suitable for activities where the generic risks are well understood, assessed and mitigated (Defra and Welsh Government 2020). Standard Rule SR2010 No4 v6.1 'Mobile plant for land spreading' (land treatment resulting in benefit to agriculture or ecological improvement) is used for spreading specific organic materials to land (Natural Resources Wales, 2016). For organic materials outside of the scope of SR2010 No4 v6.1 a bespoke permit will be required.
- Some waste materials can be reclassified as products if they meet standards for feedstock, processing and quality of material (e.g., limits on physical, chemical and microbial contaminants). Waste quality protocols (QPs) are end of waste frameworks that set out the requirements for compliance for certain wastes (including compost and digestate) that industry can volunteer to

follow to achieve product status. In addition, sewage sludge (biosolids) is not regulated as a waste when it is used in agriculture and the requirements for land application set out in the Sludge (Use in Agriculture) Regulations (1989) are fulfilled.

- In addition, Farm Assurance Schemes and the Biosolids Assurance scheme place additional timing restrictions (e.g., harvest non grazing intervals) on the application of organic materials to reduce the risk of contamination of ready to eat food and forage crops.
- Note that for all organic materials (including manures/slurry) where application rates exceed crop requirements or organic materials are not spread for agricultural/ecological benefit this will be classified as 'disposal' and all materials will be subject to waste controls.

13.2 Physical constraints

13.2.1 Topography

- Slope is an important factor determining whether organic materials can be applied safely. The slope of land affects its suitability for agricultural production through the restrictions steeper slopes impose on mechanisation of crop management and on their vulnerability to soil erosion and surface runoff. However, note that this constraint will only apply to handled organic materials (i.e., excreta deposited during grazing on sloping land is not constrained).
- COAPR (2021) prohibited the spreading of organic manures where the slope was $>12^\circ$ from April 2021. The requirements of COAPR are legally binding and thus override any other advisory good practice guidance. However, note that most prior to the COAPR 2021 most good practice guidance included similar limit values for slope gradient, although some simply referred to steep slopes (without specific guidance), Table 18.

13.2.2 Watercourses, boreholes, springs and wells.

- Proximity to watercourses (and conduits for water, e.g., land drains or runoff pathways) controls the potential connectivity between the organic manure applications and the water and is as an important control over the application of materials to land. Nutrients from surface applied organic material applications can runoff into watercourses and pass through the soil to drains during rain events and when snow melts and can also leach through the soil and into groundwater over time. In general, the level of inherent risk of losses following organic material applications will be less significant if fields are not close or well connected to a waterbody. However, manure type, soil condition, type and nutrient content, slope, and crop will also influence the risk of nutrient loss following land spreading of organic materials.
- COAPR (2021) prohibited the spreading of organic manures within 50 metres of a borehole, spring or well or within 10 metres of surface water (6 m if precision spreading) from April 2021. The requirements of COAPR are legally binding and thus override any other advisory good practice guidance. Other legislation and good practice guidance already included similar advice on spreading distances (Table 18). However, despite the varied terminology used to describe surface water/watercourse in legislation/guidance the 10-metre rule applies to all rivers, streams, ditches, drains, cuts, culverts, dikes, sluices, sewers and passages through which water flows, except mains and other pipes (Water Resources Act, 1991).

Table 18. Summary of legislative and good practice guidance relating to nitrogen loading, proximity to water and slope gradient

Legislation or guidance	Whole farm limit (1 Jan-31 Dec)	Individual hectare limit (12-month period)	Proximity to water (not within specified distance)	Slope	Notes
COAPR 2021	170 kg N/ha ¹	250 kg N/ha	50 m of borehole, spring or well 10 m of surface water*	>12°	
Cross compliance SMR 1: water protection	170 kg N/ha ²	250 kg N/ha	50 m of borehole, spring or well 10 m of surface water	>12°	
GAEC 1: Buffer strips			50 m of borehole, spring or well 10 m of surface water		
COGAP Wales		250 kg N/ha	50 m of borehole, spring or well used for human consumption or farm dairies 10 m of ditch, pond or surface water	Not on steep slopes where run-off risk is high ³ .	
EPR SR 2010 No 4		250 kg N/ha	10 m of watercourse Not within a SPZ1 Or if outside SPZ1 50 m of well, spring or borehole used for the supply of water for human consumption	Not on steep slopes (defined as ≥12°)	SPZ1: groundwater source protection zone
SR 2010 No 6					
U10 Exemption		No N limit. Limit on t/ha that can be applied annually.	10 m of watercourse 50 m of spring, well or borehole		Specific conditions and limits apply to specific wastes
Biosolids Assurance Scheme		250 kg N/ha ⁴	50 m of borehole, spring or well used for human consumption or dairies 10 m of watercourse	>12° ⁵	
WRAP		250 kg N/ha	50 m of borehole, spring or well used for human consumption or dairies	On very steep slopes where run-off is a high	Established good practice should be

			10 m of watercourse	risk throughout the year.	followed, COGAP Wales
Organic farming standards Soil Association	170 kg N/ha	250 kg N/ha	<i>50 m of borehole, spring or well used for human consumption or farm dairies 10 m of ditch, pond or surface water</i>	<i>Not on steep slopes where run-off risk is high³.</i>	Distance and slope not specified but must comply with COGAP
Organic Farmers & Growers	170 kg N/ha	250 kg N/ha	50 metres of wells, springs and boreholes 10 m of ditches and watercourses	<i>Not on steep slopes where run-off risk is high³.</i>	Must comply with COGAP
Farm Assured Welsh Livestock Scheme		250 kg N/ha	50 m of borehole or well 10 m of watercourse or ditch	<i>Not on steep slopes where run-off risk is high³.</i>	Must comply with COGAP
Glastir Management options		100 kg N/ha ⁶			Several options limit or exclude organic fertilisers.
Glastir habitat land	No application				FYM can be spread for specific habitat options

¹From 1 January 2023 for livestock manure. ²Compliance with COAPR 2021. Currently only applies to land previously in an NVZ. ³Steep slope not defined. ⁴Biosolids Nutrient Management Matrix stipulates different return periods depending on soil P Index. ⁵Clause 6.5 states that “within NVZ biosolids must not be applied to agricultural land that has slope of >12° where there is significant risk of N getting into surface water (BAS 2020). However, note that in March 2021 BAS issued guidance to confirm that the guidance now applies to all of Wales (BAS 2021).

⁶Options 15b and 15d grazed permanent pasture with low inputs and for 15 d (only) mixed grazing.

*Surface water or watercourse includes all rivers, streams, ditches, drains, cuts, culverts, dikes, sluices, sewers and passages through which water flows, except mains and other pipes

13.3 Nutrient management

- Effective nutrient management planning involves applying nutrients (either fertiliser or organic manures) based on soil and crop requirement. This approach ensures that nutrients are utilised efficiently on farm and only used when and where necessary. There are four key stages of nutrient planning which should be followed to maximise nutrient use efficiency and minimise the potential risk of nutrient losses to the environment: 1) quantify crop requirement, 2) quantify soil nutrient supply and pH, 3) quantify the crop available nutrient supply from any organic material applications and 4) account for the nutrients supplied by organic materials when planning manufactured fertiliser additions.
- From 1 January 2023 the COAPR 2021 will set a legally binding limit of 170 kg N/ ha from livestock manure (including direct excreta from grazing animals and manure spread to land). In addition, from the same date a 250 kg N/ha field limit on organic manure will apply (excluding manure deposited by grazing livestock). However, note that most legislation and good practice guidance already includes a limit of 250 kg N/ha for any individual field.

14 Next steps

- This report has summarised the legislative, physical and other restrictions on recycling to land that exist in Wales. In addition, it has detailed the main types of organic materials (i.e., livestock manure, digestate, compost, biosolids and permitted wastes) that are applied to land. WP 2 will combine this information using the ALLOWANCE model and GIS to estimate the available landbank for organic recycling to land in Wales.

14.1 ALLOWANCE software

- The ALLOWANCE software contains a 10 x 10 km spatial representation of agricultural census data (i.e., crop areas) in England and Wales to quantify and locate the agricultural land area potentially available for the application of organic materials. The model combines livestock numbers with manure N production data (kg N/animal/year) for each livestock type to calculate N loadings to agricultural land. The N loading is subdivided into field deposited N (i.e., excreted in the field by grazing livestock) and manure N handled as FYM (straw-based farmyard manure), slurry, poultry litter or poultry manure. For other organic materials, information on the quantity produced for land spreading (e.g., biosolids or compost) is combined with data on the 'typical' N content of the materials, to calculate the N loading to agricultural land in each 10 x 10 km grid square.
- In WP2 ALLOWANCE will be used to identify areas where there is a potential shortage or surplus of available agricultural land for recycling organic materials. However, note that ALLOWANCE may overestimate the available landbank as it does not consider social and economic factors that may influence land availability for organic materials, such as farmer, retailer and public acceptance. In addition, seasonal factors affecting the availability of the landbank are not accounted for (e.g., closed periods, flooding, weather conditions etc.).
- Table 19 outlines the data sources that will be used in WP 2 to assess the available landbank for organic materials in Wales. It highlights any evidence gaps or where more up to date data would improve the accuracy of the assessments. There are reliable and up to date data sources to identify organic material inputs and legislative, physical and other restrictions on organic material use. However, note that data on the N content of materials applied to land (and hence the landbank required) is based on 'typical' values for each material type. It is not practicable to use measured values for material N content. Also, ALLOWANCE predictions are based on average conditions for a 10 km by 10 km grid square and do not necessarily reflect the physical restrictions for an individual field within that grid square.

Table 19. Datasets to be used in the work package 2 report to establish the available landbank for organic materials

Organic material	Dataset	Notes	Source	Data gap
Livestock manures	Survey of Agriculture and horticulture June 2021	Livestock numbers	Welsh Government	
	COAPR 2021	Manure production (grazing and non-grazing livestock)	Welsh Statutory Instrument 2021 No 77 (W.20)	
Digestate	NNFCC AD deployment database 2021	Location, feedstock quantity and type	NNFCC database (2021)	
	Biofertiliser certification scheme website 2021	Current PAS 110 sites	Biofertiliser Certified Producers	
	Compost/Biofertiliser Certification scheme annual report 2020	Production and digestate type Market destination	Compost/Biofertiliser Certification Scheme Annual Report 2020	
Compost	Compost sites 2015	Feedstock, certification and compost produced	WRAP Cymru (2015). Survey of green waste compost production capacity in Wales	
	Compost certification scheme website 2021	Current PAS 100	Compost Certification Scheme. Certified Producers	
	Compost/Biofertiliser Certification scheme annual report 2020	Production and compost type Market destination	Compost/Biofertiliser Certification Scheme Annual Report 2020	
Biosolids	ADAS dataset	Sewage treatment centre Production	ADAS data	
	NRW sludge returns DCWW 2020	Quantity to land Agricultural land used N (% dry solids)	DCWW/NRW	
Permitted waste	NRW waste deployment data 2020	Location Waste type Total deployment (tonnes)	NRW	
	N content of selected waste types	Application rate	AHDB Nutrient management guide	

Designation	Dataset	Notes	Source	Data gap
Topography	OS Terrain 50	Slope gradient	https://osdatahub.os.uk/downloads/open/Terrain50?_ga=2.34888033.1536661772.1633422349-475779085.1632927785	
Watercourses, springs and boreholes	Licensed water abstractions	The licensed water abstraction dataset only identifies those sources where an abstraction licence is required (i.e., >20 m ³ /day); abstractions below this threshold will not be identified. Also, private water supplies, which supply 3% of the population, are difficult to identify.	NRW sharefile portal	Abstraction licence only required for >20 m ³ /day. Excludes private water supplies (3% of population)
Source Protection Zone	Location of SPZs	Spatial dataset		
Groundwater vulnerability	Groundwater vulnerability maps	Groundwater vulnerability for principal and secondary aquifers is expressed from high to low.	https://www.bgs.ac.uk/datasets/groundwater-vulnerability-data/	
Soil	Representative Soil Sampling Scheme 1969-2003	pH	Landis https://naturalresourceswales.sharefile.eu/d-s55ed72683ece4d769ac07bfaf10a5c33	Data has a nationwide coverage but is old
	GMEP	pH (samples from 300 1 km squares 2013-2016)	https://catalogue.ceh.ac.uk/documents/0fa51dc6-1537-4ad6-9d06-e476c137ed09	
	National soil Inventory 1983 and 1995	pH and metal concentration	Landis	Data has a nationwide coverage but is old

SPA	Special protection areas boundaries	Spatial dataset	DataMapWales. Special Protection Areas	
SAC	Special areas of conservation boundaries	Spatial dataset	DataMapWales. Special Areas of Conservation	
Ramsar	Ramsar wetlands of international importance boundaries	Spatial dataset	DataMapWales. Ramsar wetlands of international importance	
SSSI	SSSI boundaries	Spatial dataset	DataMapWales. Sites of Special Scientific Interest	
NNR	National Nature Reserve boundaries	Spatial dataset	DataMapWales. National Nature Reserves	
LNR	Local Nature Reserve boundaries	Spatial dataset	DataMapWales. Local Nature Reserves	
Scheduled monuments	Archaeological sites of national importance	Spatial dataset	DataMapWales. Scheduled Monuments	
Organic agriculture	ADAS dataset (in ALLOWANCE)	See below: Glastir organic		
Glastir options (2018)	Glastir land extent under contract	Shapefile required for calculations.	Dataset to be supplied by Welsh Government	

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