TELLUS GEOCHEMICAL SOIL SAMPLING CAMPAIGN 2019

Project Report

IBR1188
Tellus Geochemical Soil Sampling Campaign 2019
Final
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rpsgroup.com

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RPS

Founded in 1970, RPS is a leading global professional services firm. We define, design and manage projects that create shared value to a complex, urbanising and resource-scarce world.

We work across six sectors: property, energy, transport, water, resources, defence and government services. Our services span twelve clusters: project and program management; design and development; water services; environment; advisory and management consulting; exploration and development; planning and approvals; health, safety and risk; oceans and coastal; laboratories; training and communication and creative services.

We stand out for our clients by using deep expertise to solve problems that matter, making them easy to understand and by being easy to work with.

1 INTRODUCTION

RPS was commissioned by Geological Survey Ireland (GSI) via public tender to conduct the geochemical soil sampling campaign for the Midlands of the Republic of Ireland during the summer of 2019.

1.1 Aim

The aim of the project is to colllect geochemical samples of the surface environment on a regional scale in the north midlands region of Ireland.

Sampling was based on an ad-hoc gridded survey design with one sample being collected per 4 km^2 survey grid cell defined. Grid squares were defined by GSI.

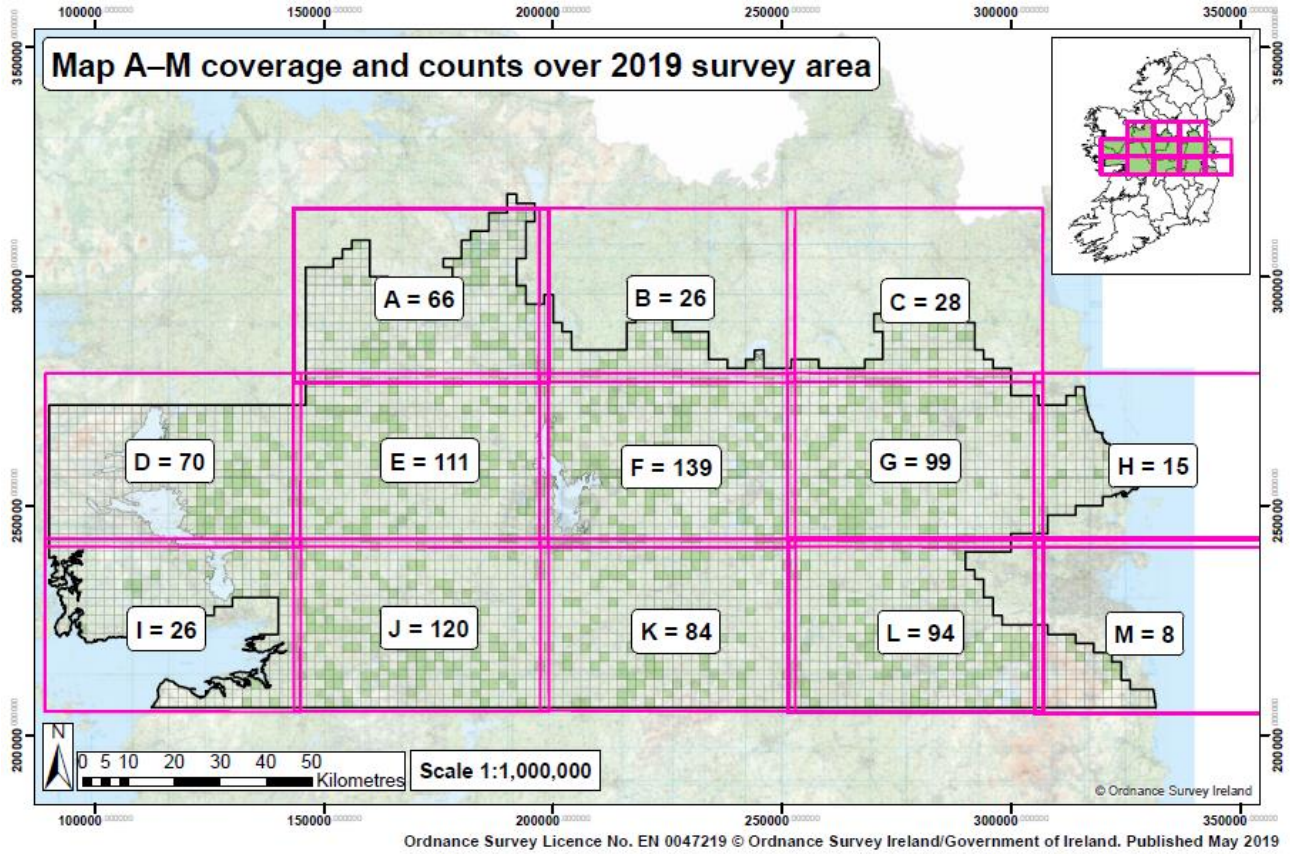
1.1.1 Overview of Method

Soil samples were obtained using a hand auger, with accompanying field observational data are required for two depths as follows:

- Shallow topsoil for depths of 5–20cm; and
- Deeper topsoil for depths typically between 35–50cm.

Sampling was conducted by teams of samplers working in pairs. All procedures and methodologies established and documented by GSI were followed by the RPS teams and verified by the field team management and project manager.

Figure 1.1 Coverage of the 886 proposed sampling grid locations



1.2 Overall Objectives

The project objectives were as follows:

1. To collect soil samples at two depths from 886 survey grid cells between July and the end of September 2019. This figure was revised by GSI to 880 due to six grid squares having no suitable land bank for sampling due to coastal or lakeside location. These sites were were identified and communicated by GSI in advance of the survey grid cells being issued to a field team for collection.

2. To sample duplicate soil samples from sites randomly spread out through the project area within the same sampling timeframe.

3. To. ensure good practice in terms of quality assurance and quality control throughout the duration of the project.

4. To provide an accurate digital database of all obervtaional data.

5. To provide all GPS coordinates for each sample to the GSI daily, and ensure sample points are also plotted in situ onto Ordnance Survey 1:50,000 maps for the survey area.

6. Deliver all checked and batch process samples and data to the Client.

1.3 Programme

Samples from the 880 survey grid cells were required to be collected between June/July (award of contract) and the end of September 2019.

RPS proposed an initial programme which commenced with field sampling on the 29th July 2019. This was subsequently amended to facilitate GSI-lead field based training on the 29th and 30th July 2019, with initiation of the field sampling on afternoon of 30th July 2019.

Field based sampling was completed on 26th September 2019 with the exception of four sites which subsequently required re-sampling. These four sites were collected the 7th and 9th of October.

2 OUR APPROCH TO THE SAMPLING CAMPAIGN

2.1 Pre-fieldwork Planning

Prior to the commencement of fieldwork RPS conducted a number of desk based exercises using geographical information systems (GIS). These can be summarised as:

1. Clustering of samples; and

2. Desk based GIS analysis of GSI sampling exclusion zones on all sample grids.

Each field team received 'mapping packs' containing the outputs from the above in printed format. RPS believe the provision of these mapping packs worked well in the field and field teams often commented on the ease of use.

2.1.1 Clustering of Samples

RPS clustered the sample grid squares prior to field work initiation in order to inform the appropriate selection of field bases for the field teams. The initial field work strategy was to select locate field bases in strategic locations so that the field teams did not have to travel more than 40-60 minutes to any location. This was in order to reduce the potential for driver fatigue and maximise available time in the field.

RPS conducted a desk-based analysis and prepared 'mapping packs' for each field team. Each mapping pack contained a 1:50k map an overview map and ortho imagery showing a cluster of sites in specific areas. Figure 2.1 is an example of the cluster overview map.

These cluster overview maps were used as an aid to guide teams and allowed them to find the required sampling location/s and easily group sampling grids. This facilitated well planned days and driving routes.

2.1.2 Pre-fieldwork Desk Based GIS Analysis of Grids

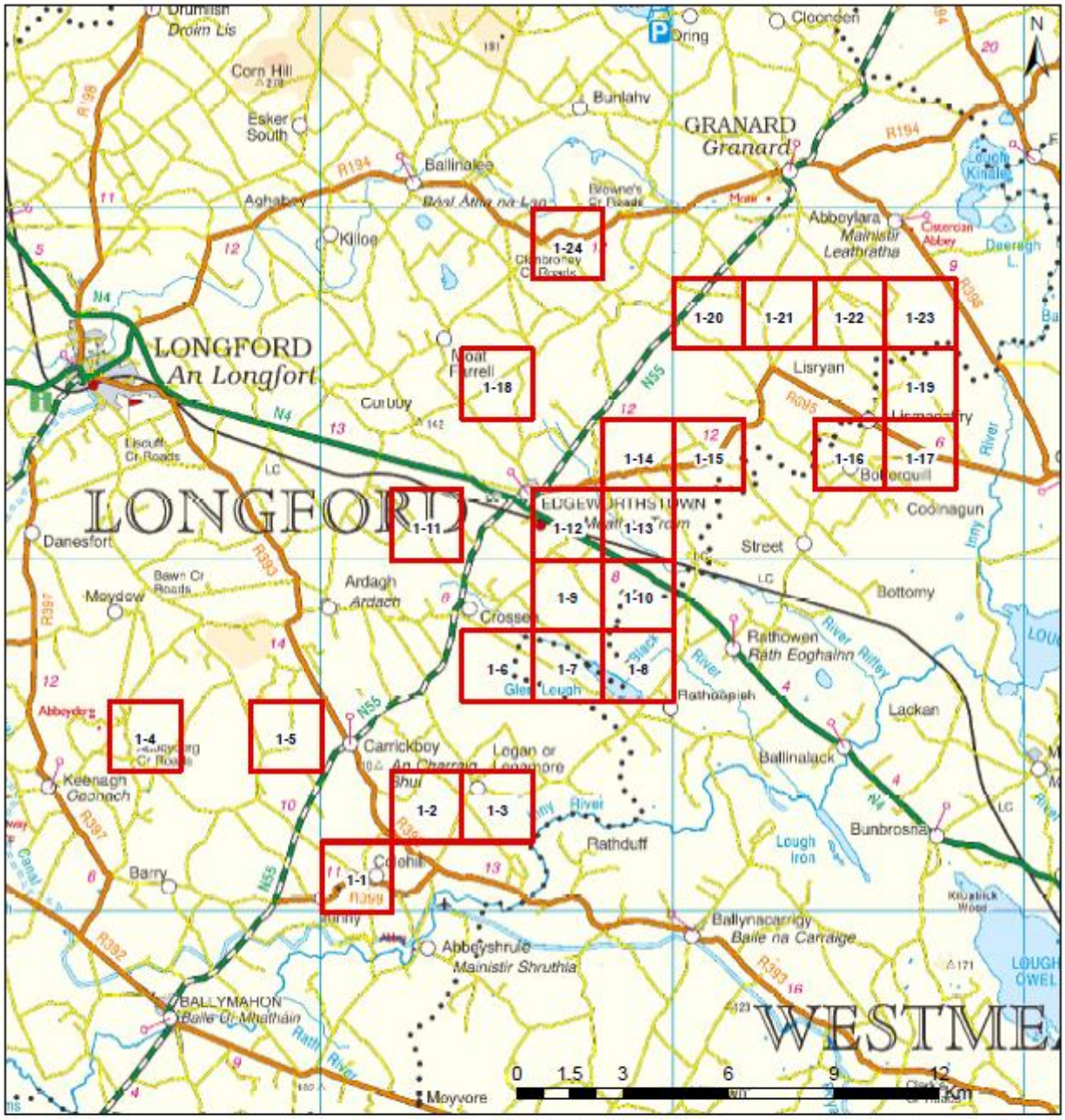
Along with the cluster overview maps, the RPS GIS team conducted desk-based analysis and prepared digital mapping packs for each field team. One map sheet was prepared for each sampling site,

An example is provided in Figure 2.2.

This map was developed to assist the team in determining where best to sample from. The ortho imagery was prepared using a projection tool with the purpose of utilising the predetermined grid squares and displaying comphrensive assessment of the area which required sampling. GIS was used to determine the suitable sampling zones taking into account the prerequisite site selection distance criteria. This map was to be used in conjunction with the 1:50,000 Ordanance Survey map to help select a suitable sample location.

RPS found this approach to be beneficial in increasing efficiency and a more approachable to those with less map reading experience from the start. The approach aided the teams whe trying to adhere to distance criteria as it allowed them to understand the surrounding field size and locality in relation to the 4km² grids.

Figure 2.1 Example of Cluster Overview Map

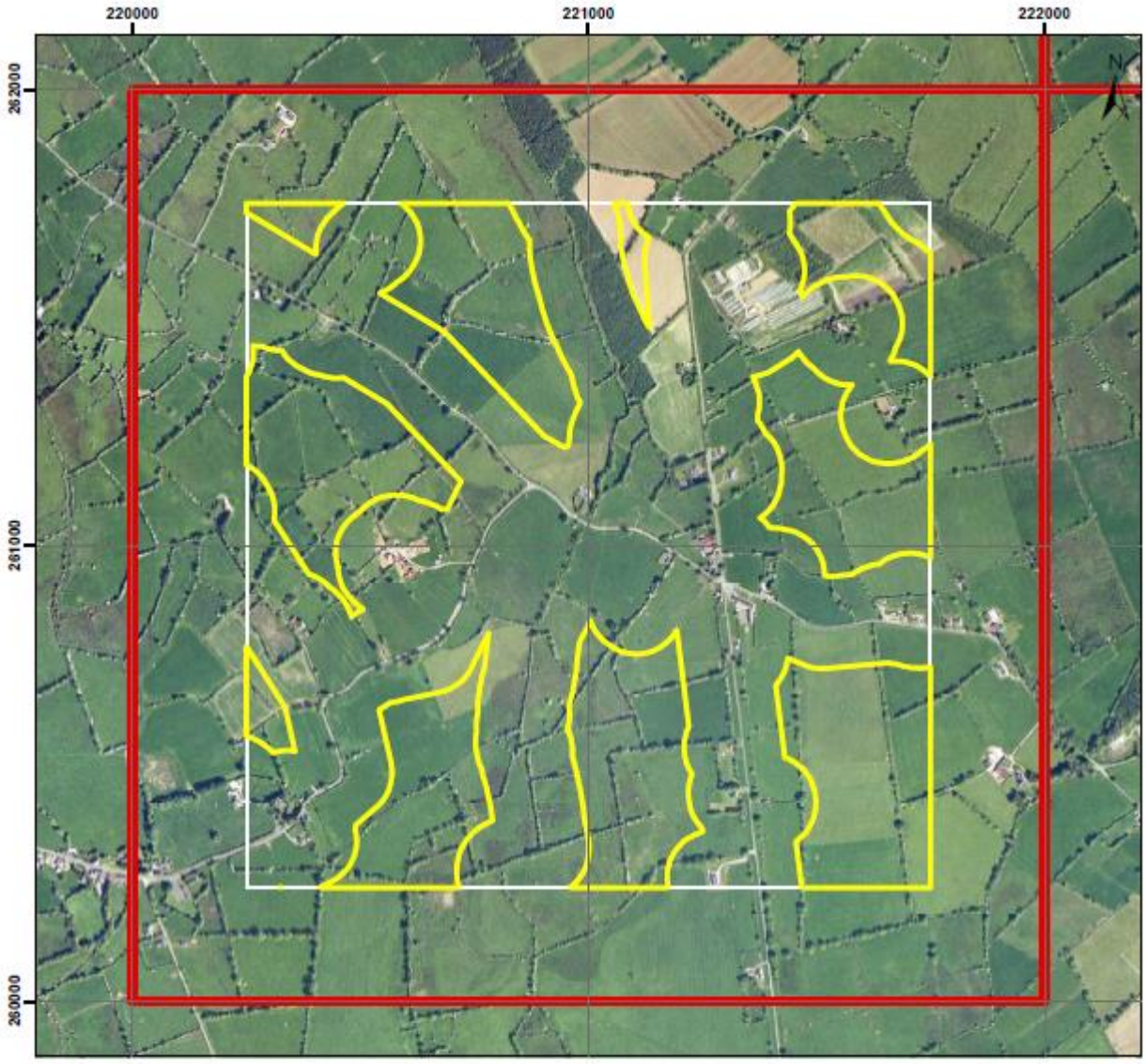


Sample Area: Athlone - Cluster 1

Date: 18/08 -05/09

Sample		Sample		Sample	
1-1		1-11		1-21	
1-2		1-12		1-22	
1-3		1-13		1-23	
1-4		1-14		1-24	
1-5		1-15			
1-6		1-16			
1-7		1-17			
1-8		1-18			
1-9		1-19			
1-10		1-20			

Figure 2.2 Example of Ortho Map



RPS Sample No.: A - 1 - 1

Grid Centre: X: 221000 Y: 261000

Random Sample No.:

Samplers Initials:

Date & Time:

Sample: A: S: D:

Landowner:

Notes:

Sample Location: X: Y:

Card: GPS: Map:

2.2 Initial Approach to Completing the Fieldwork

As previously mentioned, the initial field work strategy was to select the sites around field bases so that the field team did not have to travel more than 40-60 minutes to any location. This was in order to reduce the potential for driver fatigue, maximise available time in the field and increase efficiency, therefore quick access to the main road network was essential in selecting field base locations.

Initial fieldbase locations were anticipated to be Naas, Navan, Tullamore, Roscommon and Galway. RPS had envisaged to complete the field sampling working from east to west. However, the availability of suitable field base accommodation during the busy summer tourist period impacted on this initial approach.

2.3 Actual Approach to Completing the Fieldwork

Due to limited availability of accommodation in the Naas/Navan/Tullamore areas the RPS project management team had to amend the initial field base locations and method of covering the survey area.

Following on from an initial sampling period in Naas, the field teams then moved to Carrick-on-Shannon, to Athlone, to Galway and then back to Mullingar. Figure 2.3 to Figure 2.7 show the sites which were planned to be collected from each field base.

Figure 2.3 Actual locations collected from Naas field base

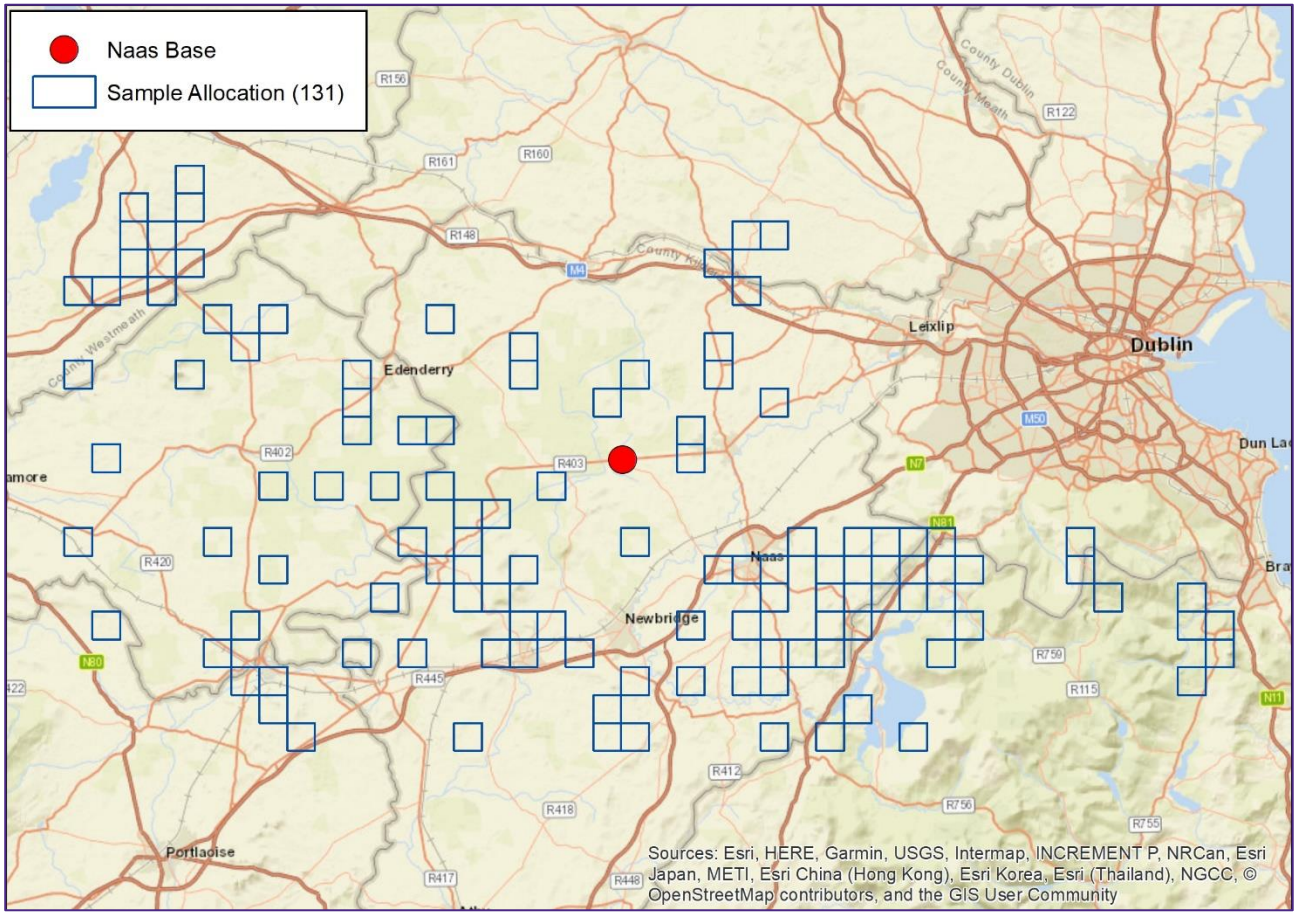


Figure 2.4 Actual locations collected from Carrick-on-Shannon field base

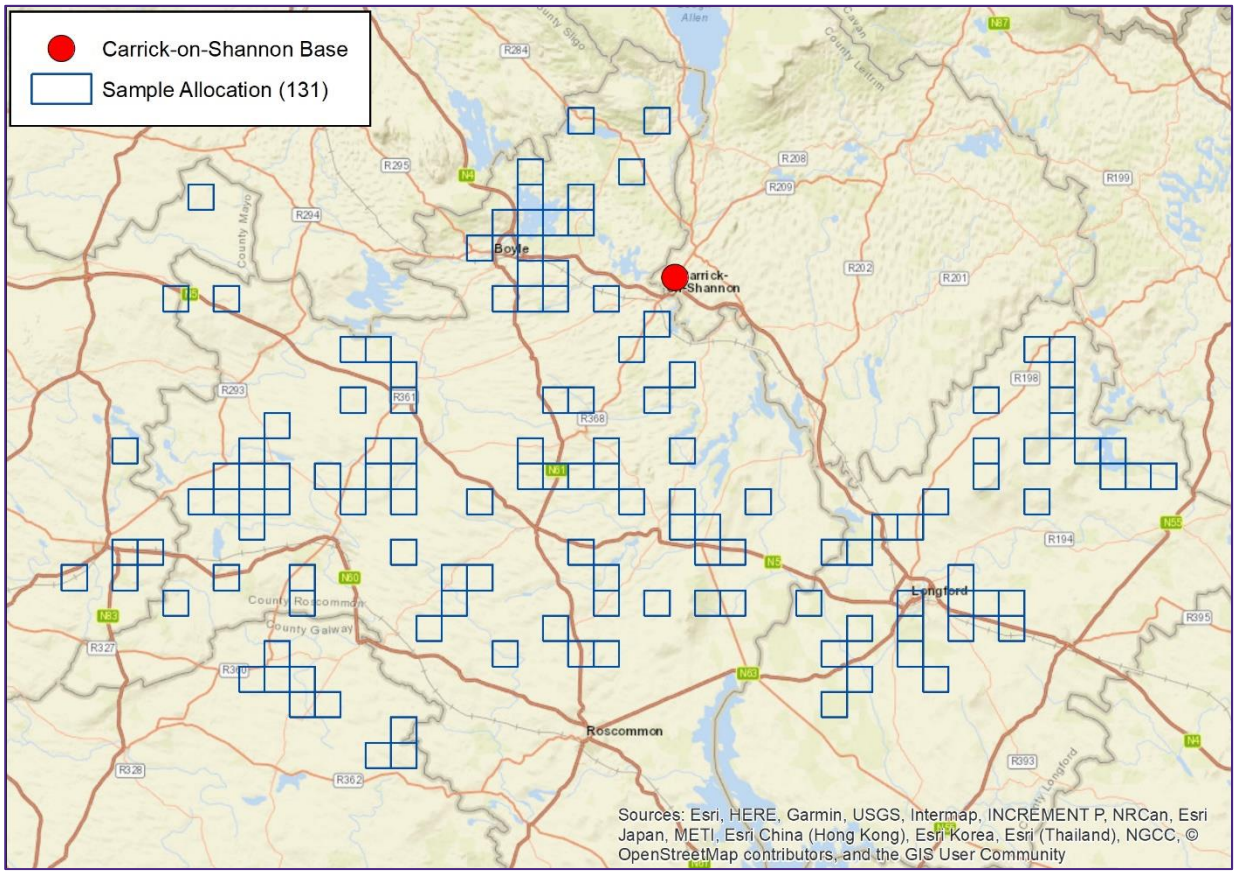


Figure 2.5 Actual locations collected from Athlone field base

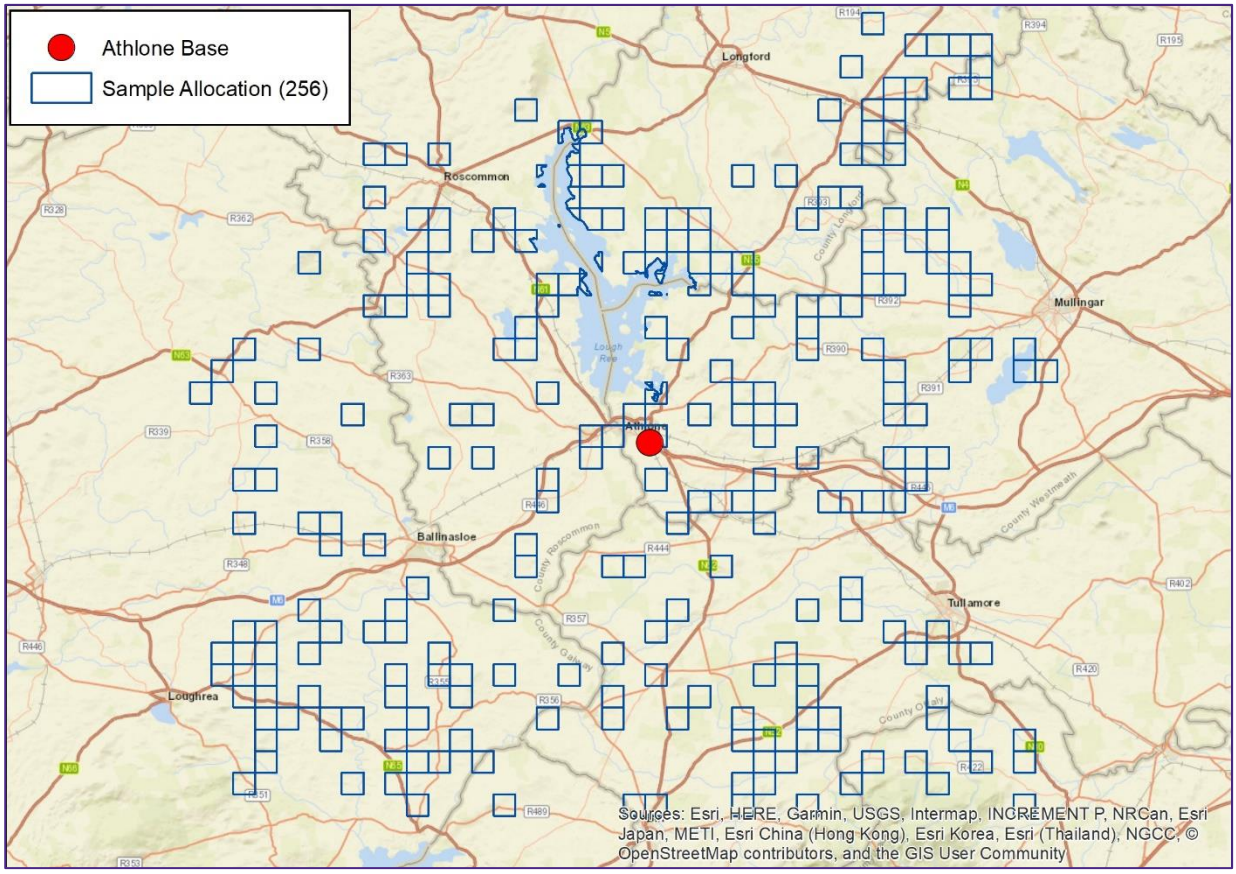


Figure 2.6 Actual locations collected from Galway field base

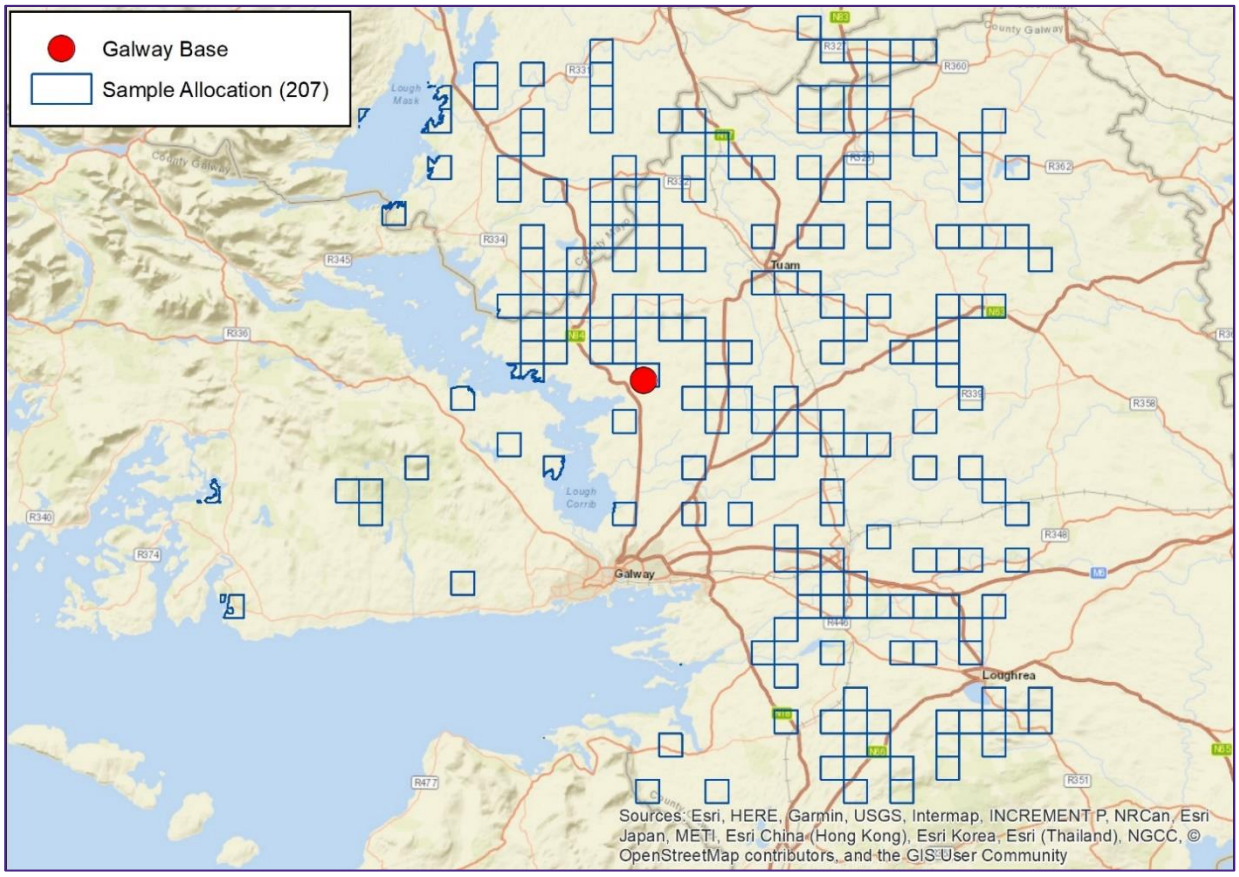
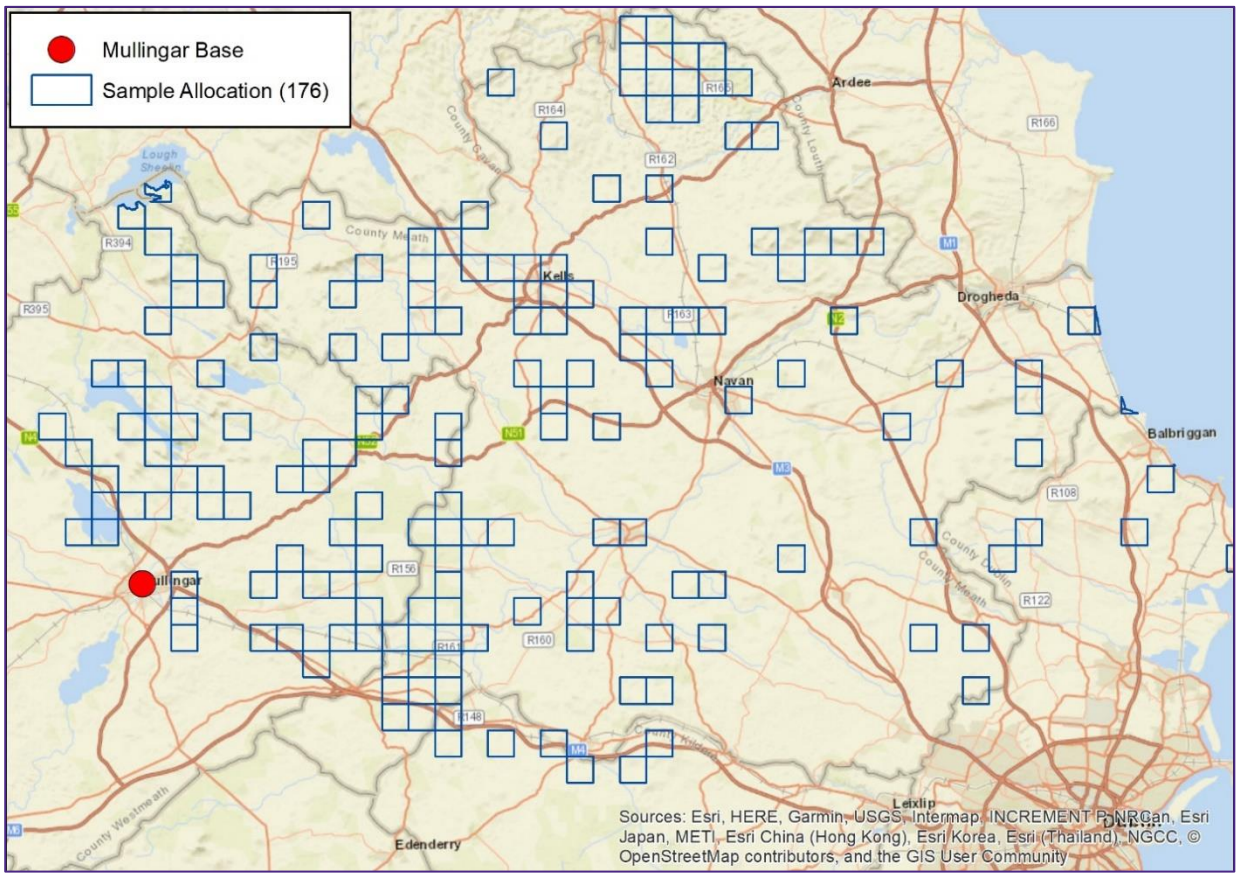


Figure 2.7 Actual locations collected from Mullingar field base



2.4 Staff Training

2.4.1 In-house Training

RPS held an in-house training session prior to fieldwork initiation. This briefing allowed the staff who would work in the field to go over the risk assessments, safe systems of work and concerns along with a brief overview of map reading and introduction to the GPS handheld units. This was also accompanied by a visit to a site which gave a brief practical aspect to the training.

This training was facilitated by RPS and included:

Project Overview

Health & Safety Requirements

Finding fields, location requirements etc.

Map reading refresher, GPS use refresher

Field base information

2.4.2 GSI Facilitated Training

Initial training was provided primarily by Kate Knights and Judith Mather on the 29th and 30th July 2019, at the Naas field base. This covered: sample site selection and criteria; sampling with an auger; labelling of sample containers; use of a GPS, field map and roamer; pacing out distances; contaminants at site and in sample; land use descriptions; soil characteristic descptions; field obervations and data; completing a field card; duplicate site samples; peat type sampling; background to the survey; communications measures by the programme; engaging with landowners and stakeholders. Training was hand-on with practical examples given. The training spanned 2 days and allowed for an informative insight into how samples should be taken, distance criteria for landmarks and human interactions with landowners, use of GSI supplied apparatus such as GPS units and roamers and how they are correctly used on the 1:50,000 maps.

The use of an example field site was organised by RPS adjacent to the field base which allowed for practical experience and learning with the use of sample bags and augers.

Training to the field management personnel was also provided on: checking field cards and field maps; use of the planning map and planning achievable field days; stable base mapping; use of the database to enter and query data; preparation of field equipment; and checking samples.

2.5 Landowner Liaison

Positive landowner engagement was critical to the success of this study as it impacted upon the rate of sampling and the programme.

The RPS Land Liaison Officer (LLO) had been out engaging with farmers and promoting the project since the 22nd July 2019. This involved contacting a number of local farmers and landowners in the area where sampling was due to commence in the up-coming days. Flyers and posters were also handed out in various locations such as local agri-stores/shops, etc. which would be frequented by farmers.

The aim was to have the LLO work ahead of our sampling teams to ensure that there was a knowledge of the project within the area before our samplers got there. However, after a period of approximately 2 weeks RPS determined that this approach had limited benefits to the sampling teams. This was due to a number of reasons:

- Pinpointing landowners for a particular location was not effective as teams may have decided on different location on day of sampling due to various factors which could only be determined upon entering field.

- Landowners would suggest alternative dates which would suit them to be on site with the sampling team however this was not always feasible with the schedule or sequencing of sample collection.

- Some landowners did not live near the proposed sample field and could not be contacted.

- Effectively communicating knowledge from LLO to field teams was difficult even when using GPS to register what landowners had been visited.

- On multiple occasions field teams approached landowners without the knowledge the LLO had already been there.

- Land use could change from time of LLO visiting to sampling teams visiting (i.e. livestock move or crops be cut), which would impact on choosing the most appropriate site within the grid.

RPS found that the LLO was beneficial primarily in creating awareness of the soil sampling campaign in general, amongst the farming community and building a raport with the landowner.

When using the method of an LLO to create awareness and efficiency for the sampling teams, without the initial collection of contact information for landowners the efficiency which could have been achieved was not optimised this also created difficulty for the LLO when relaying information to sampling teams as it had limited value. Field teams were encouraged to hand out the provided information leaflets when talking to people in the area which was being sampled.

The teams on site were encouraged to make contact with a landowner before entering the proposed field. Teams were given flyers as seen in Figure 2.8 as supplied by GSI and handed these out to landowners they met with. Headed letters were also provided by GSI to further help with problematic access areas. When proposed landowners requested information on the results, the team offered a results requested service, this would allow landowners to look up the laboratory results from their land through the use of their random sample number. The RPS field teams gave out 66 of these such cards following requests from landowners.

The field teams in some instances had difficuilty accessing fields this was communicated through ‘no access’ comments on data cards, in most situations this was due to the absence of a landowners coupled with ‘no unauthorised personnel’ of ‘bull in field’ signs present on field gates. This affected decision making on field selection and usually required the soil samples to find the next best opion which adhered to criteria.

Figure 2.8 Flyer provided by GSI

2.6 Field Bases and Accommodation

Six separate field bases were used during the project. Field bases were selected in each of the five regional clusters developed during the pre-fieldwork element. In the Carrick-on-Shannon area we were required to obtain two field bases due to the limited availability of properties for the duration required by RPS.

The main criteria used to determine suitable field bases is summarised below:

- Adequate number of bedrooms for RPS staff;
- Suitable living facilities for the team;
- Adequate office space with Wi-Fi capabilities;
- Suitable storage and drying space for soil samples; and
- Adequate vehicle parking.

Other criteria considered included, security of the property, proximity to a good road network and proximity to a town or village.

Details of each fieldbase used during the 2019 field sampling campaign by RPS are set out below. Each of the field base locations are shown in the **Error! Reference source not found.** below.

Table 2.1 Field Base Locations

Field Base	Location
1	Naas
2	Carrick-on-Shannon
3	Carrick-on-Shannon
4	Athlone
5	Galway
6	Mullingar

2.7 Supplementary Accommodation

As well as the field base additional accommodation was required in Carrick-on-Shannon, Athlone, Balbriggan and Galway for the team/s.

Table 2.2 Supplementary Accommodation Used

Accommodation	Location
1	Carrick-on-Shannon
2	Athlone
	Balbriggan
3	Galway

2.8 Equipment Provided by RPS

RPS provided equipment as necessary and personal protective equipment items and personal or vehicle apparel for H&S e.g. backpacks for carrying samples, waterproof and high visibility backpack covers, suitable footwear and weather protective clothing, field maps, pens (red ballpoint ink for field cards), marker pens, etc.

- The most recent edition Ordnance Survey of Ireland (OSI) paper maps at 1:50,000 scale (Discovery Series) 5 enough for one for each sampling team and spares for rotation each day. https://store.osi.ie/index.php/paper-products/discovery-and-discoverer.html?osi_map_pro_scale=50000
- Handheld laser range finders used by samplers to pinpoint distances from landmarks which had restricted criteria, this piece of equiptment assisted the roamer and 1:50k maps
- Black bullet point permanent marker pens used for labelling sample containers, bottles, bags: Pentel® Pen N50-A bullet point permanent marker.
- Hi-vis vests, light waterproof jacket, light waterproof trousers, very light rain shower jacket and t-shirts were provided to each individual sampler.
- Sun screen, insect repellent and hand sanitiser were provided to each team with strict instructions for use.

2.9 Field Sampling

RPS had three core teams working concurrently for the full duration of the project. These teams were supplemented by extra sampling team/s as and when required. The RPS programme allowed for an additional team for the last two weeks of the work. Teams worked Monday to Friday, typically working on average of 9.9 hours per day to complete the fieldwork.

Teams were allocated sample locations on a daily basis by the Field Team Leader. The Field Team leaders provided each team with daily field packs. The packs contained: the OSI map(s), an overview map with boundaries and polygons, folders with fieldcards, GPS, batteries and laser range finders.

Each team set off from the field base daily to collect soil samples and return each evening. There were limited occasions that we utilised a satellite team to survey over a two-day period, staying in separate accommodation, before delivering data and samples back to the field base.

2.10 Quality Control

2.10.1 Field sampling quality control

In relation to sampling, as it was essential that all and any possible contaminants were avoided, our field samplers ensured that their hands were clean prior to sampling.

No hand jewellery, nail varnish, no artificial/fake nails, sun lotions, fake tan or hand lotions, or medical dressings such as plasters were worn whilst carrying out geochemical sampling. If medical dressings (e.g. plasters) were worn, samplers wore heavy duty rubber gloves throughout, and a note was made in the field observational data for the corresponding sample sites affected.

2.10.2 Sample check in

Once back at the field base the samples were checked in every evening. This was completed by field team managers who cross-checked allocated random sample numbers to the samples retained by each team that day. The field team manager also assessed the bag durability and labelling and placed the checked-in samples in a numbered crate with its associated batch of samples

2.10.3 Quality check of sample site location

Field teams were required to adhere strightly to the criteria in selecting the actual sample site. The criteria to be adhered to is set out in Table 2.3 below.

Table 2.3 Adherence Criteria for Site Selection for Soil Sample

Distance Criteria
• Any site must be 250 m or more away from a boundary of the 2 km by 2 km survey grid cell. This is in order to maintain a reasonable distribution of sample sites across the survey area.
• A soil sample site should be from undisturbed and unforested land where possible.
• A soil sample site should not be collected from land where you can observe recent treatment of a fertilizer of any kind, including slurry where possible.
• A soil sample site must be at least 100 m away from any tracks, pathways, roads, buildings, pylon lines and bases, telegraph lines and bases, windmills or turbines, named antiquities such as monuments and enclosures such as ring forts, either as indicated on the map at 1:50,000 scale or as observed in the field.
• A soil sample site must be at least 100 m away from streams and man-made ditches, small water bodies <150 m in diameter, either as indicated on the map at 1:50,000 scale or as observed in the field.
• A soil sample site must be at least 200 m away from a major road, classified as any regional road, national road or motorway as indicated on the map at 1:50,000 scale, or as observed in the field.
• A soil sample site must be at least 200 m away from any excavation works, mine or quarry, or tip or landfill, or railway line or station (this includes historically mapped railways and Bord na Móna railway which may no longer be evident on the ground) which as indicated on the map at 1:50,000 scale, or as observed in the field.
• A soil sample site must be at least 200 m away from any major rivers (anything mapped at 1:50,000 scale a thick blue line or named as a river), canals, large water bodies >150m in diameter and turloughs as indicated on the map at 1:50,000 scale, or as observed in the field.
• Soil samples should preferably be collected centrally in the open space available and as far as practicable from field boundaries including; wire fencing, wooden posts, dry stone walls, drainage ditches/culverts, gate access points and treeline or hedgerow boundaries, while still adhering to other distance criteria.
• Prior to initiating sample collection, samplers must ensure that they look for any evidence of contamination or contaminants in the area. Samplers must avoid point source contamination. The final sample site must be moved away and preferably upslope of any observed contamination, and such observations within 100 m must be recorded.

Field teams worked in pairs collecting samples, rotating each day meaning the same people worked with each person once on average over the course of the week. This also allowed for the trading of roles from augering to writing of the field cards which was a GSI requirement.

RPS reviewed the GPX data files from each field team on a daily basis, utilising the Garmin eTrex 10® handheld GPS units supplied by GSI. These GPS devices were used to track the field team's location, recording their routes throughout the day and taking a GPS point at different intervals (e.g. every minute). This would track all field team members to ensure accuracy of GPS points taken.

Once field teams returned to base, the GPX data files were extracted from the handheld GPS units using EasyGPS® software. The files were then converted to data files to the TM75 Irish grid system. The files were then converted into shapefiles and exported into Arcmap. From here field team managers were able to review the data ensuring all sites were correctly sampled, all compliance measures were adhered to and ensuring set criteria was met:

- 'Soft' GPS points showed the field team going to the correct location
- Coordinate points matched that of the field card for each location
- No points were manually entered into the GPS, confirming field team selected the location independently
- Adequate time was spent at each of the sample points
- All distance criteria was met, and contaminants were avoided.
- Suitable effort was made to get to the best location available within the grid square.

Further measures were taken whereby field managers had to mark the sample location on physical OS maps provided by GSI. In the case where samples were not taken in an ideal / best location, field managers would liaise and discuss reasons for this with field teams, as well as suggesting a suitable alternative. On occasions this discussion would be escalated to GSI whereby advice was provided by a member of the GSI Tellus team.

Similarly when field teams on site encountered problems, they made contact with field managers to overcome any issues. These problems were typically; denied access to site/health & safety concerns from landowners. Some examples of instances when field teams couldn't gain access to site were; Flooding, Livestock, Crop, Application of fertilizer, Erection of new buildings/pylons that were not marked on OSI mapping used, could not identify contaminants etc. From here the field team provided their current location using the handheld GPS, and were directed to a suitable location.

RPS began using lazer range finders towards the end of week 2 and into week 3 to help field teams quickly judge distances from hedgerows and other obstacles when in the field. As can be seen from Table 6.5 the number of samples being rejected by RPS significantly decreased once this technology was employed on the project.

2.10.4 RPS Quality Assurance excel database

The RPS QA Checks provided an account of all samples taken, field teams responsible and allowed the refrence of grid squares to random sample numbers this ensured we had record of all samples taken and a corresponding reason for any which may have failed from GIS or RPS checks.

If RPS rejected a sample the date of rejection was noted on the RPS QA Database and details and it was released for reallocation for re-sampling. If GSI rejected a sample the same process occurred.

RPS then used elements of this QA Sheet as a Chain of Custody Document when delivering samples to GSI.

3 PROJECT PERSONNEL

3.1 Project Management Personnel

The overview of the project was carried out by the project manager who regularly visited the field team to observe progress, update GSI through weekly reports and participate in conference calls with the client. Other project management personnel had keys roles to play in initial set up of the GIS software and makeup of the field team clusters which they have been given on a daily bases to help with clarity in their location when on site.

Table 3.1 Project Management Personnel

Role
Project Director
Project Manager
Data Manager

3.2 Field Team Management

The field team management stayed in situ at the field base analysing the site selections from the previous day using GIS software, plotting the sites on the stable base maps, planning for following days and recording information from the field cards into the database.

As already detailed, the LLO began working as an assistant to the field team manager, approximately two weeks into the project. This changed occoured around the 8th of August towards the end of the first week in Carrick On-Shannon

Table 3.2 Field Team Management

Role
Field Team Leader
Field Leader Assistant
Backup Field Team Leader

3.3 Field Teams

The soil sampling technicians were responsible for the collection of samples allocated to them daily they completed this in teams of two, they also gathered information on the mapped geology of a site after the collection of the sample had been taken.

Furthermore RPS were required to draft in additional personnel to assist with the workload of the field team management. A number of the field team staff also assisted in occasional days and in the evenings, primarily with database entry.

Table 3.3 Field Teams

Role
Soil Sampling Technician 1
Soil Sampling Technician 2
Soil Sampling Technician 3
Soil Sampling Technician 4
Soil Sampling Technician 5
Soil Sampling Technician 6
Soil Sampling Technician 7
Soil Sampling Technician 8
Soil Sampling Technician 9
Soil Sampling Technician 10

4 PROJECT REPORTING

4.1 Daily Locations

The Field Team Manager and Assistant provided daily locations for each field team, either early morning or the evening prior to sampling. RPS also provided the general sample location via email to the GSI to inform project communication and the PR team managing the project information line.

4.2 Daily GIS Points

RPS provided the GPX data files for each team on a daily basis. RPS utilised Garmin eTrex 10® handheld GPS units supplied by GSI.

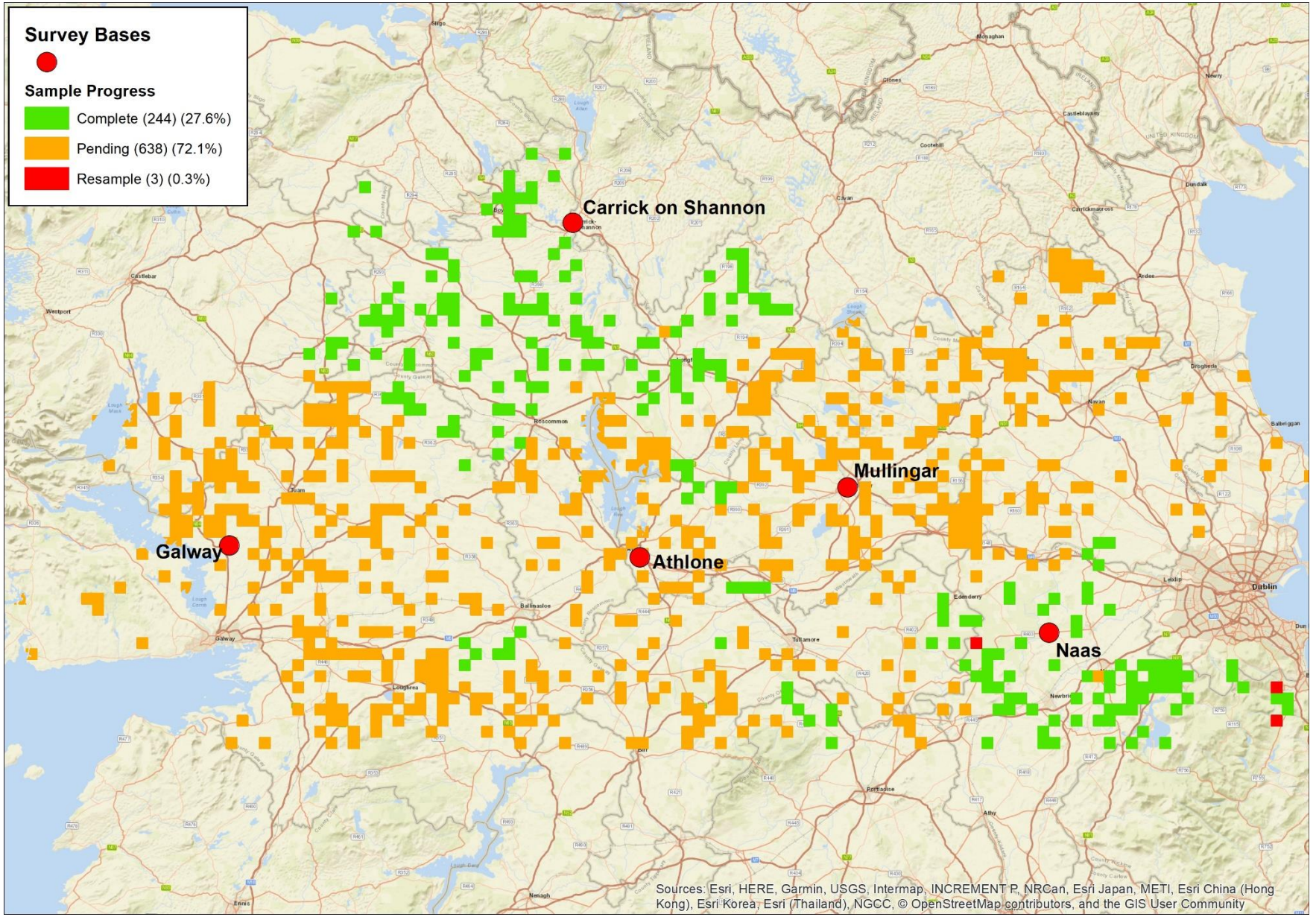
GIS was utilised by the field team manager on a daily basis for the purpose of plotting GPS points.

The Field Team Manager reviewed these to ensure the samples were located correctly and in accordance with the site selection criteria.

Furthermore the GIS data was reviewed prior to each batch delivery to GSI.

GIS also played a role in the project programming and project monitoring, visible in Figure 4.1 (example from half way point of project).

Figure 4.1 GIS monitoring on grid locations, 21st August 2019



4.3 Database Exports

Database exports were provided to GSI on a regular basis detailed in Table 4.1 below.

Table 4.1 Database Exports Delivery Records

Date	Record Number
09/08/2019	67
14/08/2019	78
15/08/2019	122
20/08/2019	229
22/08/2019	266
27/08/2019	282
30/08/2019	356
02/09/2019	371
03/09/2019	436
10/09/2019	591
11/09/2019	600
12/09/2019	611
13/09/2019	690
16/09/2019	779
17/09/2019	793
19/09/2019	891
24/09/2019	989
27/09/2019	1136
03/10/2019	1145
04/10/2019	1144
10/10/2019	1146
18/11/2019	1146

4.4 Weekly Progress Reports

RPS provided details on project overview and sampling statistics and progress to GSI through a weekly report.

In addition the weekly reports summarised field base details, vehicle usage, effectiveness of ongoing outreach from GSI, health and safety matters, recorded public engagement both positive and negative along with the forthcoming plan for the week ahead.

5 PROJECT PROGRAMME

5.1 Programme for Completion

The collection process was envisaged to run for 9 weeks from the week starting 30th of July to the end of September.

Sampling was slow and the field teams did not achieve the anticipated sample numbers at the start of the project this was due to a lack of familiarity with sampling procedure. RPS also found the area around Kidare more difficult to gain access, this was due to large stud farms with stricter traffic movement in and out of their fields due to high prized animals and more landowners being absent or not living beside their land holding.

The sampling rate increased teams and samplers became more familiar with the process.

Our initial programme included for the addition of an extra field team towards the end of the sampling campaign, however it was required to initiatie this 4th team on an ad-hoc basis from week 2 onwards. This team worked as a satellite team helping to ensure RPS achieved the planned sampling targets.

The effort employed by the RPS team ensured the project was completed on time.

Table 5.1 Programme

	Proposed Programme	Actual Programme
Week 1	90	41
Week 2	90	62
Week 3	90	93
Week 4	90	117
Week 5	90	100
Week 6	90	100
Week 7	90	126
Week 8	144	130
Week 9	120	107
Week 10	0	4
	894	**880**

6 SAMPLING STATISTICS

6.1 Samples Collected By Date Order

Table 6.1 outlines information on the number of samples collected each day of the 45 collection days throughout the project. The table also shows that the amount of A and S samples through the collection process matched up for each site. Information for this table was taken of the Access Database using the daily collection queries.

In total RPS collected 955 soil samples from 880 unique sample sites, which included 75 duplicates.

Table 6.1 Number of samples collected each day of the Sampling Campaign

Date	Total	Samples A	Samples S
30/07/2019	4	4	4
31/07/2019	9	9	9
01/08/2019	14	14	14
02/08/2019	14	14	14
05/08/2019	17	17	17
06/08/2019	12	12	12
07/08/2019	12	12	12
08/08/2019	17	17	17
09/08/2019	7	7	7
12/08/2019	25	25	25
13/08/2019	27	27	27
14/08/2019	14	14	14
15/08/2019	18	18	18
16/08/2019	13	13	13
19/08/2019	17	17	17
20/08/2019	14	14	14
21/08/2019	23	23	23
22/08/2019	26	26	26
23/08/2019	34	34	34
24/08/2019	6	6	6
26/08/2019	25	25	25
27/08/2019	18	18	18

Date	Total	Samples A	Samples S
28/08/2019	26	26	26
29/08/2019	24	24	24
30/08/2019	17	17	17
02/09/2019	34	34	34
03/09/2019	28	28	28
04/09/2019	25	25	25
05/09/2019	26	26	26
09/09/2019	32	32	32
10/09/2019	36	36	36
11/09/2019	27	27	27
12/09/2019	22	22	22
13/09/2019	24	24	24
16/09/2019	33	33	33
17/09/2019	40	40	40
18/09/2019	24	24	24
19/09/2019	25	25	25
20/09/2019	21	21	21
23/09/2019	34	34	34
24/09/2019	36	36	36
25/09/2019	29	29	29
26/09/2019	22	22	22
07/10/2019	3	3	3
09/10/2019	1	1	1
Total	**955**	**955**	**955**

6.2 Sites Sampled per Team Member

Table 6.2 outlines the total number of samples taken by each field team member of whom were part of a pair which were alternated each day.

Table 6.2 Number of Samples within a Team

Samplers Initials	Number of Samples per Team Member
Soil Sampling Technician 1	292 Samples
Soil Sampling Technician 2	284 Samples
Soil Sampling Technician 3	284 Samples
Soil Sampling Technician 4	259 Samples
Soil Sampling Technician 5	252 Samples
Soil Sampling Technician 6	246 Samples
Soil Sampling Technician 7	80 Samples
Soil Sampling Technician 8	62 Samples
Soil Sampling Technician /Field Leader Assistant	62 Samples
Soil Sampling Technician 9	62 Samples
Soil Sampling Technician 10	30 Samples
Field Team Leader	1 Samples

6.3 Duplicate Samples

For each batch of one hundred samples, typically two field duplicates are to be collected. A field duplicate is a second complete set of samples (of all sample types, 'A' and 'S'), allocated another sample site number. The duplicate site is taken from approximately 21 m away from the original sample site, at the same time and by the same team that collects the original sample.

The location of the site at which a field duplicate is collected is not pre-determined, but determined by the field team when they are satisfied that a duplicate sample can be accurately taken in the field.

In addition to two duplicate sites per hundred field batch, this contract called for an additional 55 duplicate sample sites to be sampled. A total of 75 duplicate samples were collected by the RPS Team, spread out throughout the survey area.

6.4 Soil Composition

Figure 6.1 shows the summary composition and summary soil classification of all the soil samples collected. The composition of the soil did not impact on the programme.

Table 6.3 sets out the soil classifications used during the project. As can be seen the majority of soil samples were mineral soils with the soil being primarily silt.

Figure 6.1 Soil Textures & Composition (S sample)

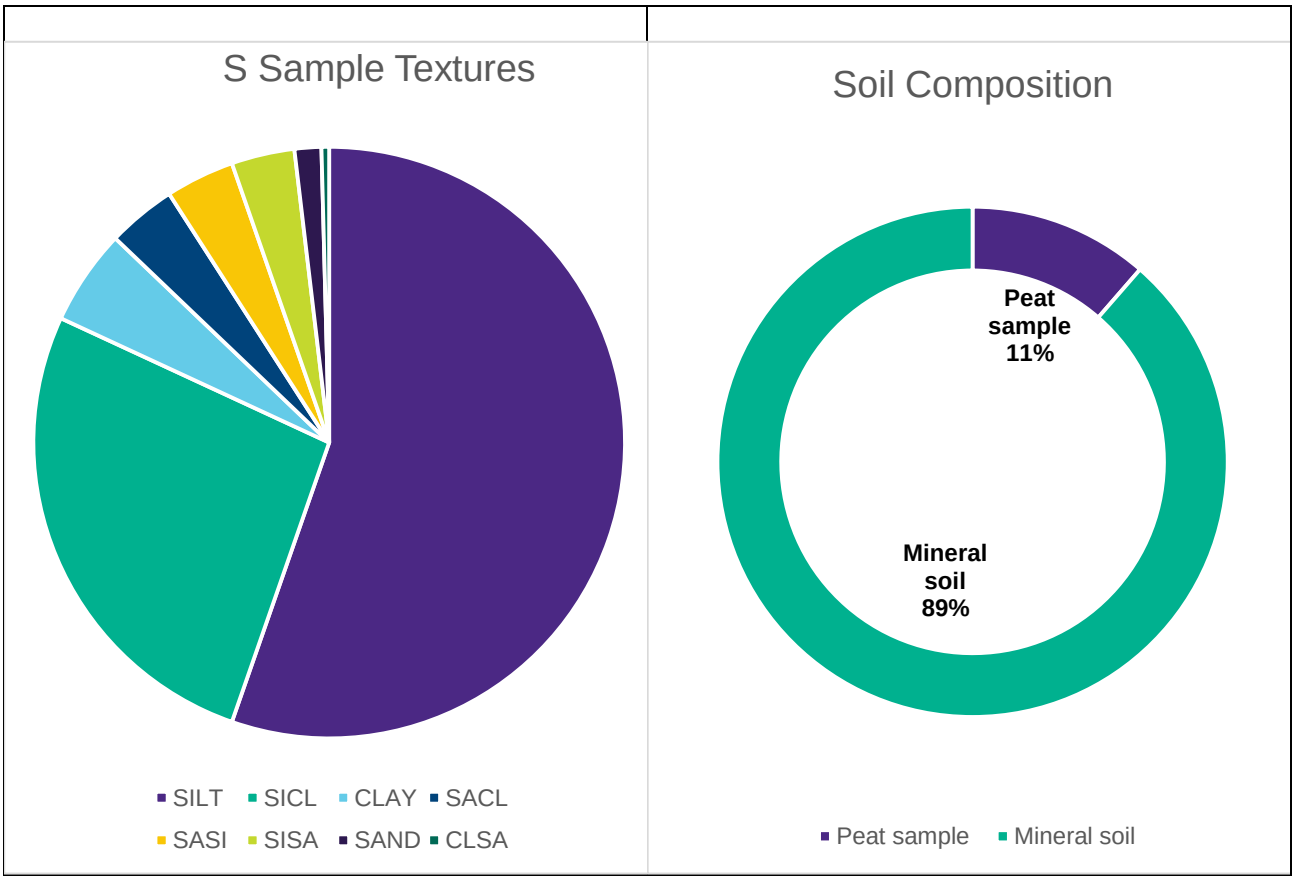


Figure 6.2 Soil Textures & Composition (A sample)

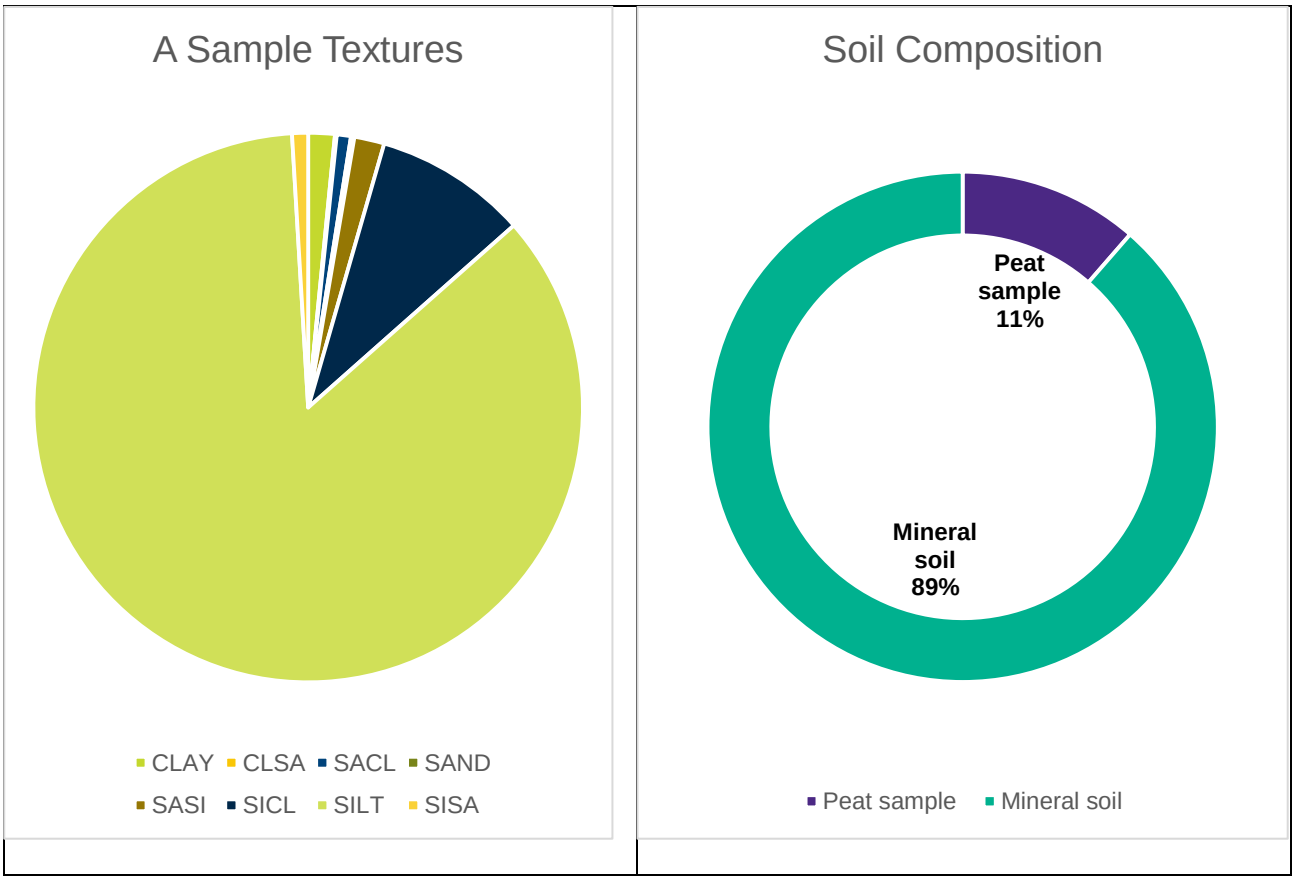


Table 6.3 Soil Classification Key

Soil Code	Soil Type
SILT	Silt
SICL	Silty clay
CLAY	Clay
SACL	Sandy clay
SASI	Sandy silt
SISA	Silty sand
SAND	Sandy
CLSA	Clayey sand

6.5 Topography of Samples

Table 6.4 shows the topography of the sample locations. As can be seen from Table 6.4 a total of 459 samples were taken from land described as a level field or flood plain with 379 samples taken on land with a gentle slope.

Table 6.4 Topography of Sampled Sites

Slope Descriptors	Number of Samples
Hill top	12
Gentle slope (5-20°)	379
Steep slope (>20°)	44
Foot slope base of valley side	2
Valley floor	1
Hollows with marsh or bog	58
Level field, flood plain	459
Total	**955**

6.6 Samples Rejected by RPS Field Team Manager

Table 6.5 outlines the number of samples taken by RPS and failed by the RPS Field Team Manager following initial GIS and stable base map checks. Rejection rates decreased as each field team became more aware of project expectations and their skills improved in relation to acknowledging exclusion zones, map reading and calculating distances on 1:50,000 OS map.

Table 6.5 Weekly Sample Rejection Rates

Week Commencing	Percentage of sampled failed by RPS field team management)
30/07/2019	10.20%
05/08/2019	8.75%
12/08/2019	3.60%
19/08/2019	3.94%
26/08/2019	0.00%
02/09/2019	0.78%
09/09/2019	1.64%
16/09/2019	7.82%[1]
23/09/2019	1.65%
Overall Average	**4.26%**

[1] This number is higher due to the loss of GPS data for 1 day's sampling.

7 BATCH DELIVERIES

7.1 Delivery Process

RPS conducted a batch delivery after every complete field hundred batch of samples and data were collected and checked. The rate of deliveries increased towards the end of the sampling campaign as more samples were being collected per week allowing double batch deliveries along with duplicate samples. Batch deliverys were sent wiith the field cards, sample stickers and a full chain of custody which RPS adapted from the QA checksheet which outlined all samples within the delivery.

Table 7.1 Details on the Batch Delivery of Soil Samples

Delivery Number	Sample Batch	Date Delivered	No. of Samples
1	6165xx	22/08/2019	100
2	6166xx	27/08/2019	100
3	6167xx	02/09/2019	100
4	6168xx	04/09/2019	100
5	6169xx	12/09/2019	100
6	6170xx and 6171xx	19/09/2019	200
7	6172xx	24/09/2019	100
8	6173xx and 6174xx	27/09/2019	114
Duplicate 1	6121xx to 6131xx	12/09/2019	15 duplicate pairs
Duplicate 2	6125xx to 6153xx	19/09/2019	25 duplicate pairs
Duplicate 3	6154xx to 6159xx	24/09/2019	7 duplicate pairs
Duplicate 4	6123xx to 6164xx	27/09/2019	10 duplicate pairs

The Field Team Assistant was generally tasked with driving the samples to GSI headquarters with the relevant physical samples and paperwork.

7.2 GSI Rejections

GSI rejected a number of samples collected by RPS. The rejections were due to a number of reasons such as:

- Distance criteria;
- Sample depth;
- Inadequate amount of soil in sample bags; and
- Some paperwork did not match after re-bagging.

On one occasion the GIS Field Team Manager wiped a GPS prior to downloading the data and all samples collected on this day from the field team was subsequently rejected.

Table 7.2 sets out the number of samples rejected by GSI for each batch delivery.

Table 7.2 Batch Rejections

Batch	Sample Batch	No. of Rejections
Batch 1	6165xx	6
Batch 2	6166xx	7
Batch 3	6167xx	7
Batch 4	6168xx	8
Batch 5	6169xx	1
Batch 6	6170xx and 6171xx	0
Batch 7	6172xx	1
Batch 8	6173xx and 6174xx	3
Duplicate 1		2
Duplicate 2		2
Duplicate 3		0
Duplicate 4		0
Total		**37**

8 HEALTH AND SAFETY

RPS has a focus on achieving the highest standards of health and safety management on our projects. To do this we communicated our effective health and safety policy and put in place clear standards for the project from project inception which underpinned our health, safety and environmental management system.

As set out in Section 2.5, each team member received in-house training on our risk assessments and safe systems of work prior to the GSI introduction. These were then reviewed during the mid-way training session. Furthermore our driving for work policy was explained in detail.

The applicable risk assessments and safe systems of work used during the project are set out in Table 8.1.

Table 8.1 Health and Safety Documents Communicated with the Project Team

Risk Assessments	Safe Systems of Work
RA1.0 RPS Employees undertaking routine office activities	SSW4.0 Surveying along a Roadside
RA4.0 Surveying along a Roadside	SSW5.2 Public Communication and Consultation
RA5.2 Public Communication and Consultation	SSW5.22 Work in Isolated locations
RA5.22 Work in Isolated locations	SSW5.3 Lone Working
RA5.3 Lone Working	SSW5.7 Working in or near Water
RA5.7 Working in or near Water	SSW5.19 Visiting Greenfield sites & Walkover Surveys
RA5.19 Visiting Greenfield sites & Walkover Surveys	SSW6.0 Driving for Work Purposes
RA6.0 Driving for Work Purposes	

8.1 Health and Safety Matters Arisings During Project

Matters of health and safety were communicated to GSI through weekly project management reports. We have set out below health and safety concerns highlighted by RPS through the weekly reports.

- Week 1 – Request for additional PPE by RPS as hands were getting blistered
- Week 4 – Incident in relation of crops within field and team feeling generally uneasy and decided to relocate sample.
- Week 6 – Field team member did not wear suitable footwear to site
- Week 7 – Field team chased by a bull.
- Week 8 – Field team drove van in field following landowner's permission causing damage to hire van.
- Week 9 – Field Team Manager Assistant involved in a near miss on M50 when delivering samples to GSI.

A mid project health and safety review was conducted by the Project Manager on 11th September in Galway with all team members present. This was to reiterate on the importance of health and safety and adherence to developed safe systems of work.

8.2 Driving for Work

Samplers were supplied with the RPS Driver's Handbook and required to familiarise themselves with its contents. The driver's handbook has been developed specifically for RPS staff and it provides information on driver safety and advice on what to do in the event of an accident or emergency

All field team members had a responsibility for their own safety, the safety of their passengers and all other road users. Field teams ensured that the vehicle they were using was roadworthy, they were licensed and insured to drive, and they were physically capable to drive responsibly.

8.2.1 Vehicles

At the beginning of the project each sampling team utilised their own vehicle for field sampling. Car journeys were shared so that driving responsibility was evenly distributed amongst everyone throughout the week.

Each van had magnetic GSI branding present for the duration of the sampling campaign. RPS continued to ensure that each team member was insured on the vans to ensure that driving was evenly distributed.

8.2.2 Arrival and Parking

Upon arrival at a farm/field, if a farmer or landowner was present, it was courtesy to introduce yourself and inform him/her you were there to take the soil samples. The RPS teams ensured that all vans were parked on suitable ground and were not causing any obstruction to the yard/road. All field teams were supplied with parking monitors which outlined the time a van was parked at each location. This allowed anyone who came across the van to establish the duration of which the field team had been situated at the location.

9 LESSONS LEARNED

9.1 Key Learnings

We have set out a number of key learnings under a number of headings below.

9.1.1 Communications

- The Landowner Liaison Officer role, which was adopted for the initial first two weeks of the project, was removed due to feedback from the soil samplers and the wider team.
  - To make this a success in future campaigns greater project lead-in time would be required to organise and ensure that the landowner liaison and landowner engagement was focussed and worthwhile.
  - Utilising a Landowner Liaison Officer could potentially work better in the future if the sampling locations were more precise.
- When the field sampling teams consisted of two female samplers little questions were asked by famers and permission to sample was always forthcoming.

9.1.2 Field Base Requirements

- The suitability, facilities, size and location of the various field bases was key to the success of the project. Fieldbases need to be spacious to facilitate working and living space and to provide secure dry spaces for laying out sampling and batching samples into boxes.
- Moving from fieldbase to fieldbase after relatively short timeframes was onerous, particularly on the field team management who had to set up the office facilities each time. Moving between five field bases in a 9-week duration was very time consuming and it would have been more effective to establish longer term field bases.

9.1.3 Mapping Packs and Equipment

- The mapping packs containing the overview maps, ortho-maps and lazer range finders were advantageous to the field teams over the course of the project, with few samples becoming rejects based on their location.

9.1.4 Quality Control

- Use of GIS at the field base was helpful as the field team manager could lisiae with the field teams in real-time if they had queries in relation to sampling locations.
- The requirement to provide GIS from the GPS to GSI daily was time consuming. Typically, this should be provided to the Client on a weekly basis.
- Downloading GPS data daily is onerous. The GPS's are capable of storing a significant quantity of data and therefore do not necessarily require to be downloaded daily.
- The RPS QA Check Sheet was the only location where grid square numbers and random sample numbers were stored in a database. This proved useful when checking back on samples throughout the duration of the project.
- The requirement for all teams to return to the fieldbase each evening to check in samples makes for inefficient working. Where teams are able to work a few days in the field moving methodically from site to site rather than returning to the field base each day would provide for greater efficiencies.

9.1.5 Access Database

- Accuracy in data input into the Access database is paramount. Errors in database entry can delay end of batch checking and sample delivery preparation.

- The Access software and the way it uses predictive field boxes were not helpful as it allowed a higher error count based on the user's ability to scroll over numerous sample inputs unknowingly changing edits such as coordinates, map numbers and dates, to those of the samples number previous.

9.1.6 Sample Delivery

- Preparation of batch delivery was time consuming on the team as samples had to be in numerical order and arranged in crates.

9.1.7 Efficiency

- Field sampling teams were increasing daily sampling numbers just when the project was drawing to completion. Therefore, the project did not benefit from efficiencies due to the short-term nature of the project. Furthermore, the rate of sampling and indeed progress was somewhat impacted by the disparity of the spread of survey grid cells.

- The large number of duplicates samples required was time consuming on the team. Typically two duplicates per 100 samples is the requirement for the Tellus soil sampling campaign, however this project required over four times more duplicate sampling.

- When sample sites needed to be re-visited at the end of the project these were spread out and inefficient to sample from.

- The use of a satellite team mopping up sites in areas the three core teams had primarily visited worked well. It allowed the sparce outer samples to be collected in a more efficient manner.

9.1.8 Field Team Management / Project management

- Both field management and project management responsibilities are significant for a project of this nature and scale and the scope of these roles should be fully detailed in the specification for the works.

9.2 Recommendations for Consideration

We have set out below a number of recommendations for future soil sampling campaigns.

- Field card data entry followed by subsequent data entry of the same information into the Access database is not efficient. It is suggested that GSI consider moving to capture data in real-time in the field by the use of a digital hand-held device. This would avoid the doubling up of data entry on the field card and subsequent data entry of field card to Access database.

- GSI should consider covering a larger area of land over a longer period of time to allow for increased sampling efficiencies and consistency over a larger area.