

SUMMARY

- Limited slurry storage capacity at Home farm is compromising winter slurry management.
- The farm would like to add 6 months' slurry and fouled water storage capacity; for better nutrient management, to further reduce soil damage and pollution risks from winter spreading, to comply with Farming Rules for Water management requirements, and to meet NVZ storage rules, should they apply at any time in the future.
- An earth-lined lagoon to contain 6 months' slurry, yard runoff and dairy and parlour washings could be constructed on a 0.47 hectare (1.2 acre) site situated on sloping land 630 metres to the south-west of the farmyard.
- Test pits show the lagoon site to be feasible for earth-lined lagoon construction if additional impermeable material is taken from stockpiles on the farm. Soil samples have been taken for subsequent laboratory testing of permeability.
- During construction, the contractor must ensure that all impermeable soil is kept back for lining the lagoon inner banks and base, and not wasted on building up embankments.
- Construction guidelines have been given for lagoon construction. These are based on CIRIA C759b information.

The figures in this report may not correspond exactly with those subsequently input to, and generated by **Slurry Wizard** calculations. Should differences become significant at a later date, required lagoon size can be recalculated on request.

1 FARM DETAILS

Home farm is a specialist dairy unit based on 270 owned and 50 rented acres. None of this land falls within a Nitrate Vulnerable Zone (NVZ) at present.

160 dairy cows (year-round calving, with average milk yield 9,800 litres per cow per year) are milked and cubicle-housed (for 6 winter months on straw). 50 heifers are cubicle-housed during the winter months, and younger replacement stock are straw-bedded.

At present, excreted slurry, dairy and parlour washings, and fouled yard runoff are spread to land on a frequent basis.

1.1 Reasons for the visit

The farm is planning to increase slurry and fouled water storage capacity - for better nutrient management, and to further reduce soil damage and pollution risks from winter spreading.

There is land on the farm which is suitable for the construction of an impermeable earth-lined lagoon for slurry storage. This report summarises volumes to be stored and gives an example lagoon size for the containment of this material.

During the visit, test pits were dug on the proposed lagoon site and soils were assessed for permeability. Based on these findings, example lagoon base and bank construction details are given, in accordance with the recommendations given in CIRIA guides:

[Livestock manure and silage storage infrastructure for agriculture, parts C759a and C759b](#) Full details are provided at the end of this report.

1.2 NVZ and Farming Rules for Water implications

Home farm is not in a [Nitrate Vulnerable Zone](#), and it is not possible to predict whether this will continue to be the case. However, when planning for slurry and foul water storage, it is beneficial to bear the NVZ regulations in mind, as accommodating them can usually be achieved at little additional cost if constructing an earth-lined lagoon. For this reason, NVZ references and implications have been included in this report.

The [Farming Rules for Water \(FRfW\)](#) were introduced in 2018 (details, and where to find up to date guidance, can be found at the end of this report). Within these rules, slurry application to land must take into account crop need and soil condition, and application limits need to be complied with during winter months (see EA guidance notes for details).

Taking into account its cropping, soil types, and topography, the farm has taken the decision to provide **6 months slurry and fouled water storage** in the proposed lagoon.

2 SLURRY AND FOULED WATER QUANTITIES TO BE DIRECTED TO THE PROPOSED LAGOON

Calculation of excreta and fouled water volumes in this report is based on NVZ Guidance data; also used in [AHDB's Slurry Wizard](#), which can be downloaded from:

<https://ahdb.org.uk/knowledge-library/slurry-wizard>

Excreted slurry collected from the cubicle buildings and scraped from yards (in current NVZ Guidance format) will be:

Livestock type	Livestock number	Proportion of excreta collected as slurry	Volume per livestock unit per month m ³	Slurry volume produced each month m ³	Slurry volume produced in 6 months m ³
Dairy cow after first calf (over 9000 litres milk yield)	160	100%	1.92	307	1,843
Dairy cow from 13 months up to first calf	50	30%	1.20	18	108
totals	210			325	1,951

Rainfall, in millimetres, and based on Slurry Wizard data for the proposed lagoon's grid reference, is predicted as:

Year	Oct	Nov	Dec	Jan	Feb	Mar	6 month winter total	winter monthly average
Grid reference average rainfall 851	93	88	104	95	62	64	506	84
Adjusted likely rainfall 978	107	101	120	110	71	73	582	97

Based on 582 mm of adjusted winter rainfall, and the farm's information on open yard areas, the **Fouled water** volumes arising will be:

Source of fouled water	Area (m ²) *	Volume, wettest month (Dec) (m ³)	Volume in six winter months (m ³)	NVZ Definition
Dairy and parlour washings 145 cows milking @ 30 litres per cow per day		135	792	dirty water (LFW)
Silage clamps	1,360	163	792	
silage clamp apron	840	101	489	dirty water (LFW)
dirty water totals	2,200	399	2,073	83% of total
feed area, cows	310	37	181	slurry
feed area, beef	230	28	134	slurry
feed area, heifers	150	18	88	slurry
'slurry' totals	690	83	403	17% of total
Fouled water totals:				
'Slurry' and 'dirty water' combined	2,890	482	2,476	
		106,000	545,000	gallons

* yard areas have been rounded up to the nearest 10 m²

For information, in the table, the **NVZ definition** is shown for each fouled water source. This gives an indication of its nitrogen content ('slurry' is higher than 'dirty water'), and whether it can be spread to land during the winter (closed) period. However, since 2018, the **Farming Rules for Water** have required, in general, that all fouled water contaminated by livestock excreta is stored over the winter period.

This information is for future reference only, since Home farm is not currently in an NVZ, and the decision has been taken to store all open fouled yard runoff and dairy and parlour washings over the winter period, irrespective of its NVZ or FRfW definition.

In total, therefore, **6 months' slurry and fouled water** to be stored will be:

$$1,951 + 2,476 = \mathbf{4,427\ m^3}$$

3 EARTH-LINED LAGOON SIZING AND PROPOSED SITE

As an example of lagoon dimensions to contain all the slurry and fouled water from 6 months winter housing (4,427 m³), if a rectangular 5 metre deep lagoon were to be built on flat ground, it could be 62 x 43 metres along the inside top banks, giving a total volume of 7,900 m³ (1.7 million gallons). These dimensions allow for

- 1 in 2½ slopes on the inner lagoon banks (see scale model image to the right, photo below, and diagram in CIRIA 759b)
- the rain falling into the lagoon over 6 winter months, with a 15% contingency for wetter years
- a 750 mm design and operating freeboard (green strip in the model)



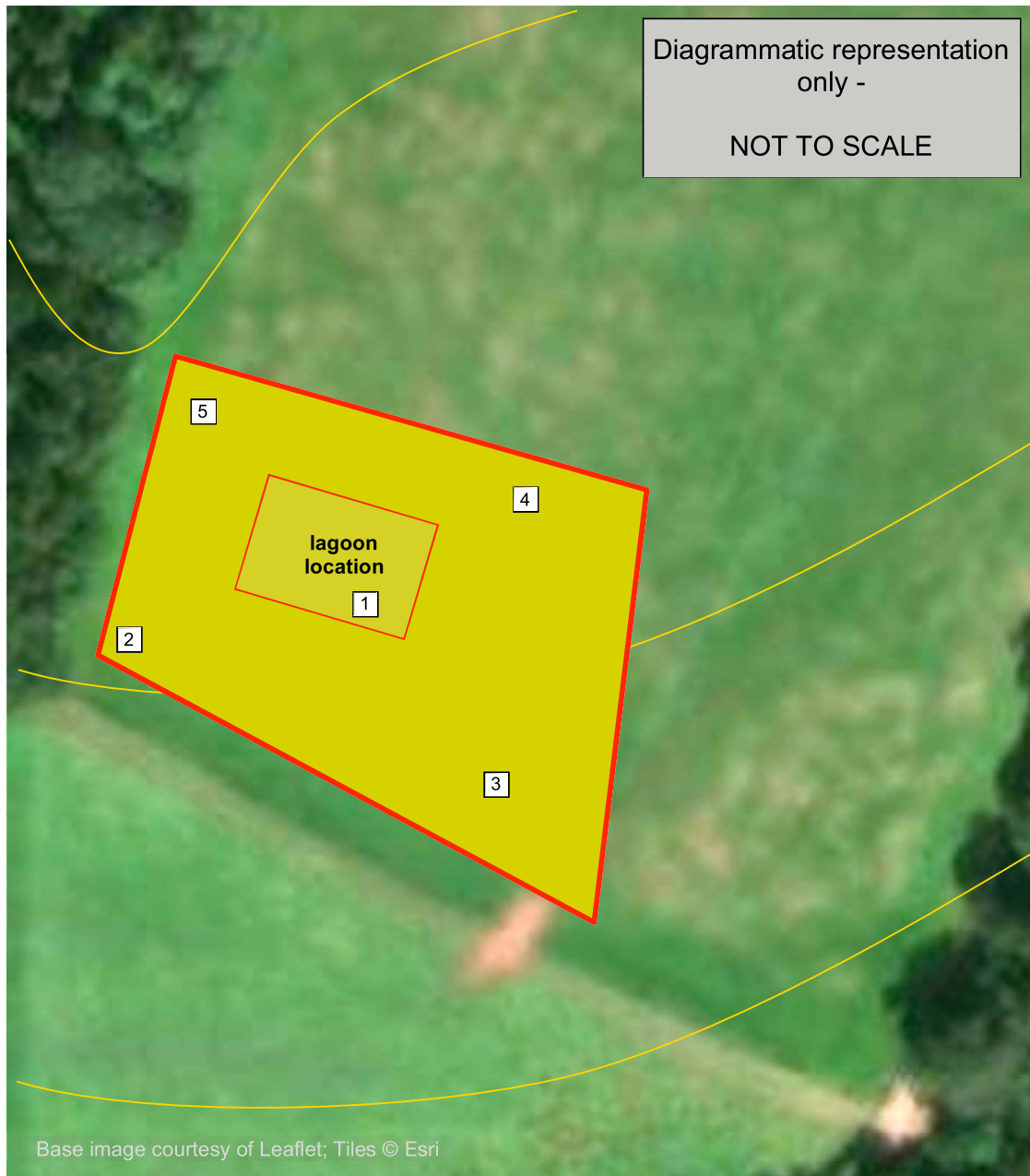
Overall land area required could be in the order of 0.47 hectares (1.2 acres) including the outer banks. The floor of the lagoon would be 37 metres long x 18 metres wide (though access ramp arrangements could alter these figures)

However, the site is not flat, and fitting a lagoon into will not result in a rectangular shape at the outer banks, but the above example gives some idea of the dimensions that you need to work to.

Also note that, if you are planning to add a **ramp down the long side of the lagoon** (more on this later), you would, for instance, need to make the lagoon 3 metres wider to allow for the storage volume lost from a 6 metre wide ramp.

3.1 Proposed site

The proposed lagoon site is situated 630 metres to the south-west of Home Farm farmyard, at grid reference ST 854 720. It is shown over a satellite image of part of the field in which it will be sited (north at the top):



Notes

- The lagoon outline and inner bank tops are shown in red, with relevant 5 metre contours shown in yellow (the land falls towards the south-east)
- The test pit locations are numbered 1 to 5
- The nearest watercourse is situated 840 metres to the south-west of the proposed lagoon location

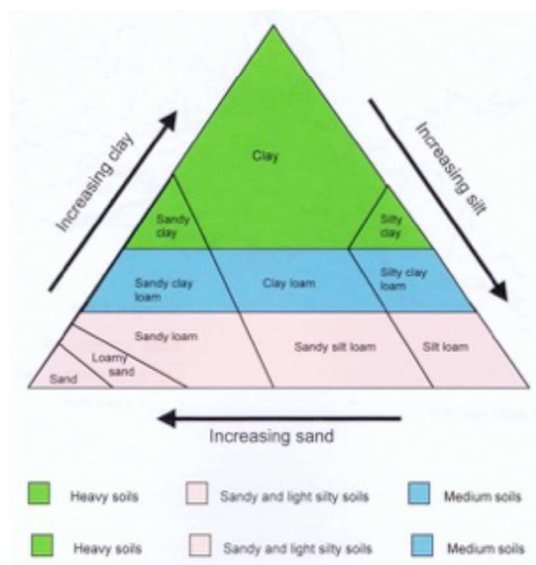
4 EARTH LINED LAGOON FEASIBILITY

The most suitable soils for impermeable lagoon base and embankment construction have a 20-30% clay content, shown as the blue 'clay loam' area in the middle of the soil texturing diagram to the right.

These soils have a suitably low permeability (10^{-9} metres per second or less), combined with high strength.

Clay contents above 30% (green areas) result in very low permeability, but care is needed during construction to ensure that embankments are stable.

In clay loam and clay soils, up to 30% stone content can be tolerated without compromising permeability.



4.1 Test pits and preliminary soil examination

Five pits were dug at the locations marked on the plan, using a 360 degree excavator.

Soil was placed adjacent to each pit in discreet piles for hand texturing for clay content, and to establish stone content. A representative sample from soil zones judged to be suitably impermeable was bagged and left on the farm, to be sent off for soil permeability testing.

The photos that follow show the main soil/shale/stone combinations excavated from the pits. No water ingress was seen in any of the pits.



Topsoil - 300 to 400 mm deep.
Well structured clay loam, with less than 10% stones to 60 mm.
This material would be **suitable** to form an impermeable lagoon layer



Middle layers - between 0.3 and 0.9 metres thick in pits 1, 2, and 5
Generally yellow clay, with up to 30% slabby stones to 300 mm long.
This material would be **suitable** to form an impermeable lagoon layer



Below the topsoil in pits 4 and 5, and below 0.8 to 1.6 metres depth in the other pits, **stone content was above 30%**, usually with a yellow clay fill.

This material would **not be suitable** to form an impermeable lagoon layer