Soils report 5 – Seán O'Riordan, Kiskeam

Introduction

This dairy farm is located 4.5 km to the north of the village of Kiskeam, in the townland of Knochnenaught, Co. Cork (Plate 1). The farm is 50 hectares in size and has approximately 100 cows. Annual precipitation is on average 1622 mm at the met. station 7.8 km away from the site. Slopes are generally between 4 and 8 degrees. The elevation is 233 m at the highest point. A tributary of the River Owenkeal runs west to east in the northern valley of the farm.

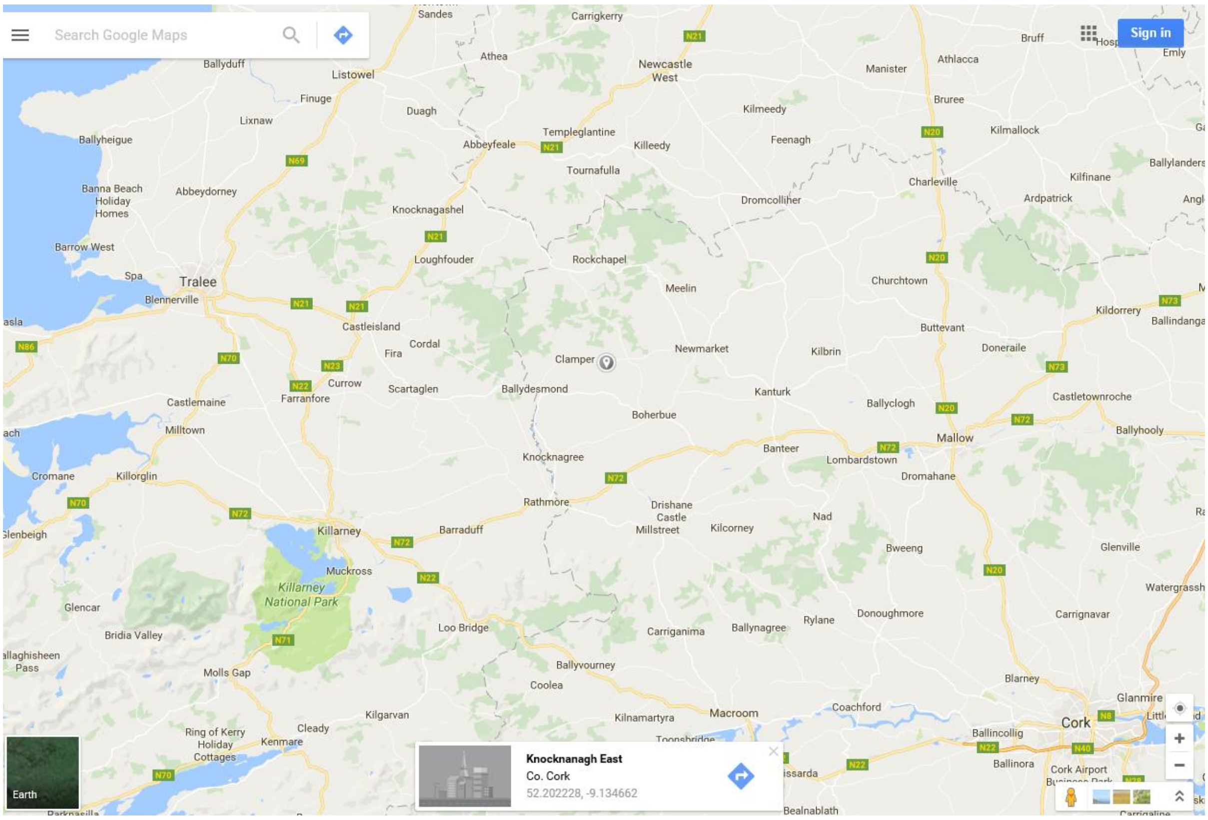

Plate 1. Location of the O' Riordan farm to the north east of Ballydesmond and the west of Newmarket, Co. Cork.

The area has high rainfall which leads to intense weathering and leaching/eluviation. This also leads to stagnation in the soils upper horizons. With the steeper slopes of 6 to 8 degrees this runoff can collect in the plateau areas and at the bottom of the valleys. Here the stagnation occurs for longer periods allowing gleying to occur. In more severe cases, humic material begins to develop in the anoxic conditions that prevail. Little of the organic matter can be broken down in these waterlogged conditions.

The on farm river runs west – east in the northern third of the farm to the south of paddocks 29 and part of 26 and the north of paddocks, 36, 37, 24 and part of paddock 26. Here waterlogged alluvial soils are found. The shale bedrock of the upper slopes has been heavily weathered mobilising silt and clay from the upper horizons to leach to the lower horizons of the soil. Therefore luvic Bt horizons are to be expected. This weathering also encourages the illuviation of iron and aluminium to lower horizons and Bs horizons would be expected (Plate 2).

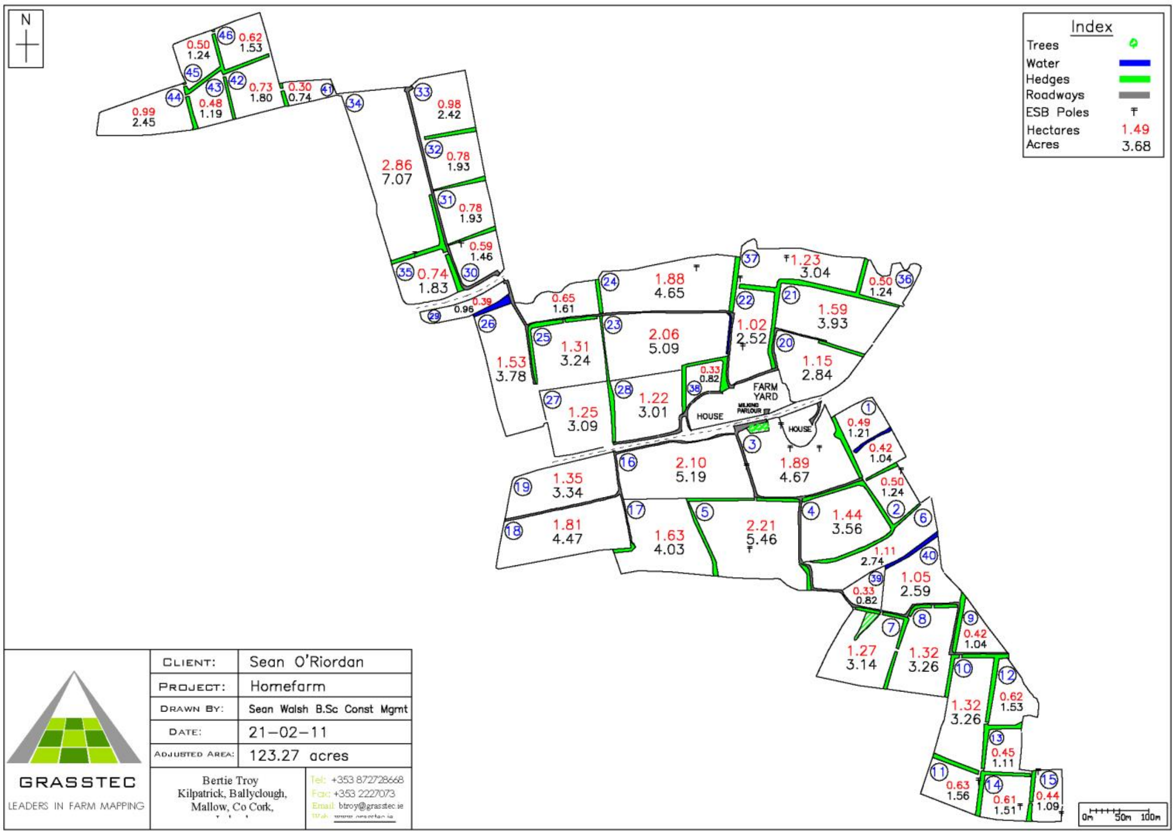

Plate 2. Distribution of the paddocks on the Kiskeam Heavy Soil Farm of Seán O'Riordan, Co. Cork.

The geology of the area is described as shale and sandstone of Namurian (undifferentiated) origin in the Geological Survey of Ireland (Pracht, 1997). The Soils in the area are formed from glacial deposits of the Saale period. The soil on the hill slopes was formed by solifuction, where the rock waste was formed by severe frost action on the areas not covered by ice. The streamlines of the bedrock in the area run east to west, as did the ice advance. The drift further down the hill slopes and in the valleys was composed of shale and sandstone derived till. As the ice receded, it is likely that lakes formed between the hills and eventually clay dominant deposits were laid down (Finch and Ryan, 1966). The subsequent Weischel glaciation did not reach south as far as this region of County Cork.

Historical soil information

There was no National Soil Survey report of this area of North West Cork. There was however the West Cork Resource survey of An Foras Talúntais, 1963. This covered as far north to the area of Kilmichael, approximately 50 km away from Kiskeam, to the south. In this area it described soils such as Driminidy a coarse loamy, Humic Surface-water Gley and Ross Carbery a coarse loamy, Typical Brown Podzolic. It also described raised peat in the area, the Allen series. These soils are in an area dominated by sandstone geology, which produces coarse loamy drift. It is unlikely that the soils would be similar to those in Kiskeam where there is a shale dominated drift of Namurian origin.

The Irish Soil Information System (Creamer et al 2014), is thus the primary resource for investigation of the soils of the area. Focussing on the Knocknenaught area, the complete area of the farm is covered by a polygon of the soil association Kilrush (Plate 3). There is also a polygon of Crosstown association, led by this Stagnic Luvisol to the south and another polygon to the north of Blanket peat. All three associations attest to the impacts of the high rainfall in the area and the consequent drainage problems.

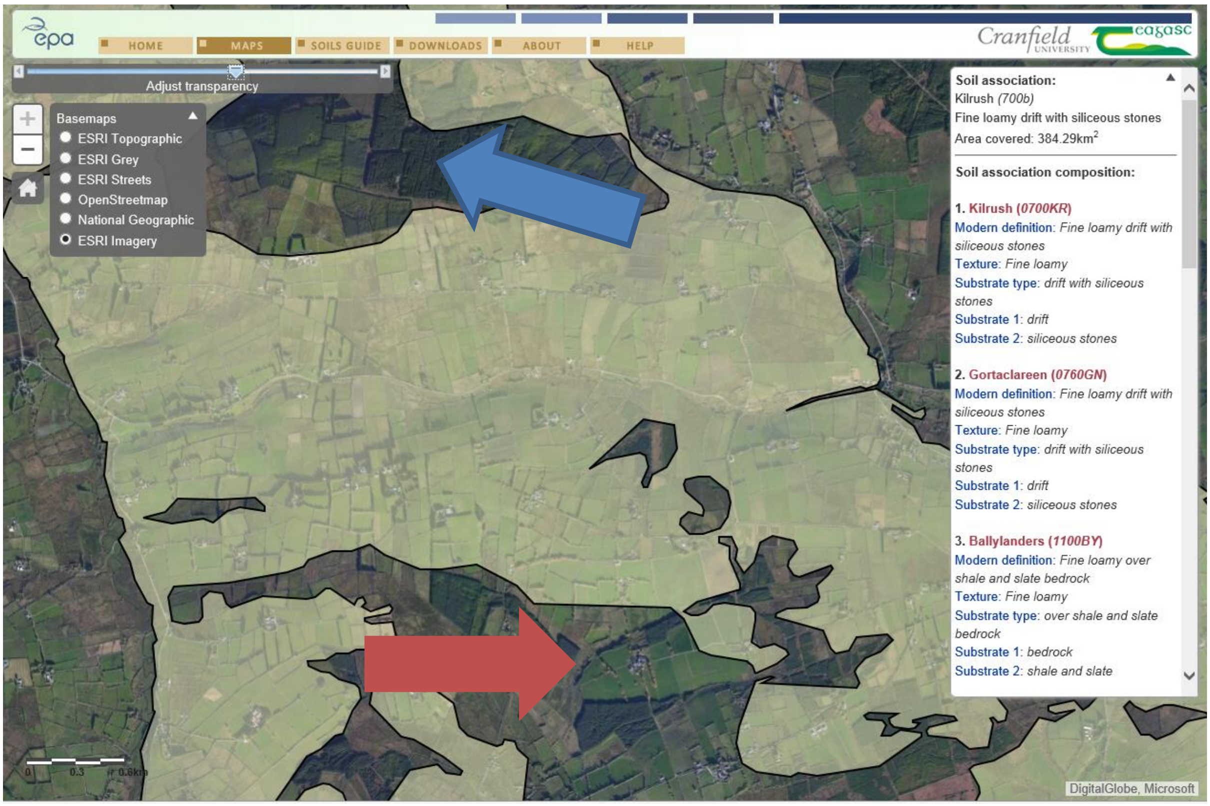

Plate 3. The Irish SIS map of the Kiskeam HSP farm. The principal polygon is the soil association Kilrush. The red arrow indicates the Crosstown association 0.5 km to the south. The blue arrow indicates the Blanket Peat 300 m to the northern edge of the farm.

Focussing on the Kilrush association that dominates the farm, this contains four different Surface-water Gleys (SWG), three different Groundwater Gleys (GWG), three different Brown Earths (BE) and one Brown Podzolic (BP). Again gleying would be expected to be due to the groundwater and perched water tables suggested within in this association, as there are seven compared to the four more free draining soils (BE and BP). Most of the soils series are defined as having fine loamy drift with siliceous stones; however there are three examples with definitions of fine silty drift with siliceous stones, two SWG and one GWG. A further 3 km to the north there is an association dominated by the Podzol Knockastanna, as the elevation increases.

Auger campaign

<u>Method</u>

The distribution of the farm paddocks are in Plate 2. An auger bore was carried out on average every hectare to investigate the soil physical features. In practice more or less augers were used based on landscape complexity. Their resulting distribution was an even coverage in this area (Plate 4). The Dutch auger was driven into the soil to a depth of 1 metre if possible. The coordinates, landscape features and soil features were described and recorded on a field tablet. Horizon type, depth, texture, colour, mottling, structure, roots and stones were recorded along with many more physical attributes detailed in the Irish SIS soil profile handbook (Simo et al 2014).

Plate 4. Distribution of the soil auger points on the Kiskeam heavy soil farm, Co. Cork.

Humic/Histic

A humic or histic layer was noted in 22 of the augers suggesting long periods of stagnation, where organic material builds up as it cannot break down (anaerobic conditions) and accumulates in the upper horizons. The stagnation occurs due to the high amounts of rainfall in the area and the shallow inclines becoming pooling areas from slope runoff (Plate 5 & 6). In this scenario the water tries to percolate downwards but is impeded by increased soil bulk density with depth. This is also confounded by the higher clay and silt contents found in the sub soils (Bt and Btg horizons). There is reduced porosity due to increases in stones, as a result and the water cannot move downwards quickly, leading to a perched water table. The organic matter from the dead vegetation builds up more quickly than the microbial population can break it down. In severe cases the breakdown has almost stopped completely and peat begins to form (histic). The humic paddocks are: 21b, 9, 10, 12, 13, 11, 15, 31, and 35. The histic paddocks are 30, 31, 35, 37, 34, 41, 42, 43, 44, 45, 46, 14 and 39.

The vast majority of these soils were Humic SWG, there were four Humic Alluvial soils and one Humi-stagnic Luvisol. In some cases the soils from the field auger, would be designated the histic qualifier; however there is no Histic SWG option, therefore the humic qualifier was used as a best fit. None of the histic horizons were 40 cm and therefore the soils did not qualify as peat. Compaction was also noted in the SWG on the northern plateau, paddocks 41 to 46.

Plate 5. Paddock 34 to north of river, with a shallow incline, 3 degrees, into plateau area.

Plate 6. A, Paddock 10 B, Paddock 12. Rushes on these shallower slopes indicate waterlogging and the docks indicate relatively good levels of nitrogen.

Bedrock and stones

Shallow stones impeded the use of the auger to 60 cm depth or less in 16 paddocks (20a, 38, 25, 27, 41, 42, 46, 19, 17, 1b, 2, 6, 7, 8, 40 and 13). The next 16 augers were impeded by stones at 70 cm. Generally the slope in these areas was between 4 and 8 degrees. Therefore many of the soils definitions were described as bedrock shale rather than drift siliceous. Most of these soils were described as Typical or Stagnic Luvisols or Typical or Humic SWG with Bt or Btg horizons (Plate 7). The stagnation occurred due to the dominance of the coarse fractions (gravel and stones) and the low soil content of the matrix. These soils had very little water holding capacity. Anoxic conditions would prevail for short periods and iron would be precipitated out of solution on the return to aerobic conditions. These soils are considered moderately or imperfectly drained based on stagnation occurrence. The old quarry in paddock 39 displayed bedded shale and mounds of this shale were found throughout the farm (Plate 8, A & B).

Plate 7. Paddock 20a. Just to the south of the drained paddock 21, bedded shale found on margins.

Plate 8. A & B. Old quarry in paddock 39 showing bedded shale prominence in the area.

Spodic Horizon.

Stagnic Brown Podzolics were found in paddocks 22, 27, 28, 19,16, 17 and 4 (Plate 9).These soils were found on the steeper slopes (6 to 8 degrees) and upper slopes/crests, around the farmyard rather than the slopes of 4 degrees to the north and south of the farm. The high silt and clay contents coupled with the abundant stones prevent drainage. As a result mottling would be in the soil matrix. Coupled with this the bedrock is shallow and illuviation and/or biochemical weathering of silicates has taken place in situ to such an extent that there is a build-up of iron in the lower horizons (Bs). There appears to be a mix of Stagnic BP and Stagnic Luvisols in these areas. Podzols with an iron pan would form if this process was not prevented by deep ploughing over time. Typical Brown Podzolics would be found in drier areas (Plate 10).

Plate 9. Paddock 19. Ridge, the auger was a luvisol but pit revealed a BP. Paddock 6 had some BP but was dominated by Luvisols.

Plate 10. Paddock 28. A Typical Brown Podzolic soil.

Water-table

Despite the high rainfall, the water-table was only noted in four paddocks (9, 30, 38 and 46). This may have been so low due to the water-table not being encountered in other augers due to the stones. It could also indicate that the rainfall flows overland quickly on the slopes to the valleys or laterally through the soil matrix. However it is more likely that it also confirms that the stagnation problem is due to the perched water table and not to the groundwater table. This is reflected in all the Luvisol and SWG soils on the farm. Paddocks 30 and 38 are alluvial soils. Paddock 46 is a Typical SWG of fluvio-glacial origin (Plate 11). These three soils have been heavily influenced by water; paddock 9 appears to be an anomaly in that it did not reveal GWG/Alluvial characteristics. The farmer did not indicate many springs were present on the farm.

Plate 11. Paddock 42, looking north to paddock 46. A plateau area on the north side of farm, a fluvio-glacial deposit.

Alluvial soil

The Alluvial soils were all found on the alluvial floodplain to the north of the farmyard along the Owenkeal tributary, paddocks 37, 36, 26, 29. Alluvial soils were also found across the R578 in paddocks 30, 31, 34 and 35. Here the slopes are shallow and it is likely they are of fluvio-glacial origin. Where the quarry is on the farm in paddock 39 another alluvial soil was described, it is more likely to be a lake/pond deposit. The soils were either Typical or Humic Alluvial Gleys, some did have histic layers, but there is no histic qualifier so they were also described as humic. These soils have very poor drainage and had very high clay and silt contents. Anoxic conditions prevail for most of the year, leading to gleying and mottling within 40 cm of the surface. The organic material builds up over time and few stones were found in the soil profiles (Plate 12 and 13).

Plate 12. Paddock 37. Overgrown in rushes, with a histic upper horizon, an Alluvial Gley

Plate 13. Paddock 29. Catena looking south to paddock 26 (Stagnic Luvisol). Standing in the floodplain, there is an Alluvial Gley, with the river just to the south, overgrown with vegetation.

Conclusion

The auger survey description resulted in 11 Stagnic Luvisols, 11 Humic Surface-water Gleys, 9 Typical Luvisols and one Typical SWG out of 48 samples (Table 1). Many of the upper horizons were silty clay loam or clay loam in texture. Overall the soils had silt loam textures. It is clear that illuviation of clay and silt to the lower horizons is the dominant soil property on this farm. This results in the perching of the water table with Bt and Btg horizons.

On steeper slopes at elevation the weathering has resulted in shallower soils and a Brown Podzolic/Luvisol complex is apparent (5 HBP and 2 TBP). With all the rain on the farm coupled with the river valleys, there are 7 alluvial soils (4 Typical Alluvial Gleys and 3 Humic Alluvial Gleys). The alluvial soils on the northern hills with a southern aspect appear to be of fluvio-glacial origin.

There was one Stagnic Brown Earth found on the farm, it is likely to occur more often within the BP/Luvisol complex with more investigation. It is likely that some Knockreagh soil series will be found, a fine silty, Stagnic Brown Earth. Some Coolykereen TSWG, fine silty, may also be found in time again as the HSWG Gortaclareen is for fine loamy soils only.

A Major problem in the survey was not having the fine silty option for Luvisols. Therefore the Stagnic Luvisol option was selected as the Silt loam texture of the soil was very important. A similar problem was with the lack of a Histic Alluvial Gley designation. Another area was where the designation of bedrock resulted in the lack of a fine silty designation in the soils definition. The Irish SIS may need to reflect these series into the future.

Table 1. Field observations of soil type during the auger campaign on Kiskeam Heavy Soil Farm. Paddocks are listed with Subgroup and Soil series based on the Irish SIS (Creamer et al 2014). The drainage class is described in Schulte et al (2015).

Paddock	SUBGROUP	Series Name	Drainage Class
20a	1000 Typical Luvisol	Dromkeen	Moderately drained
20b	1020 Stagnic Luvisol	Gortavoher	Moderately drained
21a	1020 Stagnic Luvisol	Gortavoher	Moderately drained
21b	0760 Humic Surface-water Gley	Ballygree	Poorly drained
36	0500 Typical Alluvial Gleys	Vicarstown	Poorly drained
37	0560 Humic Alluvial Gleys	Camoge	Poorly drained
22	0960 Humic Brown Pozolic	Borrisoleigh	Poorly drained
38	0700 Typical Surface-water Gley	Lismeelcunnin	Poorly drained
28	0960 Humic Brown Pozolic	Borrisoleigh	Poorly drained
23	1000 Typical Luvisol	Dunboyne	Moderately drained
24	1020 Stagnic Luvisol	Gortavoher	Moderately drained
25	1020 Stagnic Luvisol	Gortavoher	Moderately drained
27	0900 Typical Brown Pozolic	Cupidstownhill	Moderately drained
26	1020 Stagnic Luvisol	Gortavoher	Moderately drained
29	0500 Typical Alluvial Gleys	Boyne	Poorly drained
30	0500 Typical Alluvial Gleys	Vicarstown	Poorly drained
35	0560 Humic Alluvial Gleys	Camoge	Poorly drained

Table 1 continued			
Paddock	**SUBGROUP**	**Series Name**	**Drainage Class**
31	0560 Humic Alluvial Gleys	Feale	Poorly drained
34	0760 Humic Surface-water Gley	Kilcullen	Poorly drained
33	1120 Stagnic Brown Earths	Mourd	Moderately drained
41	0760 Humic Surface-water Gley	Ballygree	Poorly drained
42	0760 Humic Surface-water Gley	Cluggin	Poorly drained
43	0760 Humic Surface-water Gley	Ballygree	Poorly drained
44	0760 Humic Surface-water Gley	Ballygree	Poorly drained
45	0760 Humic Surface-water Gley	Ballygree	Poorly drained
46	0760 Humic Surface-water Gley	Gortaclareen	Poorly drained
16	0960 Humic Brown Pozolic	Borrisoleigh	Poorly drained
19	0960 Humic Brown Pozolic	Borrisoleigh	Poorly drained
18	1020 Stagnic Luvisol	Gortavoher	Moderately drained
17	0900 Typical Brown Pozolic	Cupidstownhill	Moderately drained
5	1020 Stagnic Luvisol	Gortavoher	Moderately drained
3	1020 Stagnic Luvisol	Gortavoher	Moderately drained
1a	1020 Stagnic Luvisol	Gortavoher	Moderately drained
1b	1000 Typical Luvisol	Dunboyne	Moderately drained
2	1000 Typical Luvisol	Dunboyne	Moderately drained
4	0960 Humic Brown Pozolic	Borrisoleigh	Poorly drained
6	1000 Typical Luvisol	Dromkeen	Moderately drained
39	0500 Typical Alluvial Gleys	Gurteen	Poorly drained
7	1000 Typical Luvisol	Dromkeen	Moderately drained
8	1000 Typical Luvisol	Dromkeen	Moderately drained
9	1020 Stagnic Luvisol	Gortavoher	Moderately drained
10	0760 Humic Surface-water Gley	Gortaclareen	Poorly drained
40	1000 Typical Luvisol	Dromkeen	Moderately drained
12	0760 Humic Surface-water Gley	Gortaclareen	Poorly drained
13	1000 Typical Luvisol	Dromkeen	Moderately drained
11	1020 Stagnic Luvisol	Gortavoher	Moderately drained
15	1062 Humic Stagnic Luvisol	Ballyduff	Imperfectly drained
14	0760 Humic Surface-water Gley	Gortaclareen	Poorly drained

Representative soil profile pits

Using the auger survey as a guide, four pits were selected to represent the dominant soils on the farm and to investigate the principal drainage restrictions identified. Paddock 37 was to represent the Humic Alluvial Gleys at the bottom of the slopes along the river of the farm. Paddock 22 was chosen to represent the more Humic Brown Podzolics in the upper slope and crest areas with less severe drainage problems. Paddock 34 was to represent the Humic Surface-water Gleys in the shallower slopes of the farm with drainage problems. Paddock 19 was originally excavated to represent the Luvisols on the farm with minor drainage problems, however on excavation it turned out to be a disturbed Bown Podzolic. In the Irish SIS there was one pit dug previously on the farm, a Humic Brown Earth in paddock 10 (Plate 14).

Plate 14. Distribution of the four Heavy Soil Farm soil pits. Paddock 34 the most northerly. Then paddock 37 along the river bank. Paddock 22 just to the south west of this. Further south west again is paddock 19. The most southerly point was the Irish SIS pit in paddock 10.

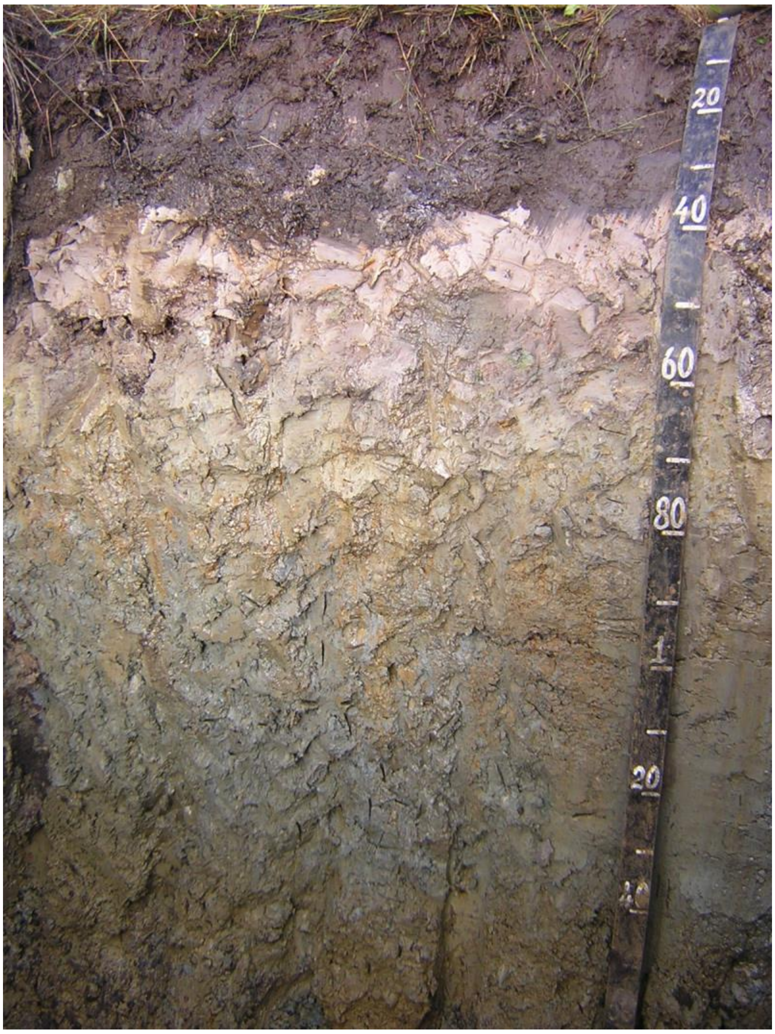

Plate 15. Paddock 37 Humic Alluvial Gley, 0560, soil series Feale.

Table 2. Soil profile description of paddock 37, Kiskeam Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
35	Ap/O	Very dark grey, common mottles, A part texture silt loam. Few to common stones. Top 15 cm root mat, coarse roots. Weathered stones, saturated.
55	Btg	Light brownish grey, few mottles. Texture silt loam, common stones sub rounded. Manganese coats prominent. Compacted. Sand lens, weathered stones. Stone layer at bottom of hz. Dead roots and coarse roots.
85	Cg1	Light yellowish brown, many mottles, silt loam. Very few stones, Stagnic channels. Very sticky, coarse and dead roots.
140	Cg2	Greenish grey, common mottles, silt loam. Abundant stones, coarse and dead roots. Compacted.
190	2Cg	Light yellowish brown. No roots. Clay loam. Plastic. Common mottles. Abundant stones. Cemented.

Paddock 37 soil pit was the most acidic on the farm (plate 15) and the acidity increased with depth (5.3 to 4.9). The surface water logging and fluctuating groundwater table is likely to mobilise the hydrogen ions and their levels were the highest on the farm. The silt content increased from 46 to 50 to 61 from horizon 1 to 3, which is indicative of alluvial deposition. The sub rounded stones of hz2 indicate some water sorting which would again be evidence of alluvial formation. The lower horizons have been compacted and there is a lithological discontinuity in horizon 5. It has a different texture, Clay loam and may represent the drift present before the most recent glaciation. This horizon is also cemented. The dead roots indicate that at some time growth was possible but changed abruptly. Now only the coarse, strong deep roots of the rushes can cope with the compacted soils at depth (Plate 16).

Plate 16. Cross section through coarse roots of the rushes found in this field. The plant can bring oxygen to anoxic layers. As a consequence of the oxygen at depth, iron has precipitated out in the area surrounding the root – orange/red colour.

Plate 17. Paddock 22 Humic Brown Podzolic, 0960, soils series Borrisoleigh.

Table 3. Soil profile description of paddock 22, Kiskeam Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
25	Ap	Dark grey, common mottles, few stones. Silty clay loam. High organic content. Weathered stones. Some manganese concretions bottom of hz. compacted
65	Bt	Strong brown. Many red mottles. Common stones. Silt loam. Humus coats. Bh hz in places. Partial E horizon (white layer). Compacted.
110	Cr	Yellowish Brown. No mottles. Loam. Dominant stones. Loose in places
220	R	Fractured shale bedrock. No roots

Plate 17. Paddock 22, partial E horizon in horizon 2. High in silt content.

Paddock 22 is a good example of a Humic Brown Podzolic (Plate 16). It has high organic matter in the top soil. There is even some translocation of this humus to the 2nd hz and has developed a partial Bh hz. There is also an E horizon (plate 17) which is made of the illuviated silt from above. The Bt horizon had a greasy feel due to the iron on the surface of the soil aggregates. This has given the profile a rich red-brown colour. There is also high aluminium content in this horizon which another indication of podzolisation occurring.

It is likely that management of this paddock over the years is restricting the podzolisation process. This pit would likely become a Podzol in the long run, it possibly was many decades ago prior to deep ploughing. The breaking of the pan has allowed this soil to be relatively free draining compared to the other soils on the farm. The accumulation of humic material on top is a testament to all the rain fall and the periodic stagnation that occurs. A concern would be the compact nature of the soil in the upper horizons exacerbating this problem in the long term. The left hand side of the pit face is more likely to be a Stagnic Luvisol as it does not have the E hz or the red colour of hz 2.

Plate 18. Paddock 34, Humic Surface-water Gley, 0760, Ballygree

Table 4. Soil profile description of paddock 34, Kiskeam Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
32	AO	Very dark grey, common mottles, silty clay loam. Few stones, weathered stones. Amorphous peat. Some mixing of hz.
70	Btg	Light yellowish brown. Many mottles. Common stones. Silt loam, manganese concretions. Organic channels. Weathered stones. Iron patch remnant Bh. White silt layer top of hz. Mixed hz.
97	Cg	Brownish yellow. Common mottles, many stones, Silt loam, stagnic channels compacted
125	Cr	Light yellowish brown. Few to common mottles, dominant stones. Loam, no roots. Cemented, manganese coats.
190	R	Shale, shattered bedrock

Paddock 34 (plate 18) is a Humic surface-water Gley, however this is tenuous. The Btg horizon has undergone a lot of mixing and there is some evidence of mixing in the organic A horizon also. Amorphous peat was recorded. It could be that in the past this was a Podzol with a histic top soil. It may have been deep ploughed or dug with an excavator to 70 cm. There is also the possibility that the face is on an old field boundary that has been removed in reclamation of this field.

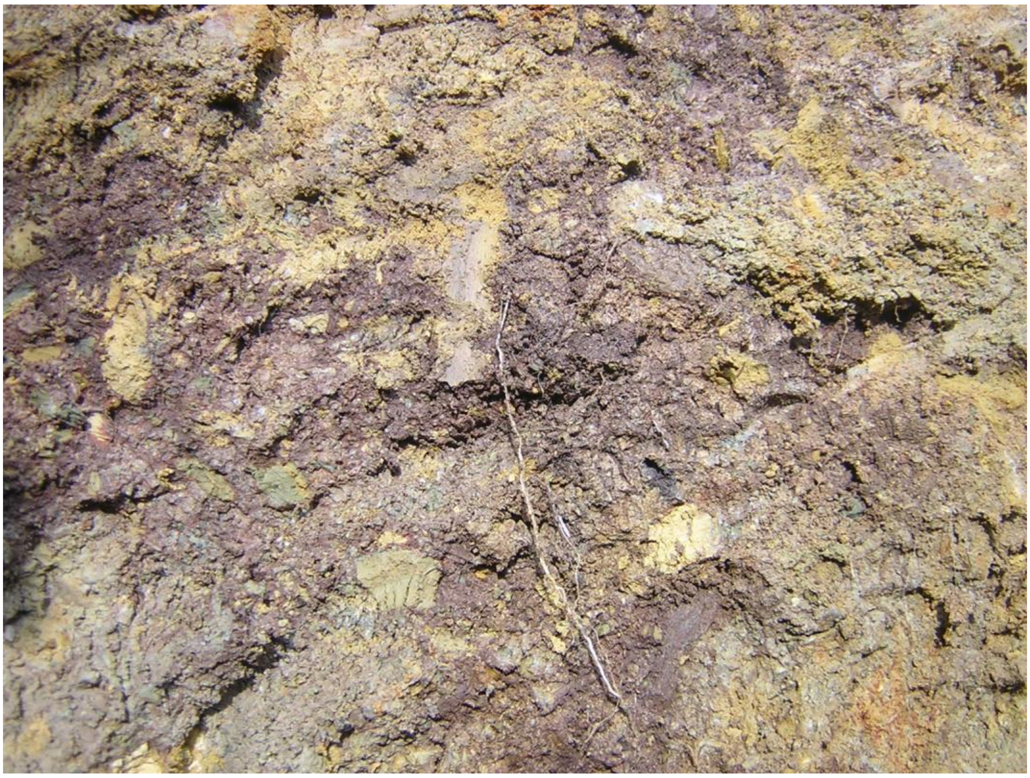

Plate 19. Detail of paddock 34, evidence of horizon mixing with many different soil matrix colours.

The mixed Btg horizon (plate 19) has many mottles and is now effectively a perched water table. This is sitting on top of a compacted hz 3 and a cemented hz 4. There is very little scope for the water to percolate downwards quickly. The many stagnic channels of the upper Cg horizon is testament to the restricted movement of the water into this horizon.

Following the excavation the peat appears to be accumulating once again in the top horizon. As the weathering process acts on the mixed horizon 2 it may start to podzolise once again. There was a remnant Bh horizon recorded in hz 2 and in the centre of the hz at 45 cm it appears that an E horizon may be developing again. There may be a case that this soil could be described as an Anthric –Humic Brown Earth, soil series Ashgrove anthropic (1196), definition: fine loamy drift with siliceous stones as a best fit (there is no silt equivalent).

Plate 20. Paddock 19, disturbed Humic Brown Podzolic

Table 5. Soil profile description of paddock 19, Kiskeam Heavy Soil Farm.

Horizon depth (cm)	Horizon designation	Description
35	Ap	Very dark grey. Common root mottles. Many stones. Weathered stones, mixed patches with lower hz.
68	Btg/Bs	Yellowish brown. Common to many mottles. Many stones. Weathered stones. Parts of A in hz. Many iron coats. Sticky
94	Cr	Light yellowish brown. Common mottles. Dominant stones. Compacted. Sticky.
150	R	Bedded shale. Water ingress.

Paddock 19 is found on the crest of the main hill where the farm yard is located (Plate 20). Brown Podzolics and Luvisols were located in this area with the auger campaign. Originally it was hoped to excavate a Luvisol on shale bedrock. However the result was this disturbed Humic Brown Podzolic. Coarse fragments (stones & gravel) dominated this profile. There were many stones present in horizon 1 (Table 5). There appeared to be some fragments of E and B horizons present. In the 2nd

horizon there were parts of A present. Again there were many stones, there were however areas with many iron coats (Plate 21) indicating illuviated iron into this area and precipitation on the return to oxic conditions. The stagnation is therefore intermittent enough to not gley the soil matrix. The third Cr horizon has dominant stones and is now compacted allowing very little water movement. The boundary between hz 2 and hz at 90 cm had water ingress to the profile pit. At some points in the bedrock there was also water ingress, more likely to be lateral flow at this depth through cracks.

Plate 21. paddock 19 patches of iron coats in the second horizon.

It is apparent from the abrupt boundary between hz1 and hz2 that this mixed layer was created through management. The breaking of the iron pan/horizon in the past has allowed better management of this profile. In the long run this maintenance needs to be continued otherwise the podzolisation process will dominate once again and form the iron pan. Especially so to 50 cm where large remnants of the pan can be starting points for the collection of more iron.

Conclusions

The soils on this farm fit roughly into two categories: a Brown Podzolic/Luvisol (BP/L) complex that is relatively free draining compared to the Alluvial Soils and the Surface-water Gleys (A/SWG). The BP/L are found on the upper slopes and crests in the farm, where the soils are shallow, have been heavily weathered in the past, contain many coarse fragments, suffer from stagnation for short periods have high silt content and high clays contents in the uppers (Plate 22).

The A/SWG are found in shallower slopes or plateau areas and at the bottom of the farms valley. These soils are inundated with water for far longer periods of time, leading to gleying of the upper horizons. There are less stones and they therefore have greater porosity and water holding capacity in their high silt and clay soil textures. They dry out less frequently throughout the year. Humic or histic horizons have developed in the top soils due to the persistent water logging.

The BP/L has greater potential for productivity with less management effort. The farmers efforts are clearly working in these areas producing good sward cover. The lower areas are far more problematic and would require greater investment.

Caution may need to be exercised in the shallower slopes or plateaus areas as they may not result in the desired effects (Paddock 29). The bedrock undulates and where there are heavier soils combined with shallow bedrock these areas may require alternative measures. However to counter act this there may be better soils unrecorded on the farm such as Humic Brown Earths (Paddock 10) which was found in the Irish SIS study, but not in the current auger campaign where the point found a Humic SWG.

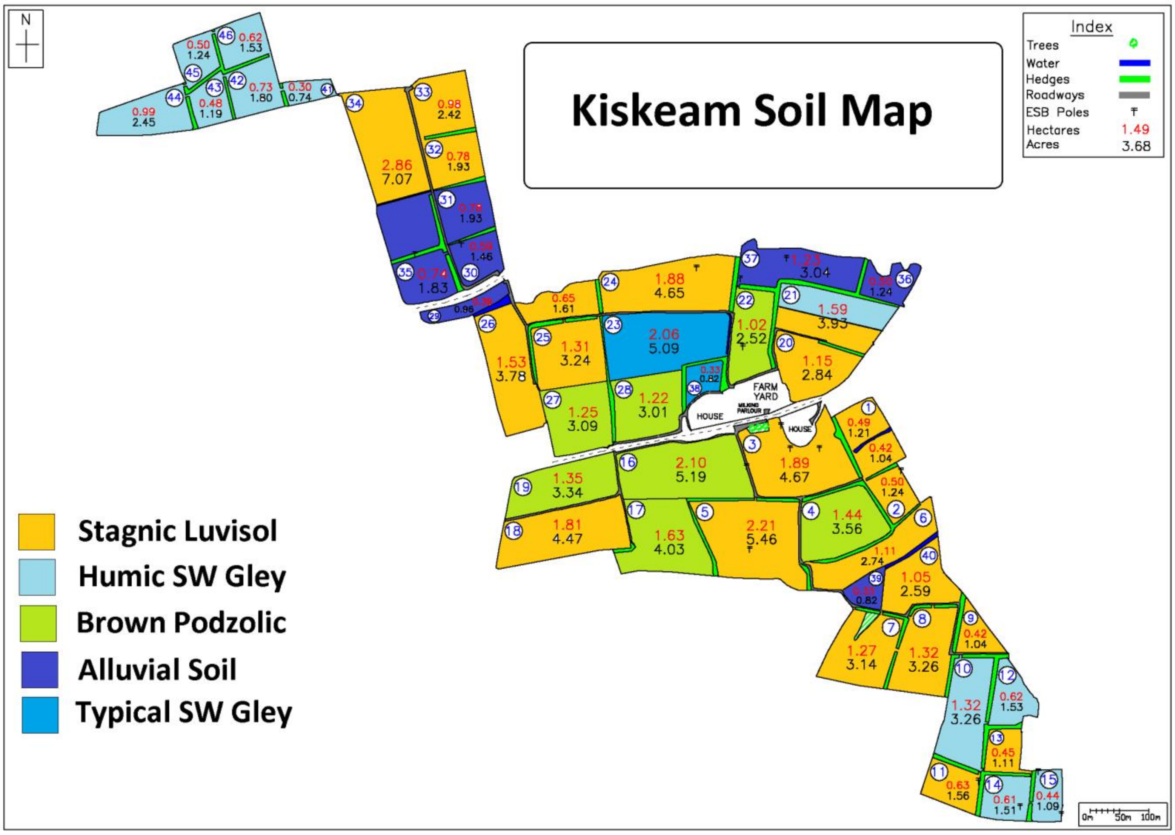

Plate 22. Map of principal soil types distribution at the Kiskeam, Heavy Soil Farm.

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Appendix.

Table 6. Laboratory data for samples taken from soil pits at Kiskeam HSP farm.

Label	Paddock	Sample	Clay (%)	Silt (%)	Sand (%)	Dry Density (g/cm^3)	Bulk Density (g/cm^3)	Gravimetric Moisture Content (%)	Total Exchange Capacity (meq/100 g)	pH	Organic Matter (%)	Estimated Nitrogen Release (#'s N/acre)
SOR 1	34	HZ1	34	49	17	0.93	1.50	60.73	19.63	5.8	11.85	126
SOR 2	34	HZ2	22	60	18	1.30	1.79	33.23	7.64	5.8	2.79	76
SOR 3	34	HZ3	10	59	31	Too many stones-no samples			6.32	5.7	1.52	50
SOR 15	34	HZ4	24	42	34	Too many stones-no samples			6.83	5.1	1.33	47
SOR 4	37	HZ1	34	46	20	0.61	1.39	130.78	13.53	5.3	17.53	129
SOR 5	37	HZ2	22	50	28	1.53	2.00	30.64	9.13	5.1	2.24	65
SOR 6	37	HZ3	21	61	18	1.43	1.96	34.55	5.25	5	1.13	43
SOR 7	37	HZ4	22	53	25	1.71	2.25	17.51	5.55	4.8	1.18	44
SOR 8	37	HZ5	29	37	34	Too many stones-no samples			8.39	4.9	1.02	40
SOR 9	22	HZ1	36	49	15	0.96	1.53	55.80	15.42	5.4	11.03	126
SOR 10	22	HZ2	25	54	21	0.97	1.47	35.21	5.91	5.9	4.41	94
SOR 11	22	HZ3	21	40	39	Too many stones-no samples			4.63	5.9	2.26	65
SOR 12	19	HZ1	34	40	26	0.89	1.45	64.31	18.73	6.1	13.3	127
SOR 13	19	HZ2	19	54	27	0.85	1.31	24.61	9.93	6.1	4.1	91
SOR 14	19	HZ3	17	45	38	Too many stones-no samples			7.01	6	2.18	64

Table 6 continued…

Label	Paddock	Sample	S* (ppm)	P* (mg/kg)	Bray II P (mg/kg)	Ca* (mg/kg)	Mg* (mg/kg)	K* (mg/kg)	Na* (mg/kg)	Ca** (%)	Mg** (%)	K** (%)	Na** (%)
SOR 1	34	HZ1	13	40	73	2686	87	44	24	68.42	3.69	0.57	0.53
SOR 2	34	HZ2	18	12	11	1025	39	20	21	67.08	4.25	0.67	1.2
SOR 3	34	HZ3	16	4	6	792	36	24	24	62.66	4.75	0.97	1.65
SOR 15	34	HZ4	16	6	6	509	59	95	43	37.26	7.2	3.57	2.74
SOR 4	37	HZ1	12	15	31	1337	96	31	40	49.41	5.91	0.59	1.29
SOR 5	37	HZ2	9	6	4	775	67	22	34	42.44	6.12	0.62	1.62
SOR 6	37	HZ3	9	3	3	321	89	22	22	30.57	14.13	1.07	1.82
SOR 7	37	HZ4	8	7	13	186	147	37	34	16.76	22.07	1.71	2.66
SOR 8	37	HZ5	8	4	5	284	248	57	41	16.92	24.63	1.74	2.12
SOR 9	22	HZ1	14	29	53	1538	142	108	38	49.87	7.67	1.8	1.07
SOR 10	22	HZ2	22	2	1	760	60	28	33	64.3	8.46	1.21	2.43
SOR 11	22	HZ3	21	2	4	593	45	29	29	64.04	8.1	1.61	2.72
SOR 12	19	HZ1	18	48	84	2718	148	92	38	72.56	6.58	1.26	0.88
SOR 13	19	HZ2	17	6	6	1452	75	34	23	73.11	6.29	0.88	1.01
SOR 14	19	HZ3	18	6	7	1013	39	29	27	72.25	4.64	1.06	1.67

Table 6 continued…

Label	Paddock	Sample	Other Bases** (%)	H** (%)	B* (mg/kg)	Fe* (mg/kg)	Mn* (mg/kg)	Cu* (mg/kg)	Zn* (mg/kg)	Al* (mg/kg)
SOR 1	34	HZ1	5.8	21	0.59	503	6	2.77	1.02	884
SOR 2	34	HZ2	5.8	21	0.27	243	< 1	2.57	< 0.4	1350
SOR 3	34	HZ3	6	24	0.3	458	< 1	1.44	< 0.4	1250
SOR 15	34	HZ4	7.2	42	0.29	262	2	1.24	1.48	1773
SOR 4	37	HZ1	6.8	36	0.41	541	23	0.37	2.73	933
SOR 5	37	HZ2	7.2	42	0.31	548	9	0.9	0.55	568
SOR 6	37	HZ3	7.4	45	0.21	263	6	4.98	1.32	968
SOR 7	37	HZ4	7.8	49	0.45	698	24	6.81	2.43	894
SOR 8	37	HZ5	7.6	47	0.31	349	102	1.61	1.14	640
SOR 9	22	HZ1	6.6	33	0.55	517	33	1.24	1.79	873
SOR 10	22	HZ2	5.6	18	0.31	301	6	0.76	< 0.4	1312
SOR 11	22	HZ3	5.6	18	< 0.20	183	6	0.59	0.46	1524
SOR 12	19	HZ1	5.2	13.5	0.71	498	11	1.4	2.71	794
SOR 13	19	HZ2	5.2	13.5	0.22	360	2	1.52	< 0.4	1199
SOR 14	19	HZ3	5.4	15	< 0.20	292	< 1	1.32	< 0.4	1594