QGIS for Archaeologists
Getting Started

Guide 42

BAJR Guide to Data and Functionality in QGIS

Contents

This guide uses, but does not reproduce, data uploaded to Archaeology Data Service by the Sutton Hoo research project, Copyright Martin Carver:

Martin Carver (2004) *The Sutton Hoo Research Project 1983-2001* [data-set]. York: Archaeology Data Service [distributor] (doi:10.5284/1000266)

Open Map Local background mapping is courtesy of the Ordnance Survey

OS Terrain 50 is courtesy of the Ordnance Survey

 datasets are courtesy of the Environment Agency

Guide written by

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Files used in the text can be downloaded here in rar/zip format:

Sutton Hoo Example files

http://www.bajr.org/BAJRGuides/42_QGIS_StarterGuide/Sutton_Hoo.rar

Forgandenny Archaeological Survey files

http://www.bajr.org/BAJRGuides/42_QGIS_StarterGuide/Forgandenny.rar

1.   Introduction

This guide is aimed at people starting out in archaeological GIS, whether commercial companies looking expand their access to GIS techniques, community groups seeking a means to digitise, interrogate and ultimately publish their excavation data, or students looking for a professional way to present figures for dissertations or thesis and learn the basics of this now ubiquitous technology. For an entirely more comprehensive look at GIS the authors highly recommend visiting the QGIS website [**http://www.qgis.org/en/docs/index.html**], or alternatively read David Wheatley and Mark Gilling's *Spatial Technology and Archaeology: the Archaeological Applications of GIS.*

1.1.   So what can I do with GIS?

GIS stands for Geographical Information System and covers a variety of software packages which use maps as the primary means of displaying data. Simply, a GIS package operates a bit like a database, allowing a user to store, edit, analyse, share and display any information with spatial references.

In effect, this means that GIS packages be really useful to archaeologists: site surveys can be digitised and used to provide a basis for environmental and artefactual post-excavation analysis, distributions of artefact types may be plotted across sites, regions or countries, or spatial data like Lidar or geophysical survey may be plotted and compared together. Importantly all of this work can be summarised, mapped and shared with colleagues or the public whether they have access to a GIS of their own or not.

1.2.   Why QGIS?

QGIS is a great piece of open-source software that meets all the basic mapping and analysis requirements of most archaeologists. For advanced users QGIS also has the ability to expand the core toolkit via plugins and linking to other open-source GIS software like GRASS and SAGA. Unlike some GIS programmes, the interface is user friendly, the learning curve gentle and QGIS is also supported by a large friendly online community, so if you're having a problem it's likely someone has been there before, and will be able to help out. Oh and did we mention that QGIS is completely free? But most of all, QGIS offers an excellent array of functionality and interoperability with a host of add-ons and an active user community willing to share ideas and help out.

1.3.   What does this BAJR guide do?

Ok, so this guide is meant to be an archaeology specific guide to getting started with GIS. You'll go through installation of QGIS, starting a project and working with vector and raster data – you can download the data via the suggested links in the text as well as exercise specific materials here: [**Sutton Hoo**] and [**Forgandenny Archaeological Survey**]. There's some more in-depth information on getting the most from datasets, an introduction to the map composer, and finally, a short project to tie everything together. The concept is to provide you with confidence to install the software on your computer and be able to handle various datasets, allowing you to grasp the basics of GIS and then begin to use your own data in your own creative way.

2.   Installation

System requirements for QGIS don't really exist per-se, but for the latest release I would recommend using a PC running Windows 7 or later, 4GB of RAM or more would be helpful when trying to manipulate larger datasets such as Lidar tiles.

Having a large, fast hard drive is also a distinct advantage – as the data used in examples below are often a couple of hundred megabytes large.

The installation files can be accessed through the QGIS project webpages, at **https://www.qgis.org/en/site/forusers/download.html**

There are two basic QGIS versions to choose – the latest version and the long term release. The former has all the most up to date functionality and bug fixes and is updated three times a year; the latter is static with fewer updates and is therefore preferred by some corporate users. For the purposes of starting out you can download either of these. There is also an advanced users download from OSGeo4W which includes options to link to GRASS, SAGA etc.

Choose your system type: Windows, OS X, Linux, BSD and Android are all supported.

Windows users – check whether you're running a 32 or 64 bit version:
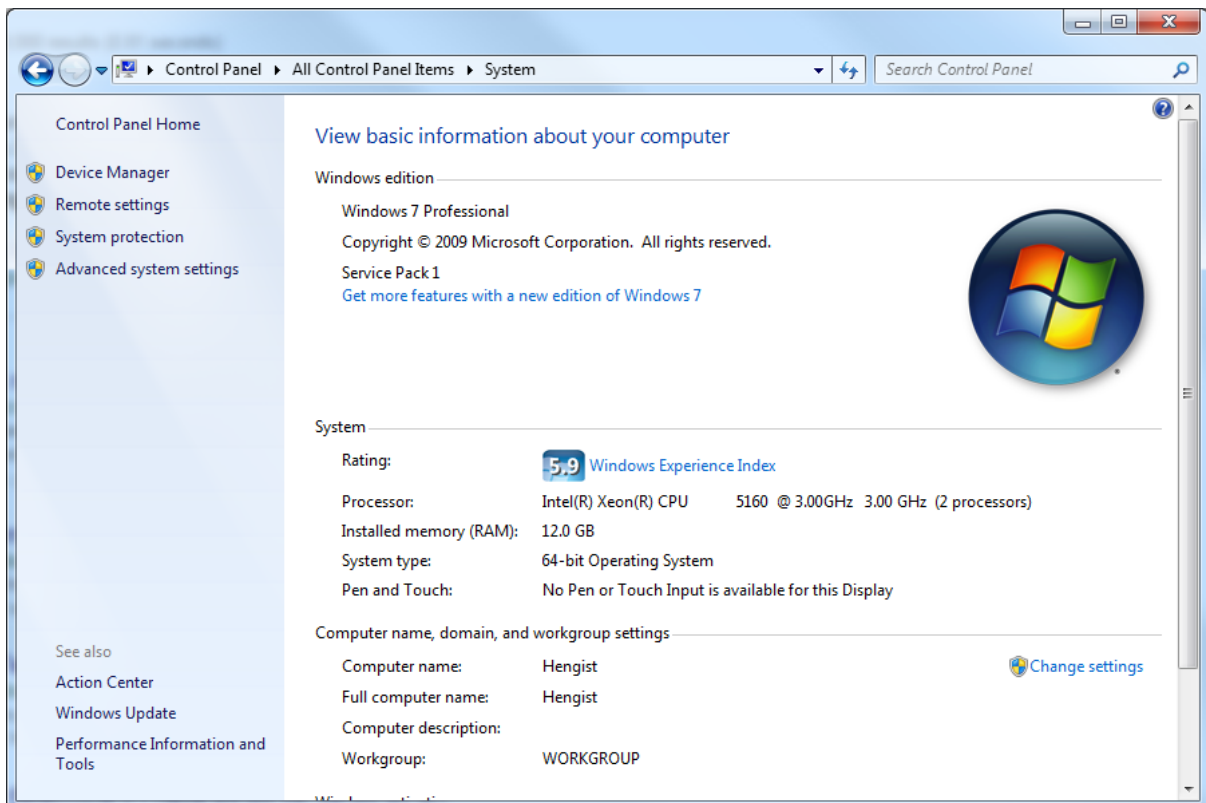
Figure 1: *System Information*

Download the correct version of QGIS and proceed with the installation…

You can skip through the options during the installation, although I would recommend downloading the example data now, so you can go through some of the exercises available through the QGIS website later. [**Sutton Hoo**] and [**Forgandenny Archaeological Survey**].

3. Fundamentals

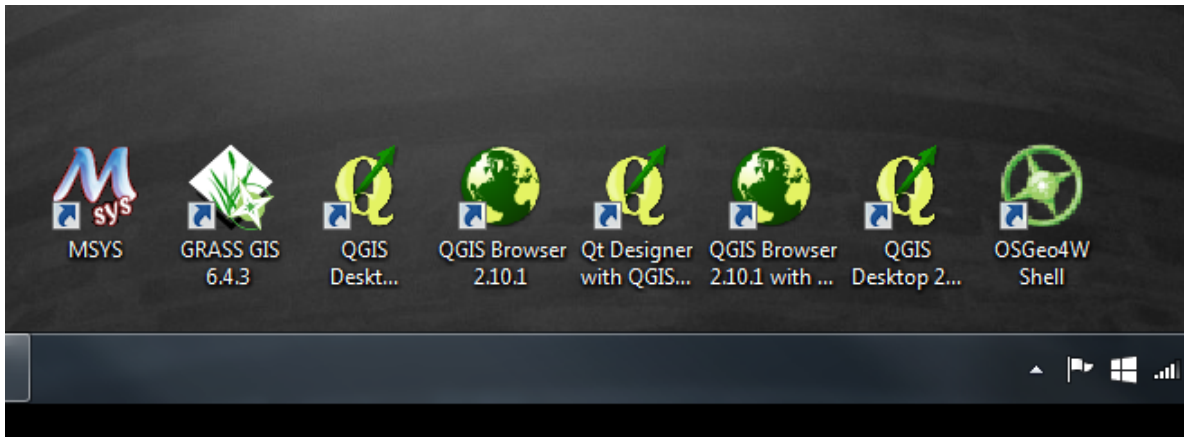Great, you've now installed QGIS, but there are a bewildering number of new icons on your desktop!

Figure 2: *QGIS Icons*

To start a normal session of QGIS, click on the Icon labelled **QGIS Desktop 3.12**

You should now see this window open…
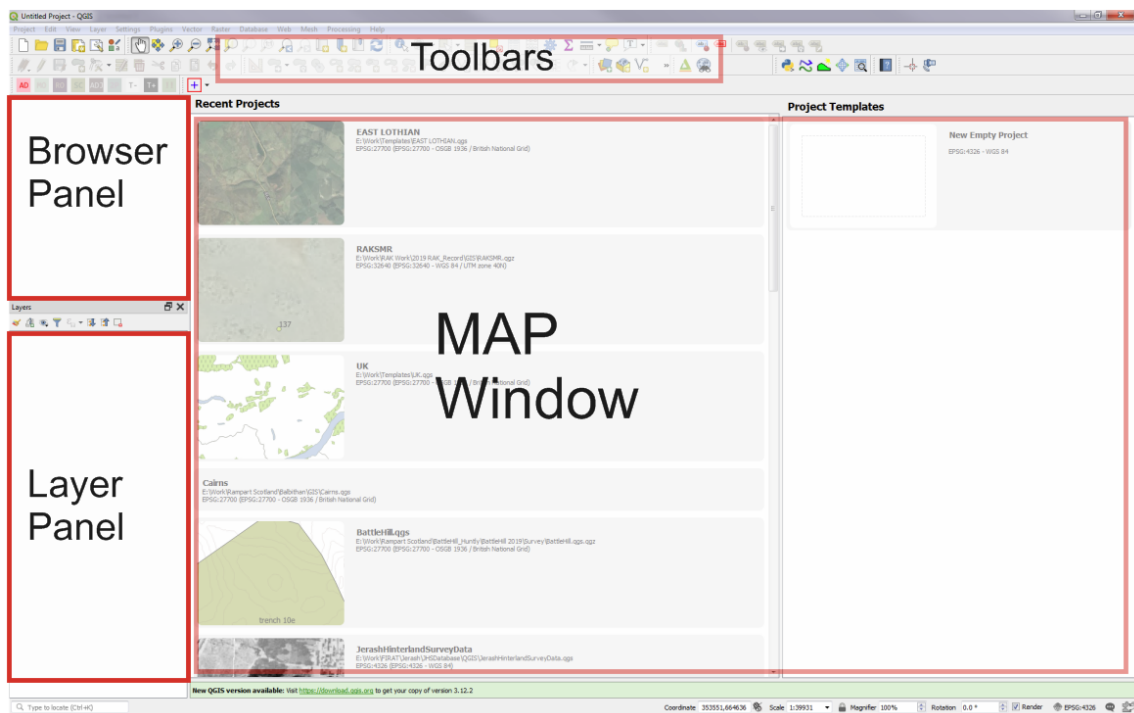
Figure 3: *QGIS Desktop Window*

The QGIS interface is split into three areas: Tool Bar at the top, Layer Menu to the left and Map Window (showing recent projects) to the right. (Figure 4) then try hovering your mouse cursor over each toolbar item and button to see what they do. (right click the toolbar area to add more elements)

Now that you're up and running, from now on the guide will refer to the QGIS 2.10 Pisa so if you're using an earlier or later version, things might be in slightly different places.

The next thing to do is to investigate some important fundamentals of GIS, let's check out the way files and file structures work.

1.4. Let's begin by setting up a new project.
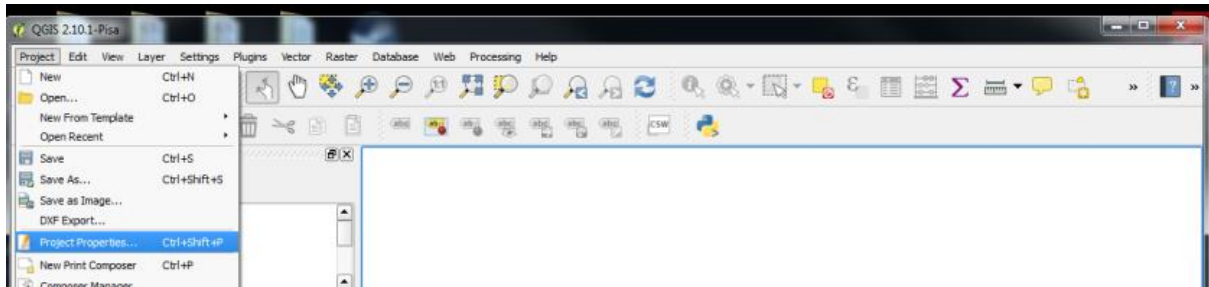
Figure 1: *Project Properties*

In the project drop-down menu at the top left-hand corner of the QGIS window, select *Project Properties.*

From here you can adjust a number of settings which will dictate how your data is displayed. GIS works by linking lots of different file types together. Your project file will not contain any of the actual data you're working with, but only information on how it is displayed.

So, it's important to make sure that you **KEEP YOUR FILE ARCHITECTURE CONSISTENT** when working in GIS. This means having a folder structure where your project file sits one step above your source data. Like this:
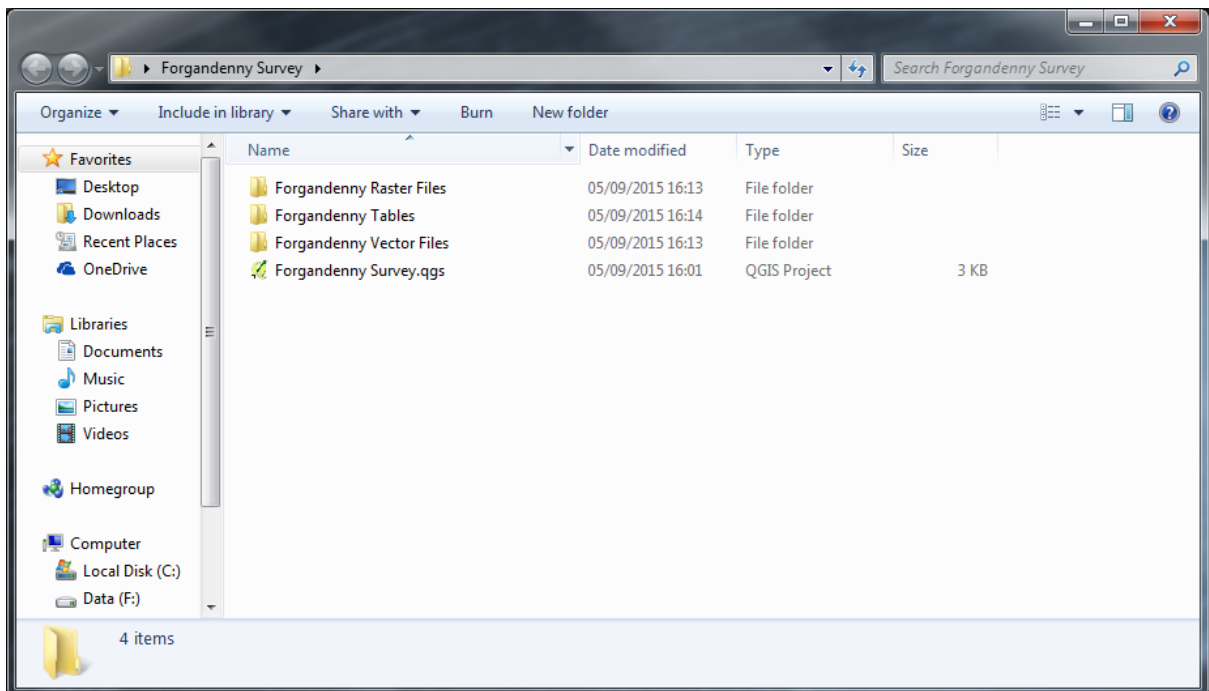
Figure 5: *File Structure Example*

IMPORTANT Back in the Project Properties menu select the *General* tab and make sure that the **SAVE PATHS** option is switched to **RELATIVE**. This means that the project file will use a relative file path, and you will be able to move the folder '*Forgandenny Survey*' on to a usb thumb drive, for example, and still maintain the file links.

On the fly transformations means that you can use data which have multiple coordinate systems in the same project and this is already enabled.

WGS84 (World Geodetic System 1984) is an example of a coordinate reference systems which covers the entire globe. OSGB36 which is the basis for the UK Ordnance Survey, is an example of a local coordinate reference system which allows greater accuracy, as it covers a smaller area of the earth's surface.
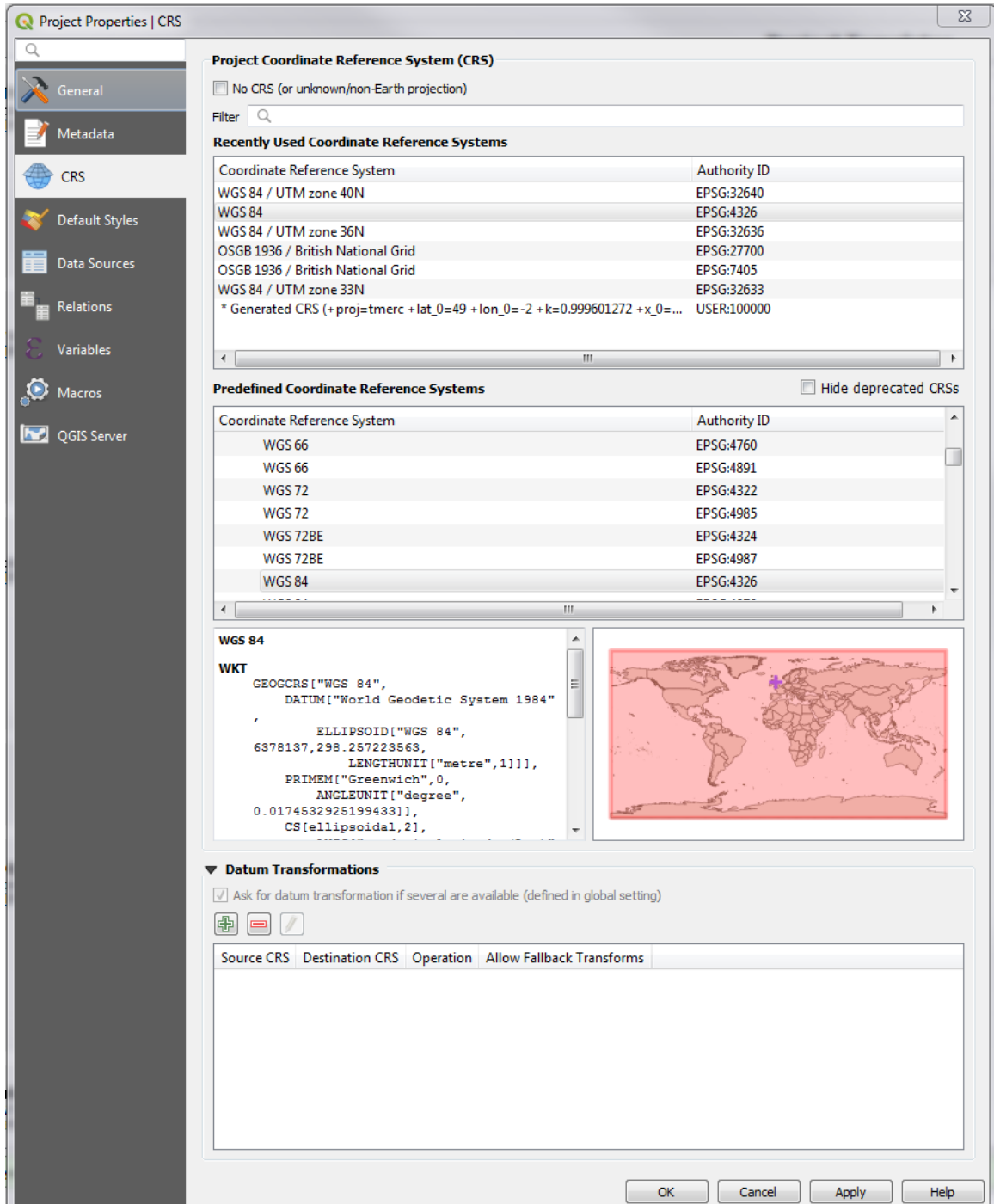

Figure 6: Select your transformation

If I select the OSGB 1936 CRS from the list (search for the EPSG id 27700 to be sure you have the correct CRS), any data with a different CRS will be re-projected on the Ordnance Survey grid. This is

especially useful when you can only find maps of the UK coast projected in WGS84, and all your thematic mapping data has National Grid coordinates.

At this stage you don't need to know much more than that, but if you'd like a bit more background you could take a 10 minutes to listen into this you tube video **(https://www.youtube.com/watch?v=8UmmEN5Og4Y).** Looking at CRS and On the Fly projection settings

When you start a new project make sure that the **project CRS** is **set correctly**.

4.   Points, Lines and Polygons - Vector Data Basics.

Vector data is a representation of the real world using points, lines and polygons. In archaeology this might include find-spots or sites on a regional distribution map, rivers or other linear features in the landscape or the edges of cut features, spreads of material or cobbled surfaces.

To illustrate how to manipulate vector data, we'll need to find a source to start with.

1) Point your browser towards:

 https://www.ordnancesurvey.co.uk/opendatadownload/products.html

2) Scroll down the screen until you find **Boundary Line,** tick the download box and scroll down to the bottom of the page and click the next button. Fill in your details and await the link which will be sent via email...

3) Click on the download link, and wait for the zip file to appear.

4) While it's downloading, CREATE YOUR FOLDER ARCHITECTURE. Make a new folder and call it *Sutton Hoo.* Within the Sutton Hoo folder, create another folder called *Sutton Hoo Vector Data.*

5) Back in QGIS click SAVE AS.

6) Save the project as **Sutton Hoo** in the *[Sutton Hoo]* Folder and make sure that file paths are set to relative, on the fly CRS transformation is checked, and the project CRS is set to OSGB36 [**27700**].

4.1.   Importing polylines

Open the Boundary Line file, open the **DATA** folder, then the **GB** folder and select **ALL** the FILES [1] which are named **high_water_polyline.** Drag and drop these files into *Sutton Hoo Vector Data.*

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[1] "One of the most common vector formats is the ESRI shapefile format. You might have data in this format from the Ordnance Survey, HER, NMR or NMP that can be overlain in your map view. Shapefile format requires different types of topologies (points / lines / polygons) to be stored in different files.

Shapefiles are also made of up to 6 separate files, so when viewed in windows explorer they look like the image below. The file parts must be kept together in order for the shapefile to work so be careful when moving them to different directories (also it is advisable to zip the files into a single folder before emailing).

contour-SMR.dbf	12/09/2011 21:52	DBF File	3 KB
contour-SMR.sbn	02/07/2012 04:43	SBN File	1 KB
contour-SMR.sbx	02/07/2012 04:43	SBX File	1 KB
contour-SMR.shp	02/07/2012 04:52	SHP File	29 KB
contour-SMR.shx	02/07/2012 04:52	SHX File	1 KB
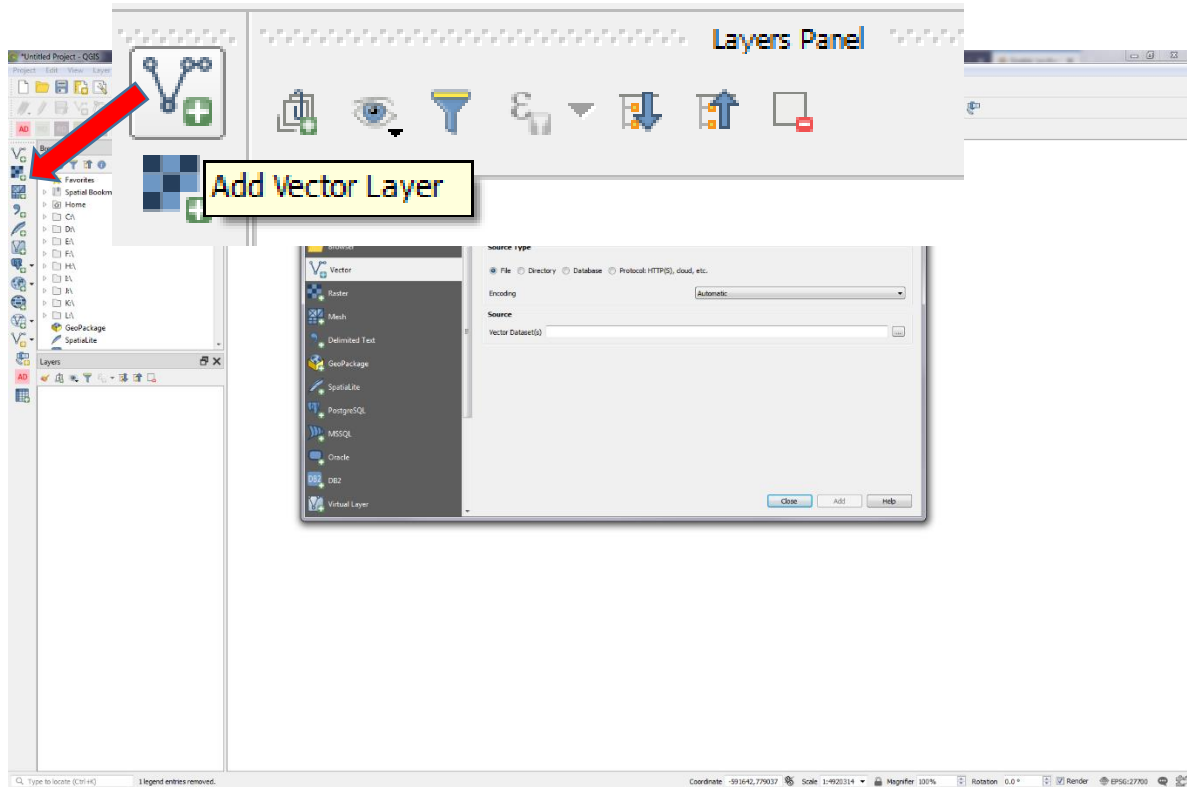
Figure 7: Import Vector Data

1) Open the import vector data tool. (Figure 7)   (if you can't see it – right click in the toolbar area and choose **manage layers toolbar)**

2) Click **source** and navigate to *Sutton Hoo Vector Data*

3) Select the **shape file** (.shp) for the high water polyline and click Add/

4) The UK coastline should now be visible in the map window (Figure 8).
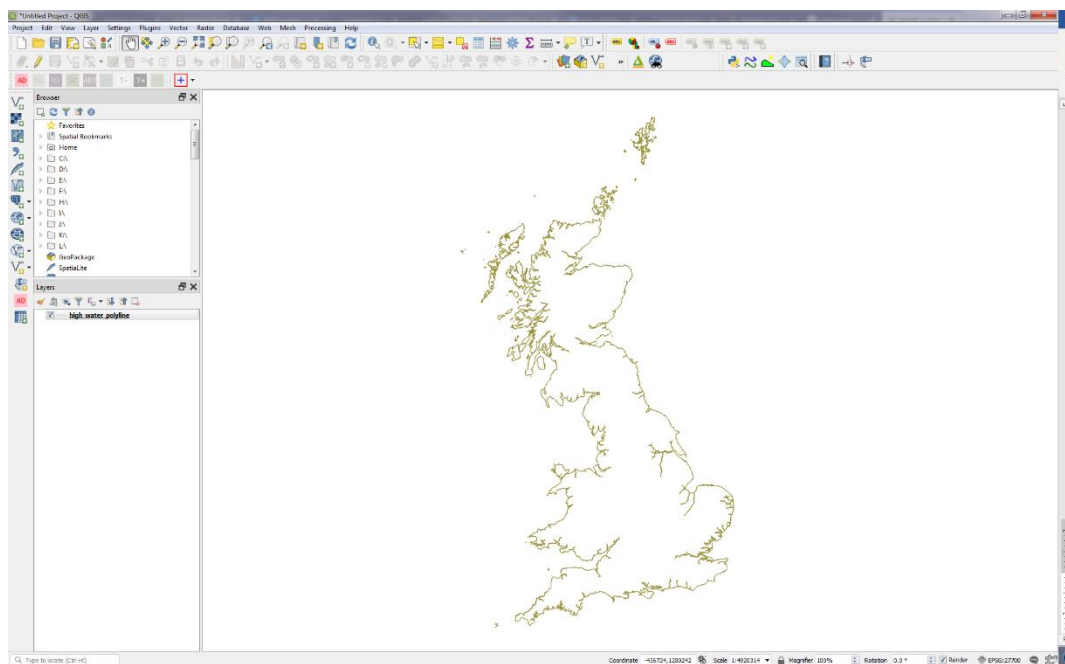
Figure 8 : *UK Coastline*

Note that the layer name is visible in the layers window on the left next to a check-box. This controls whether or not the layer is displayed.

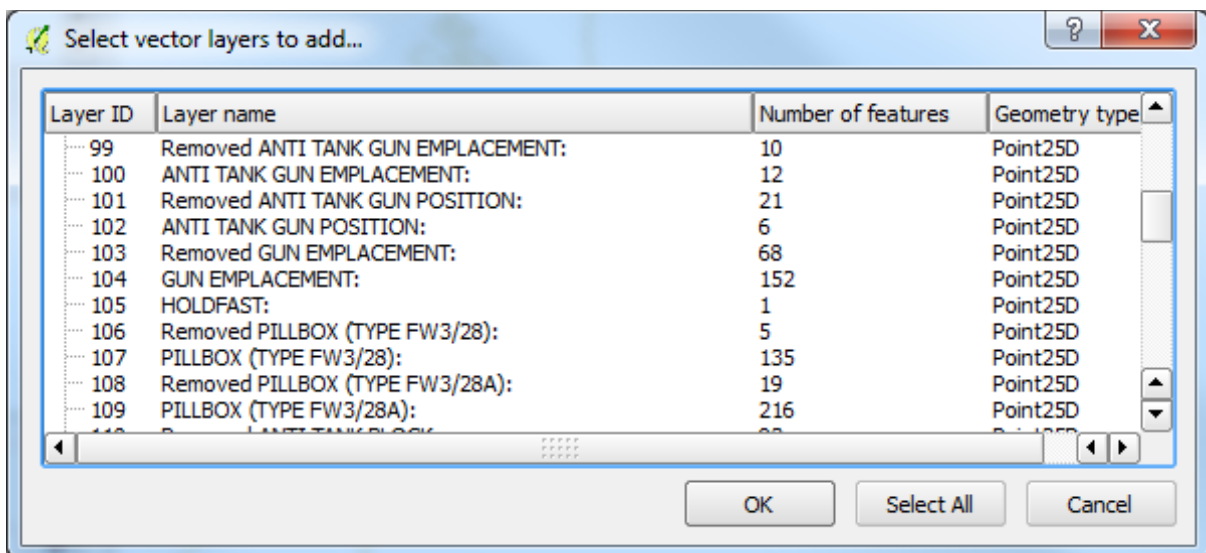The coastline is displayed as a **POLYLINE** – i.e. it isn't filled in.

4.2.   *Import point data*

Now for some more information. Point your browser towards:

http://archaeologydataservice.ac.uk/archives/view/dob/download.cfm

This is the **Archaeology Data Service** – page for the *Defence of Britain project*, which mapped every surviving and demolished Second World War installation in the United Kingdom. This is now available in Google Earth .kmz format.

1) Repeat the process with the *import vector data* tool

2) You'll now see a list of vector layers to add .

3) Choose layers **213** and **214**, (*hold down Ctrl and left click each layer to select both*) which represent extant and removed anti-landing trenches.

Layer ID	Layer name	Number of features	Geometry type
99	Removed ANTI TANK GUN EMPLACEMENT:	10	Point25D
100	ANTI TANK GUN EMPLACEMENT:	12	Point25D
101	Removed ANTI TANK GUN POSITION:	21	Point25D
102	ANTI TANK GUN POSITION:	6	Point25D
103	Removed GUN EMPLACEMENT:	68	Point25D
104	GUN EMPLACEMENT:	152	Point25D
105	HOLDFAST:	1	Point25D
106	Removed PILLBOX (TYPE FW3/28):	5	Point25D
107	PILLBOX (TYPE FW3/28):	135	Point25D
108	Removed PILLBOX (TYPE FW3/28A):	19	Point25D
109	PILLBOX (TYPE FW3/28A):	216	Point25D

Figure 2: *Choose layers to add*

You will now see a distribution of dots (*point data)* representing the location of Second World War anti-landing trenches across Britain. (Figure 10)
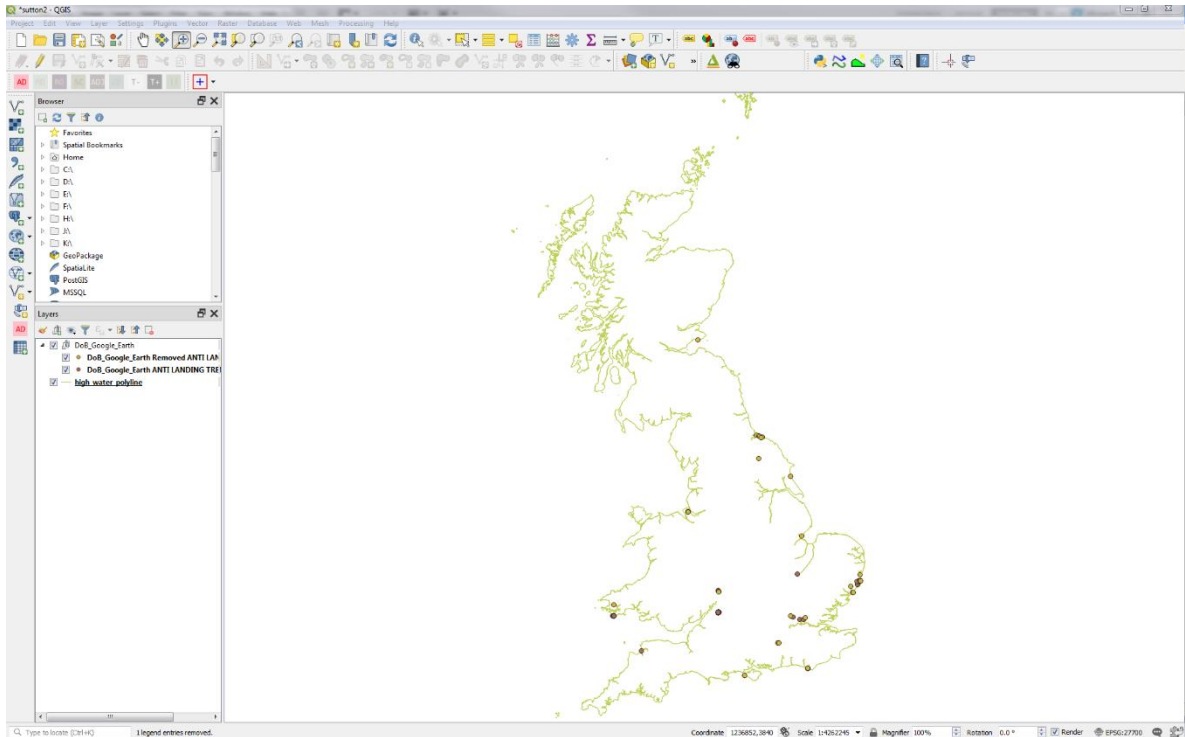
Figure 10: Distribution of Anti-Landing Trenches

4.3. *Import Polygon data*

Polygons are closed lines which can be filled with a colour, and can be used for spatial queries, more on that later.
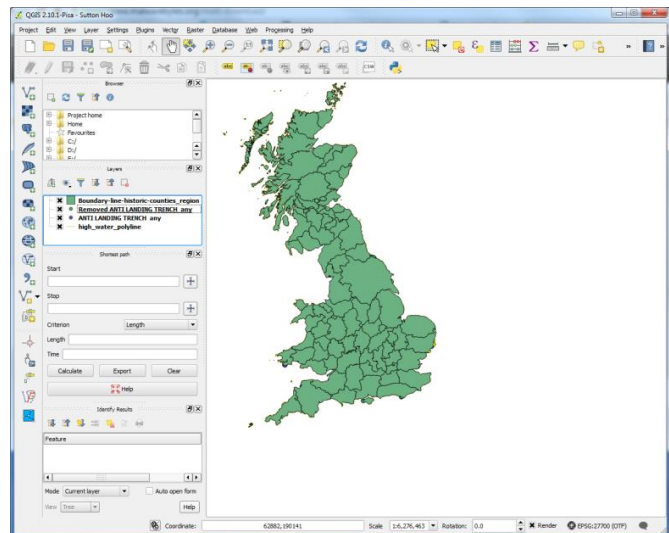
Open the zip file which you downloaded to get the UK coastline.

Go into the **Sutton Hoo Vector Data folder**

Using the **IMPORT VECTOR DATA** tool, add the historic counties shapefile (**UKDefinitionA.shp**) to your project…

You should now see the coloured-in county boundaries laid over (and obscuring) the rest of your data.

Figure 11: County Boundaries

To make your points visible again, select the **UKDefinitionA** layer, and drag it to the bottom of the layer-list. The high water line should now be visible again. You could rename it to **Historic Counties** by right clicking the layer and choosing rename this makes it easier for the user to know what that layer is.
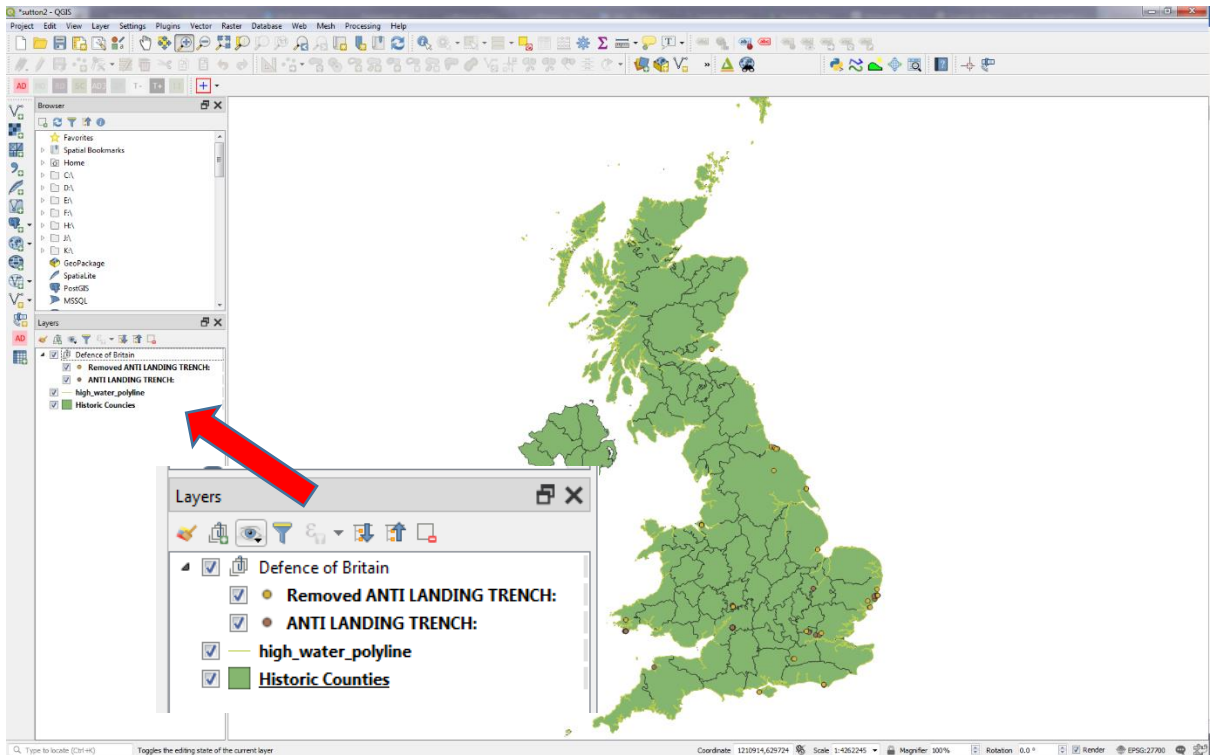
Figure 12: Layers rearranged and renamed

## 4.4. *Working with Layers*
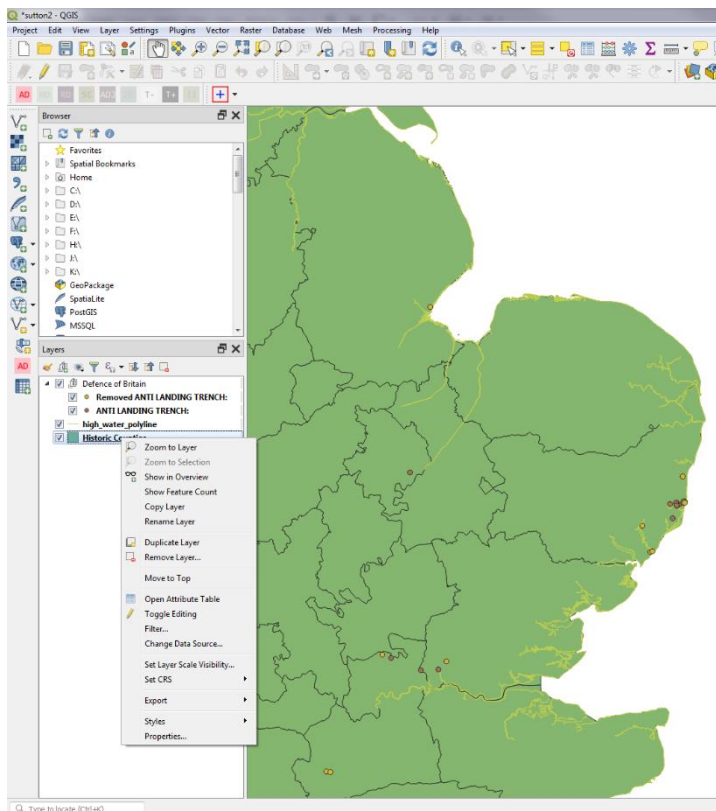
Let's say we want to focus on the Anti-Landing Trenches in Suffolk. I've forgotten which one Suffolk is, because I am ignorant of East Anglian geography. I'll make it easier by labelling all the different counties.

Find the *Historic Counties* layer properties by right-clicking where it's listed in the layer menu and selecting properties.

Figure 13: Layer Properties
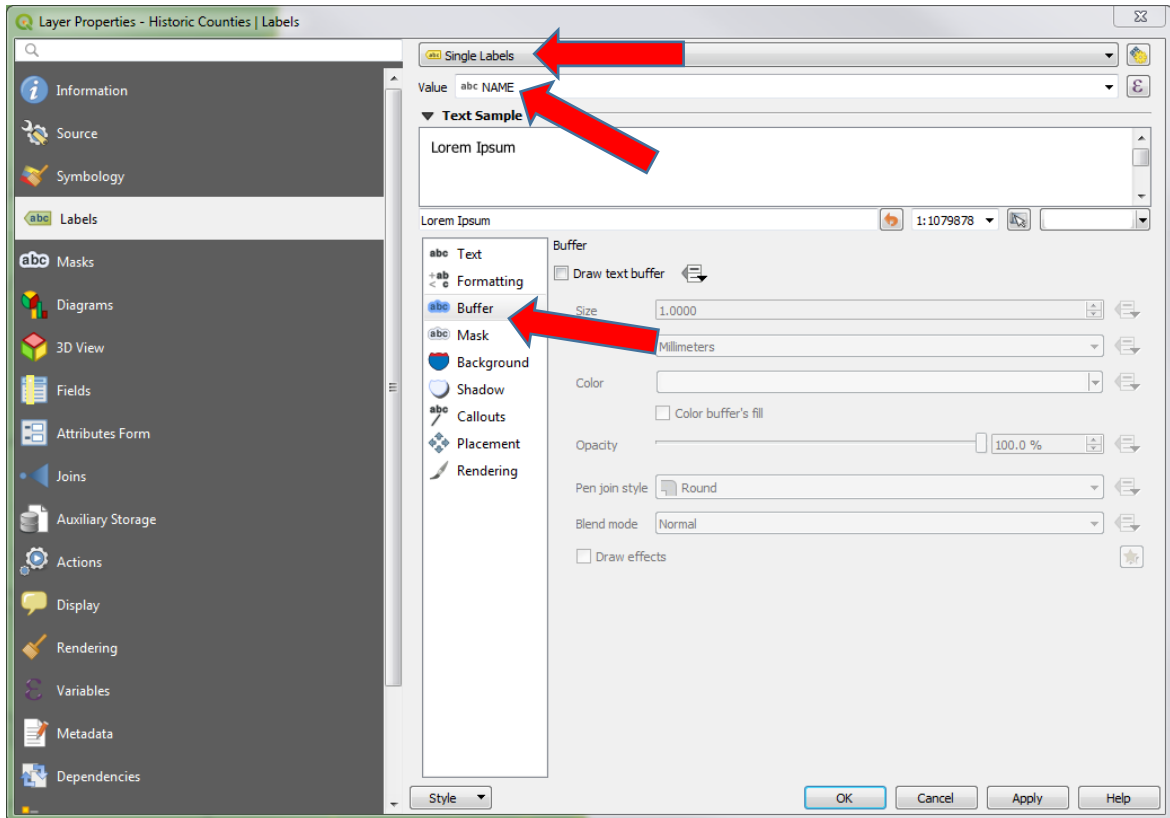
Figure 14: Layer Properties Menu

In the layer properties menu, click on the *Labels* tab, click the dropdown with *No Labels* and choose *Single Label with* and choose **NAME** from the *Value* drop-down box. Put a white colour border (buffer) around the text to make it stand out, by clicking the Buffer tab and then ticking the Draw Text Buffer box. Click Apply at the bottom of the layer properties menu window, and then OK to quit the window.

Suffolk is now clearly labelled along with all the other counties.
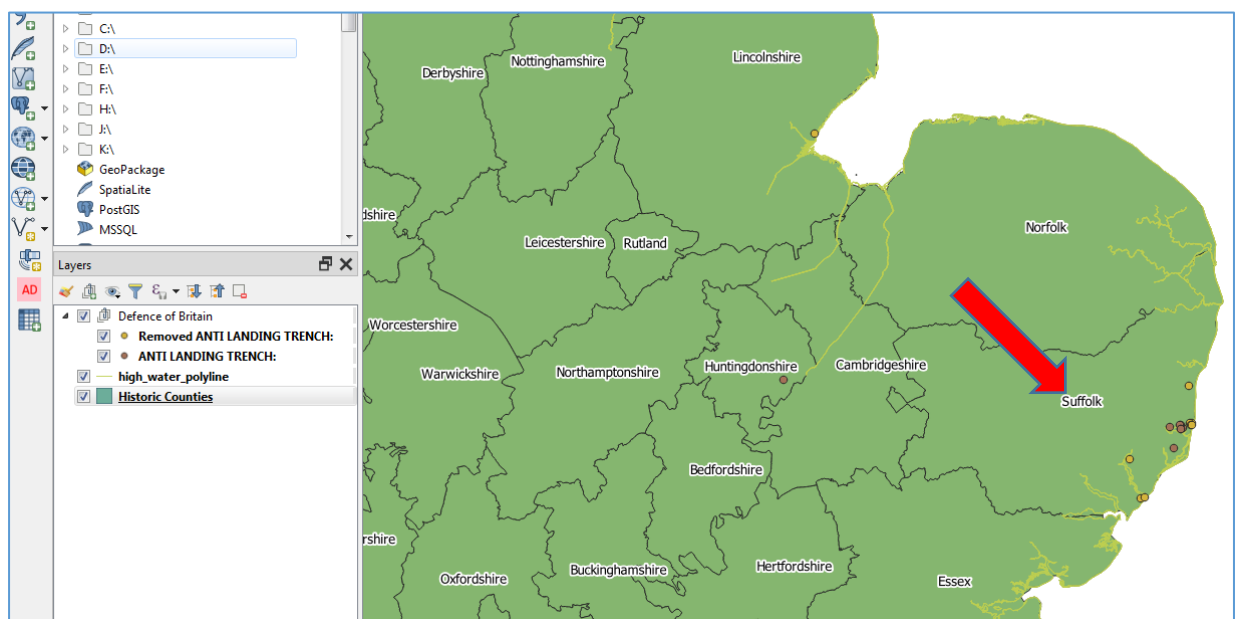
Figure 15: Suffolk Labelled

Excellent! But I'm only interested in Suffolk, so now I know where it is, let's put a filter on the County Boundaries layer, and take away all the extra information we don't need.

Right click on the **layer** [Historic Counties] and select **Filter**
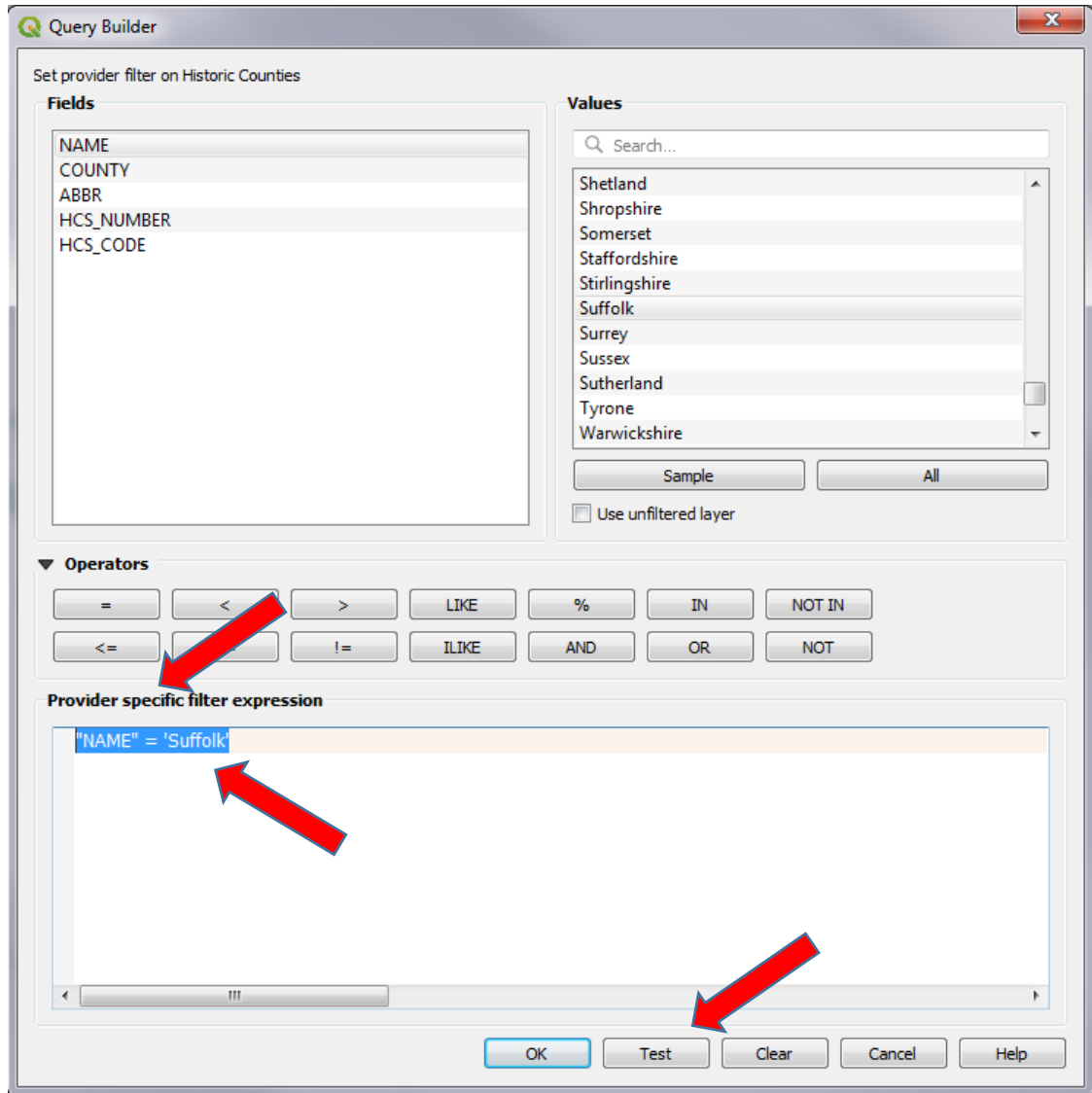
Figure 16: Filter Menu

In the box labelled *Provider specific filter expression* type "NAME" = 'Suffolk' and click **Test (note single quotes around '**Suffolk' **)** You can also double click **NAME;** click **=** in the **Operators** box; click **All** in the values box and double click **Suffolk** in the **values box.** This creates the query too.
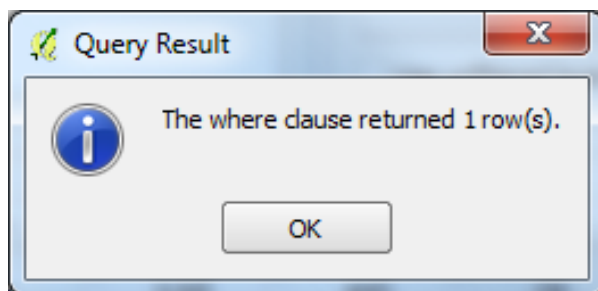
Figure 17: Successful Filter Test

The expression should return 1 row.

Press OK to exit the Filter Menu.

The map should now have only Suffolk visible.
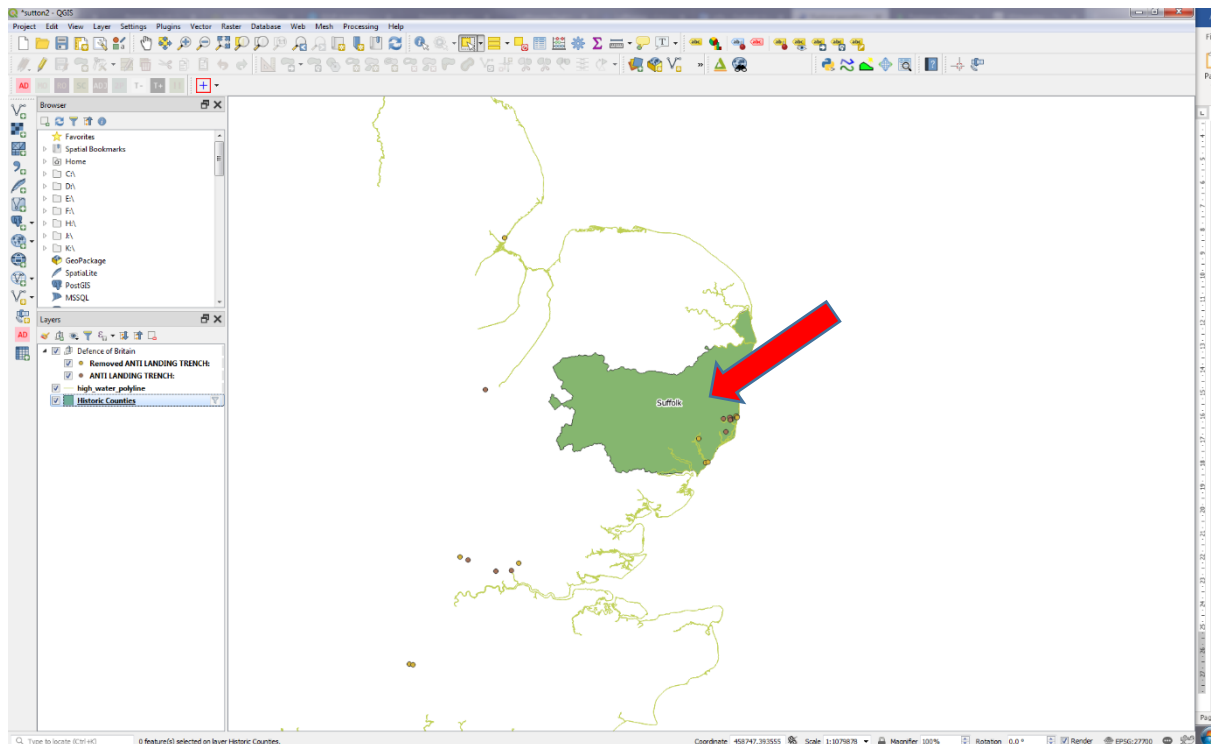
Figure 18: Only the Suffolk filled polygon is visible on the polyline map with anti landing trenches overlaid as point data.

If you're seeing the same as Figure 18, then great, if not, go back a few steps and see if your filter query looks exactly the same as Figure 16.

Now we have learned how to import the three types of vector data. If you are wondering how to import stuff which isn't already a .shp or .kml file worry not, just skip to the appendices where I'll briefly describe other stuff like importing .dxf files generated by AutoCAD, and creating your own point data in a .csv file.

After adding polylines, points and polygons, let's start to look at how to manipulate and analyse this data.

5.   The SPATIAL QUERY – Manipulating Data

Spatial query is a really useful tool if you want to know whether something occupies the same space as something else. For instance, if you mapped all your pottery finds in three dimensions, it would be really useful to produce a plan showing features which contained pottery, and those which did not. Let's keep it simple using the Suffolk example which we've already got saved.

Clear the filter on the **county boundaries layer** through the **filter menu box**, then click clear. OK. The counties should all re-appear. We will now select and display <u>**ALL**</u> the counties which have <u>**EXTANT**</u> Anti-Landing Trenches.
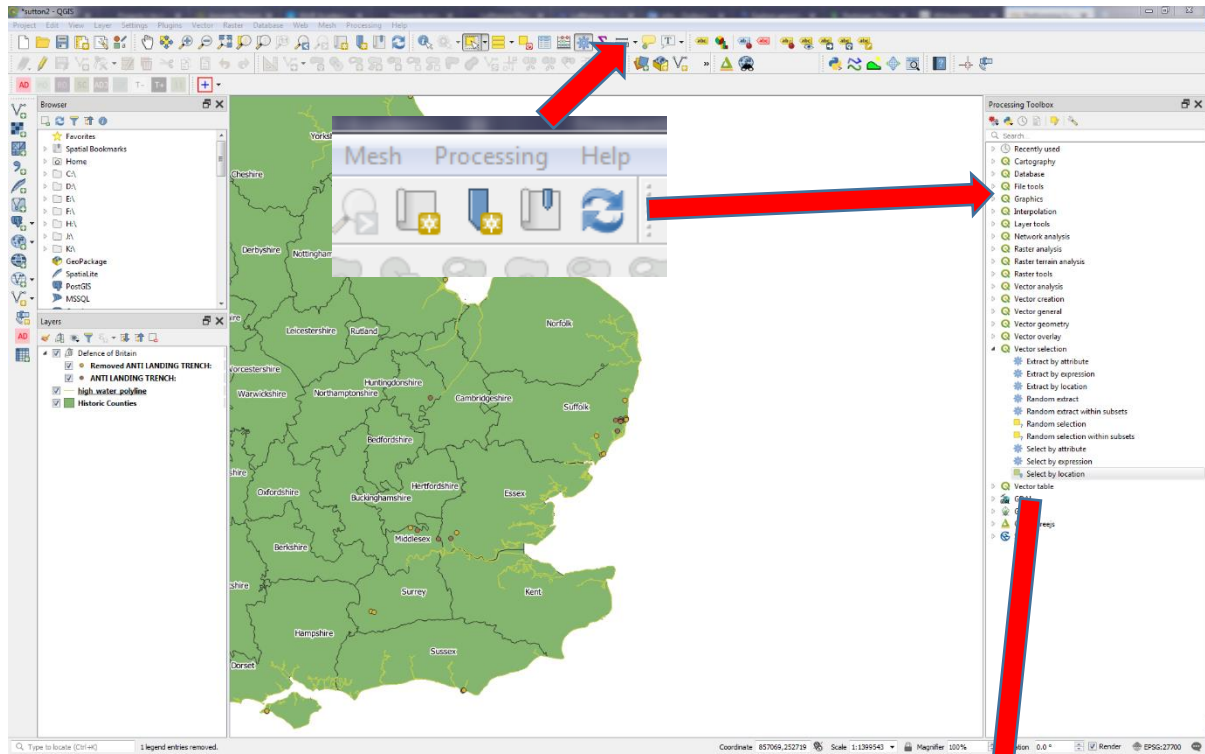
Figure 19: Spatial Query
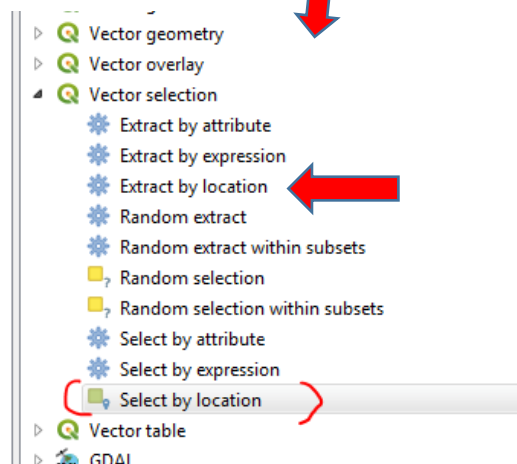
Figure 20: The Vector Selection - Toolbox Menu

The Vector selection menu allows you to design a query to suit your needs. (we will choose Select by location) - The first drop-down box lets you choose which layer you wish to select from. In this case the historic counties layer.

The next box controls the nature of the query – we want the **Contains** option.

The comparing features are the controlling layer – only counties which have extant trenches inside their polygon will be displayed.   Lastly, click **Run** to start the process.

You should now see the menu box below (Figure 21):
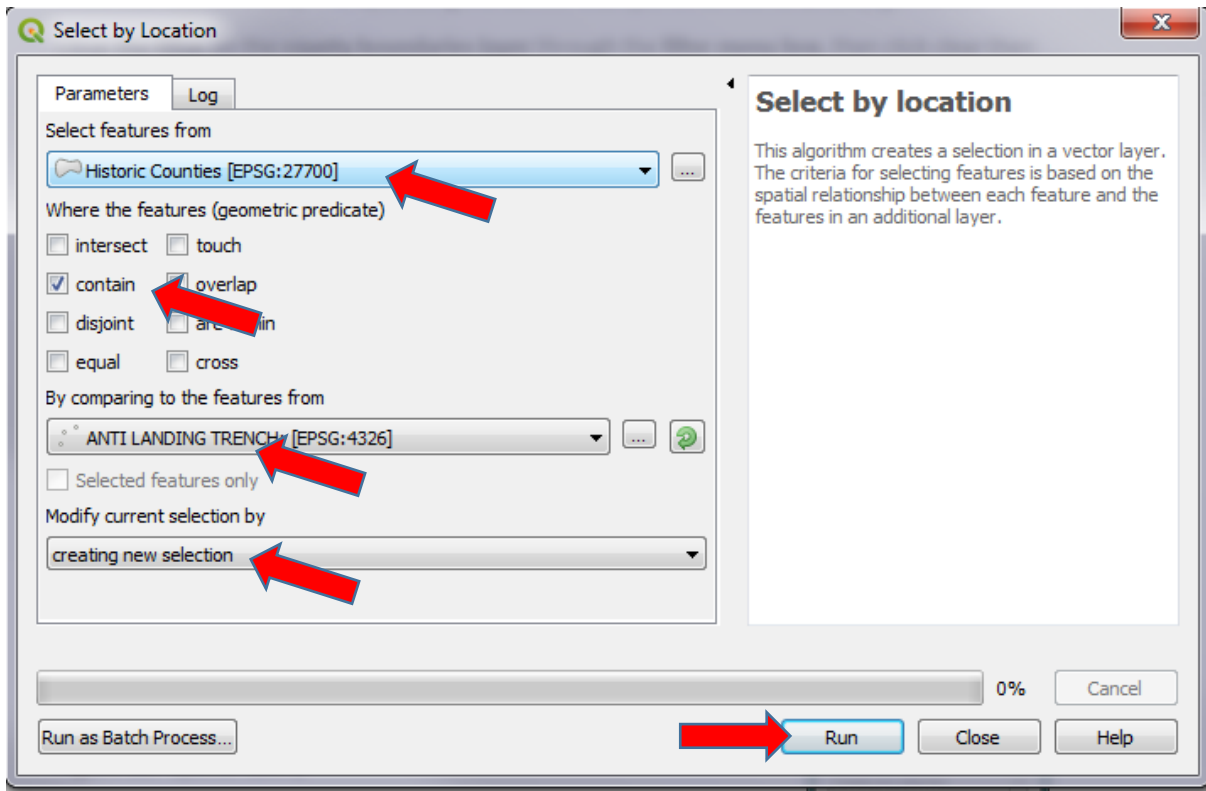
Figure 21: Vector Selection Menu

This displays the results of your query and gives you the chance to view that it is what you want. Now to create a NEW layer with just these counties on it, use the **Extract by location** – on the same Vector Selection menu in Toolbox (see figure 20) this will go through the same process, but this time create a new layer from the selected features.

You should see something like Figure 22)

Lets save this new layer. Right click the new (Extracted) location layer – rename to **Counties with AL Defences**

Now Rightclick this layer, >> click Export >> Save Features As >> and in the File Name box, click the three dots and navigate to the Sutton Hoo folder and save the shp file as **Counties with AL Defences**
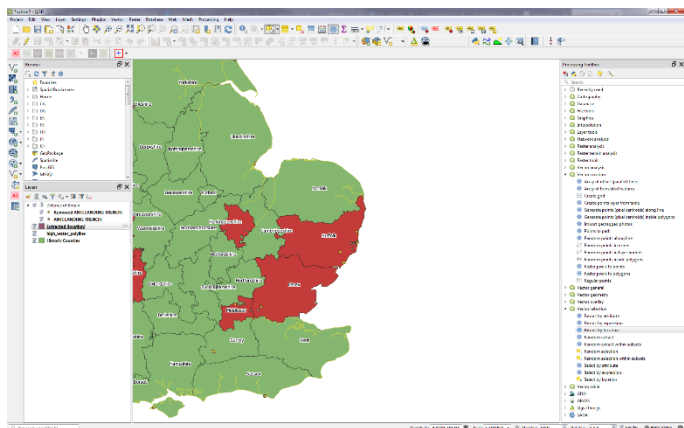
Figure 22 – Spatial Query Results

Now would also be a good time to point out that QGIS attributes colours at random (*and often without regard for taste*). This query has changed some counties a shade of red. Let's fix that.

Figure 23: Layer Properties Menu

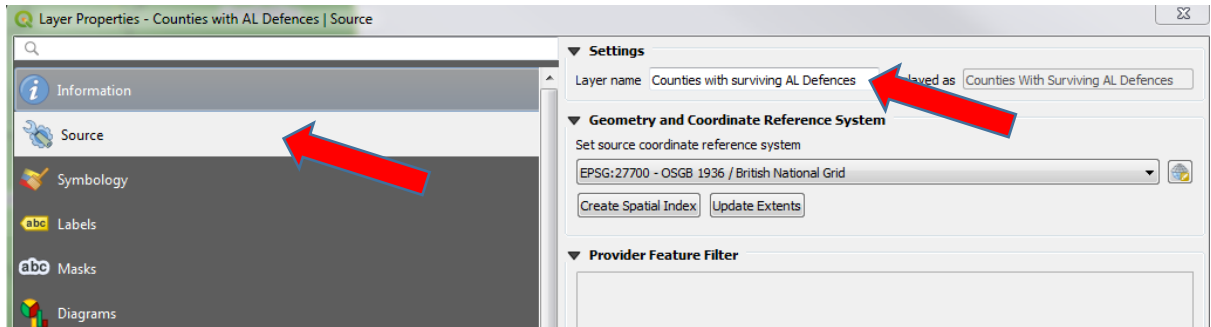In the layer properties menu (right click – Properties at the bottom) , you can do lots of other things - for example select the **SOURCE TAB** and change the layer name from **Counties with AL Defences** to **Counties with surviving AL Defences –** then click **Apply**

Now click the **SYMBOLOGY TAB**, select and change the fill colour to something more suitable.
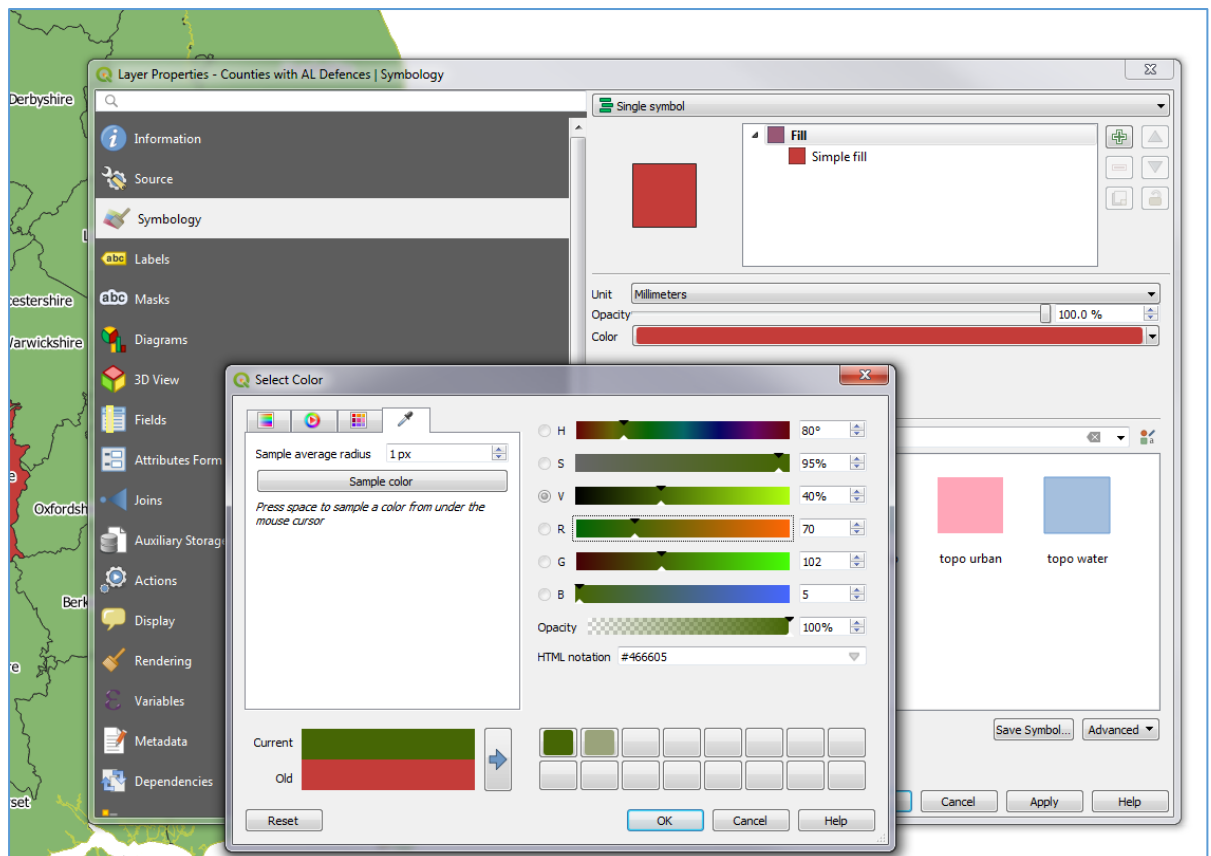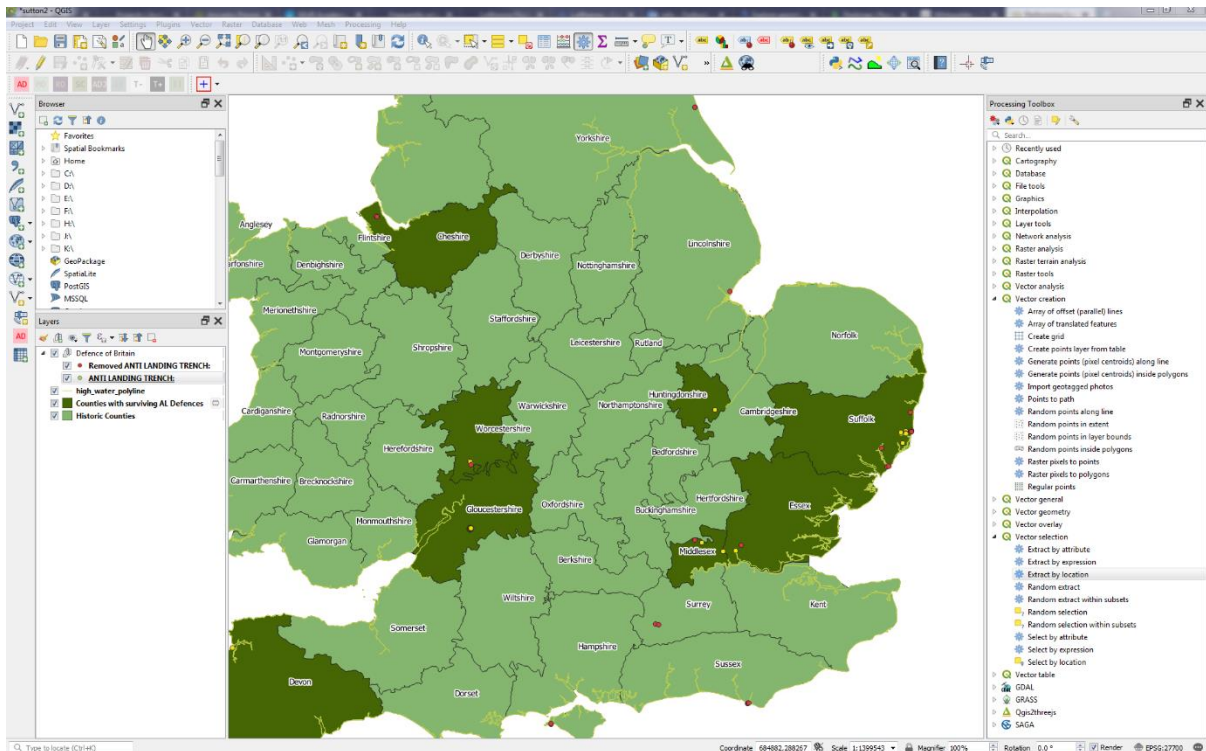

Figure 24: Fill Colour

Here's the result – you will notice how easy it is to visualise the results of the query with a simple styling – showing counties that have extant trenches. Why not do the same for the Anti Landing trenches layers

Figure 25: Result of layer styling

So, for this exercise we have one last step to add the coordinates for some of the Sutton Hoo Mounds.

To do this we'll use another useful function in QGIS, the capability to use .csv files

Comma Separated Value (csv files) are a way of structuring data so that both programs and people can understand the contents.

Open a new excel document, (you can use any spreadsheet program like in Open Office which will allow you to **save** a comma separated value file (.csv))

Enter this data into the blank sheet and save as a .csv file (MS-DOS version for Windows users)

Site	eastings	northings
mound1	628779	248701
mound2	628843	248802
mound3	628803	248672
mound7	628821	248729
mound11	628756	248635

Now find the button which allows you to create a layer from a delineated text file (including .csv's!) This will get you used to **hovering over buttons** to find out what they do, and prepare you for **further exploration of QGIS**. A great way to learn is exploration.
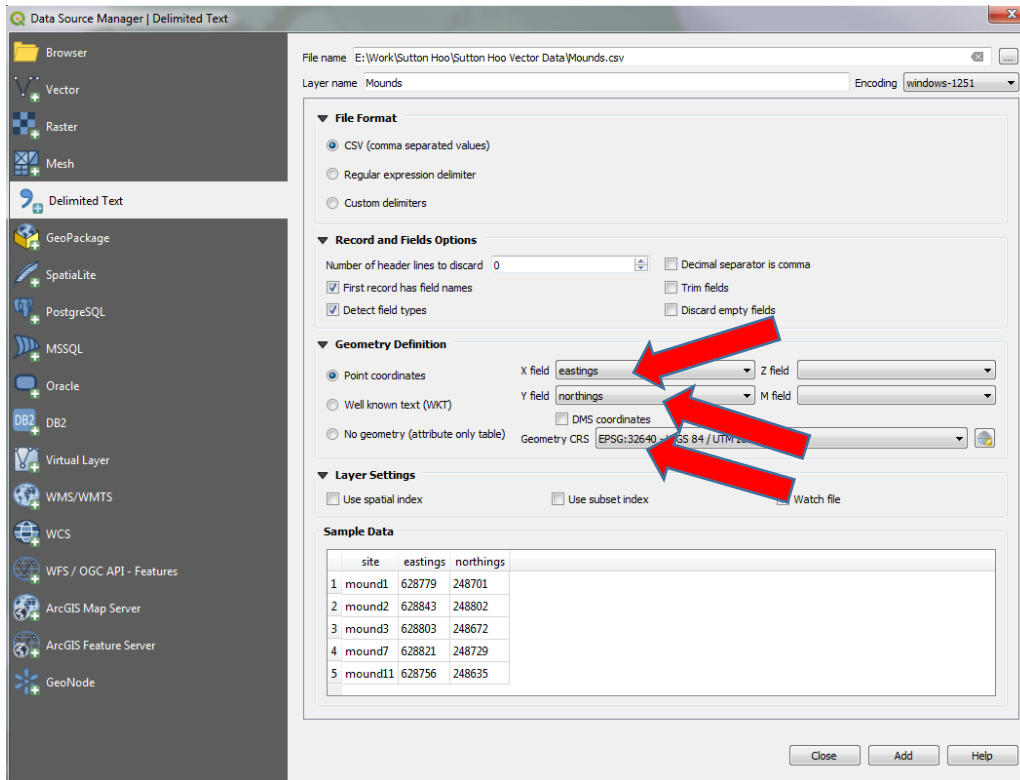
Figure 26: Add Delineated Text File Menu

Browse to the file which we just created (In this case we had named it *Mounds.csv* and saved it in the *Sutton Hoo Vector Data* folder).

Everything appears to have come through – you can see the table in the box at the bottom of the menu, and QGIS has automatically picked up the delineating character, and the first record (at the top of the table) has the **field names**. It has even worked out that **eastings** and **northings** refer to coordinates. (Figure 26) If it had not picked these out, then of course you could manually tell it what fields were an **easting** and

northing coordinate. Choose the OSGB 1936 CRS 27700

Press **Add**

Figure 27: Zoom to Layer
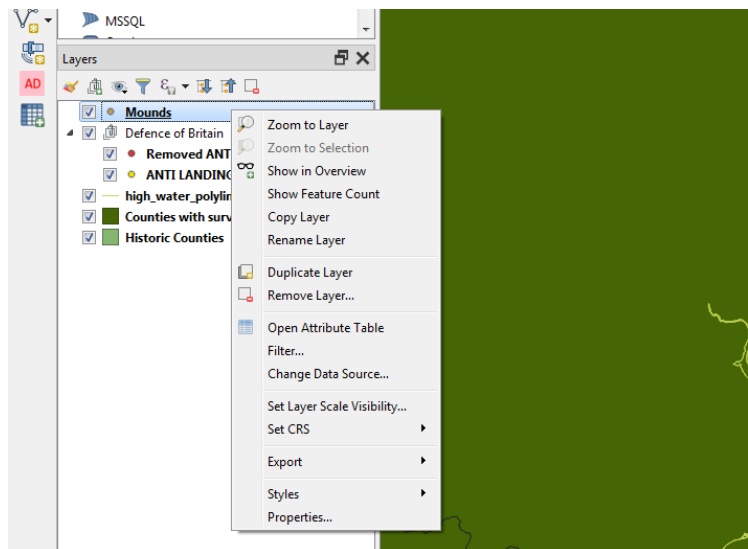
A new group of points should have appeared near to the Suffolk coastline. Turn off the anti-landing trenches layers and this should become more apparent or right click the *Mounds* layer and select zoom to layer (Figure 27).

You can change point styling by right clicking the new *Mounds* layer and choosing options in the *Symbology* tab. Zoom out to see more of the landscape.

Figure 28: Mounds Added

The hope is that this short introduction is enough to get you going with using vector data. There are loads more useful tools in the vector drop-down menu at the top of the QGIS window. They will allow you to transform lines into polygons, create new polygons from intersecting polygons and also do general data management stuff like merging two shapefiles together
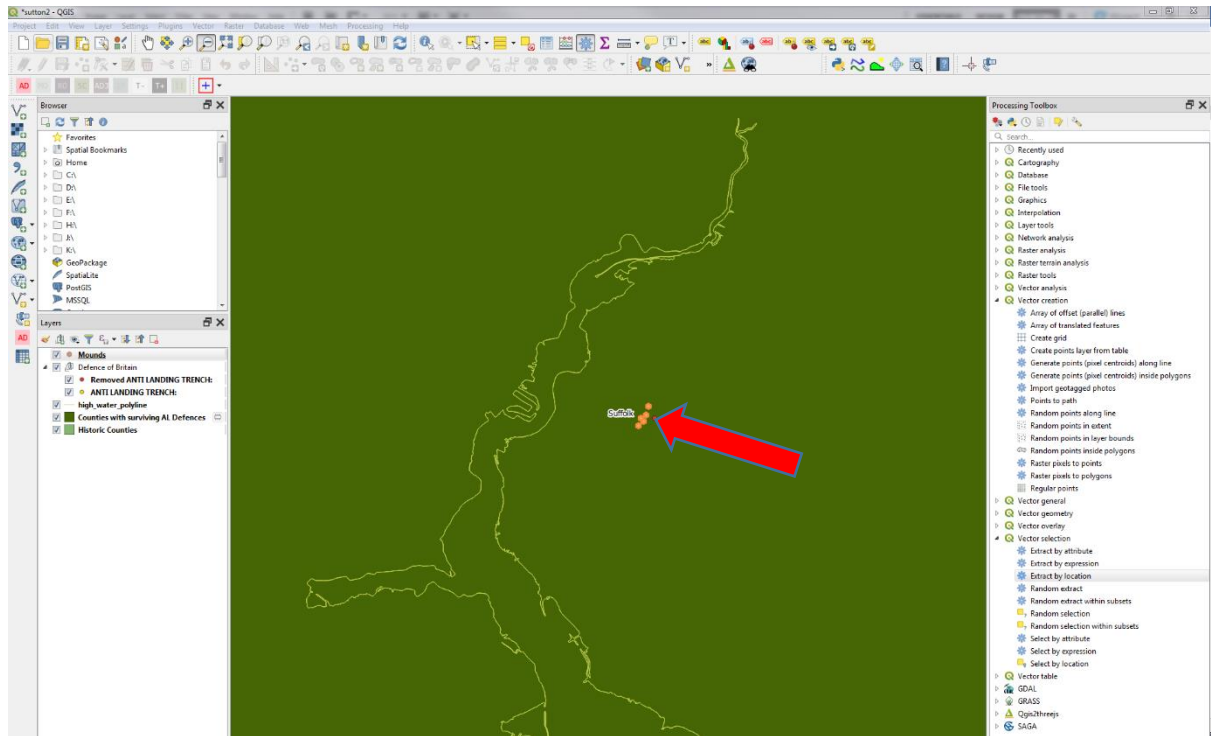
Save your QGIS project As **SuttonHoo**

6. Working with OS Open Map Data

Open Map data can be added to your GIS project from the Ordnance Survey Open Data portal:

https://www.ordnancesurvey.co.uk/business-and-government/products/os-open-map-local.html

Of course, other countries have their own access (or not) to digital data, from USGS to NASA, you may have to search for the region you need, but it is normally possible to find at least basic GIS data for everywhere on earth.

Let's add some background mapping for grid square TM into the project (Terrain 50 is downloadable as a dataset covering the whole of the UK approx 1.1 Gb! So only pick the areas you need)

Select Grid Square TM from the list available (OS Open Data is the first item in the list).

Check download, then click **Next** at the bottom of the page.

Fill in the details on the next page (Figure 29)
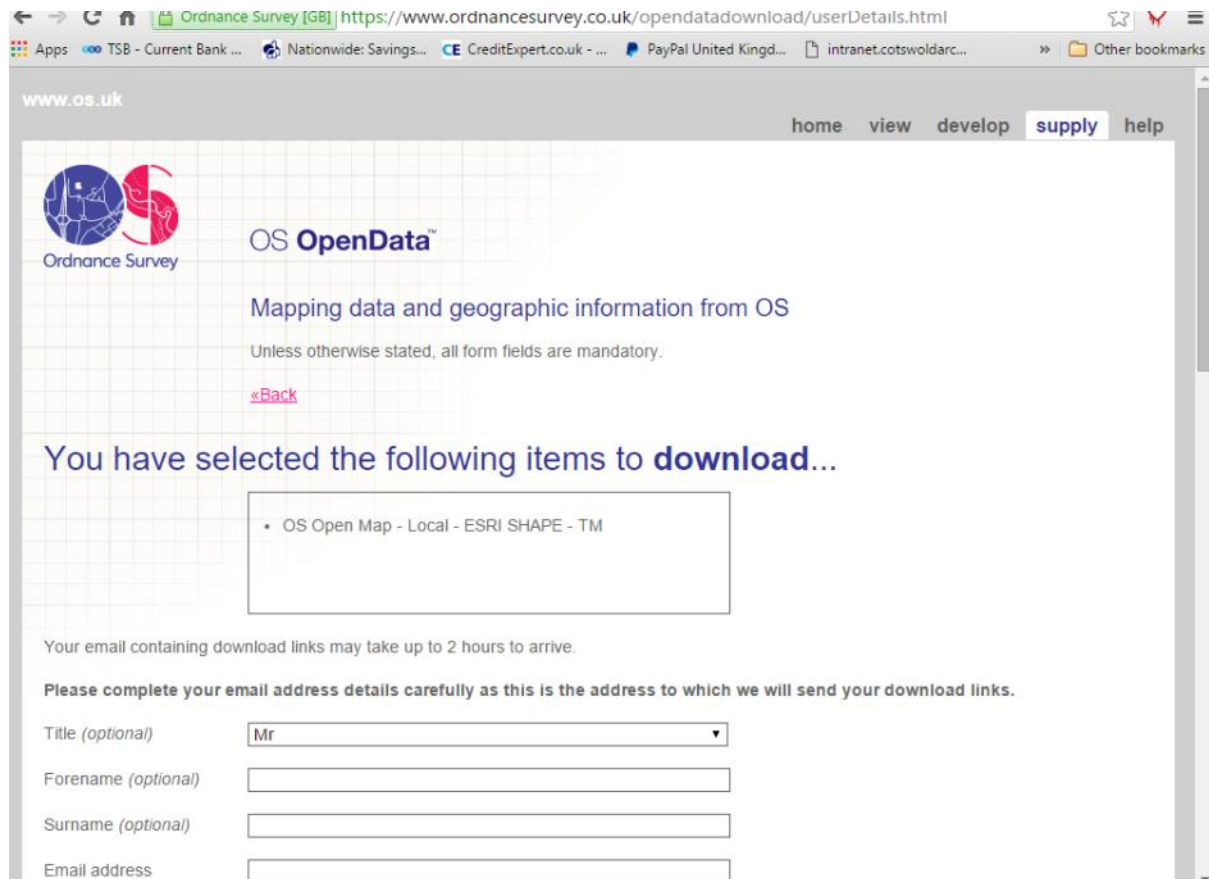
Figure 29: Open Data Details Page

Finishing the page should result in an email with a download link being sent to the address which you have just provided, this will allow you to download a .zip file containing the new vector data. Open the zipped folder and extract to the *Sutton Hoo Vector Data folder.*

Back in QGIS, let's add this new data.

Use the **add vector data** tool in the left hand toolbar, and point it at "\Sutton Hoo Vector Data\OSOpenMapLocal (ESRI Shape File) TM\data"

Set the file type selector (to the right of the file name bar) to ESRI Shapefiles, and select all the files in this folder.

Things just got a lot busier.

You'll notice that the colour scheme has been chosen arbitrarily. Let's sort that out first

Changing the colour scheme can be effected by double clicking on the coloured square next to the layer in the layer menu. This is what we came up with - but why not experiment. There is a good tutorial for creating and saving styles here:
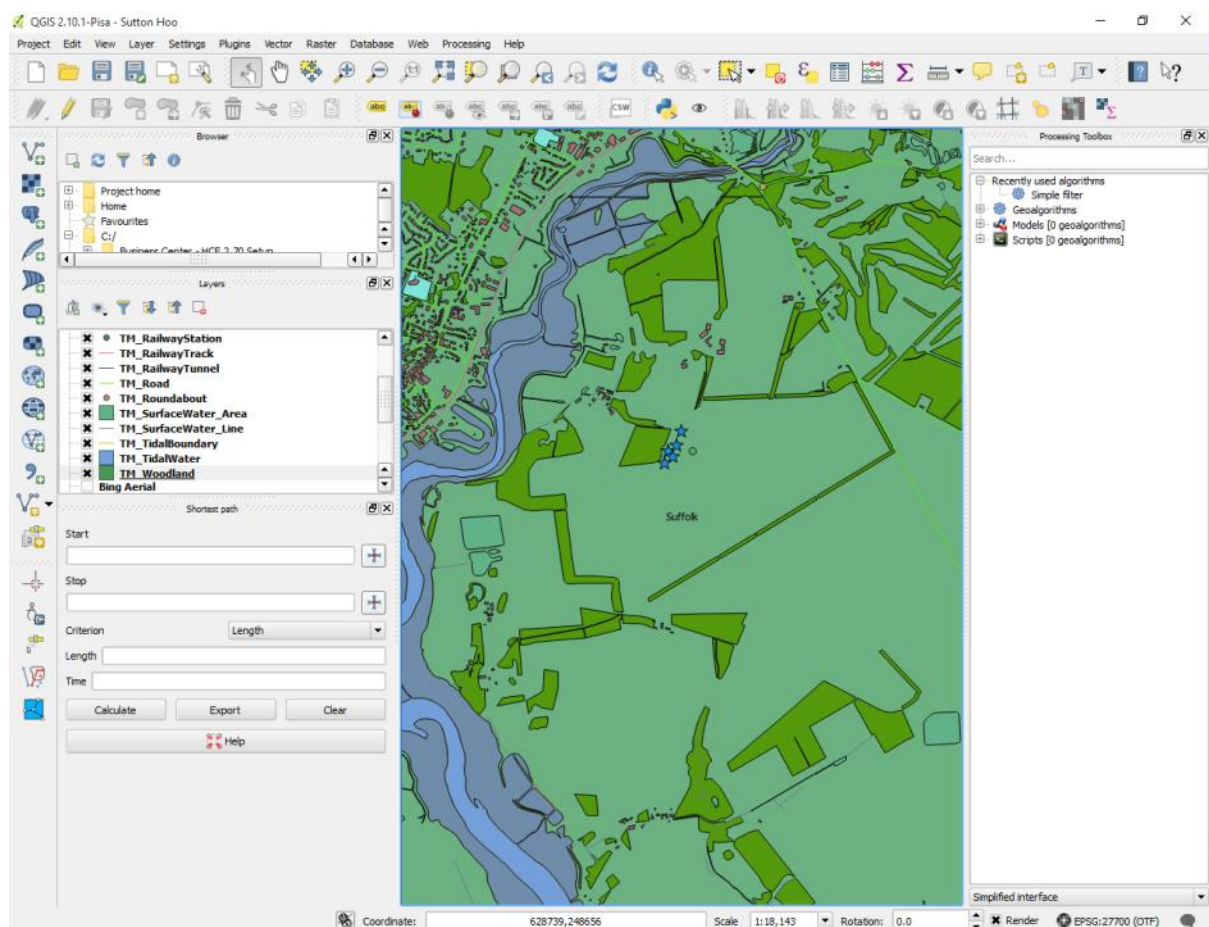
Illustration 30: *Colour Tamed*

Remember that if you use this data you must acknowledge it using the appropriate Ordnance Survey Open Data text:

Contains OS data © Crown Copyright [and database right] (year of use)

7.   The Power of the Grid!   Raster data Basics

So, now we've covered vector data, let's move on and have a look at rasters.

7.1.   What is a raster?

Digital image formats like .tiff and .jpeg are examples of a raster file format, geophysics plots and Lidar are also examples of rasters.

These file types are all structured in the same way: they are all made up of an underlying grid of cells, each of which is attributed a value, which can be a positive or negative number.
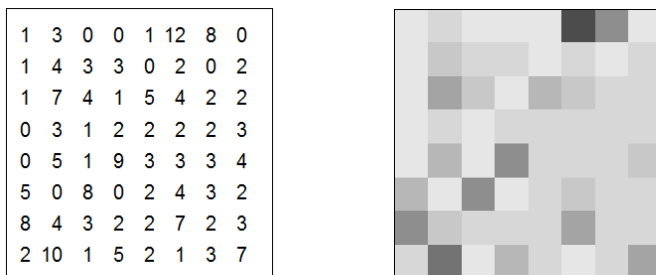
In a digital photograph like a .jpeg file, every cell is attributed a value which corresponds with a different colour.

Geophysics surveys work the same way, with each cell representing a reading taken by the instrument, across the survey grid. Lidar works exactly the same except the values correspond to height above sea-level (usually).

7.2.   Adding Aerial Imagery

Right, let's add some aerial photography into our Sutton Hoo project.

1) First, add another folder inside the *Sutton Hoo* folder, call it *Sutton Hoo Raster Data*…

2) Now to locate some satellite aerial imagery.

3) From the drop-down menus, select **Python Console** from the *Plugins* **menu**.

4) There are loads of useful tools here which you might wish to investigate in the future. – Until then… `Plugins > Python Console > Show Editor`

Next: Copy&Paste the code from the link below into a **new Python file** and press `Run`

`( you can find it by searching for the text` "Copy&Paste the code below into a new Python file and press `Run`" `in the following webpage`

https://gis.stackexchange.com/questions/20191/adding-basemaps-from-google-or-bing-in-qgis/217670#217670

Now go to `View  > Panels > Browser`
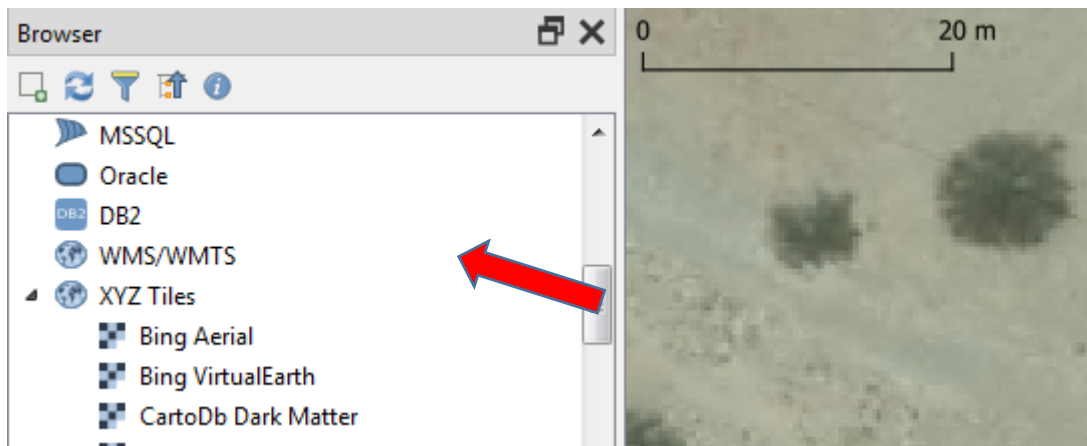
Figure 31: The Browser Panel – scroll down for "XYZ Tiles"

Scroll to XYZ tiles and choose from the available sources.

Googlemaps Aerial or Bing for this particular exercise- We currently recommend **Bing Virtual Earth – But have a look at all the other options.**

You can now turn **off** the high waterline and county boundary layers now, as we won't be using them anymore.

Figure 32: Aerial Imagery with points over the mounds.

8.   Georeferencing

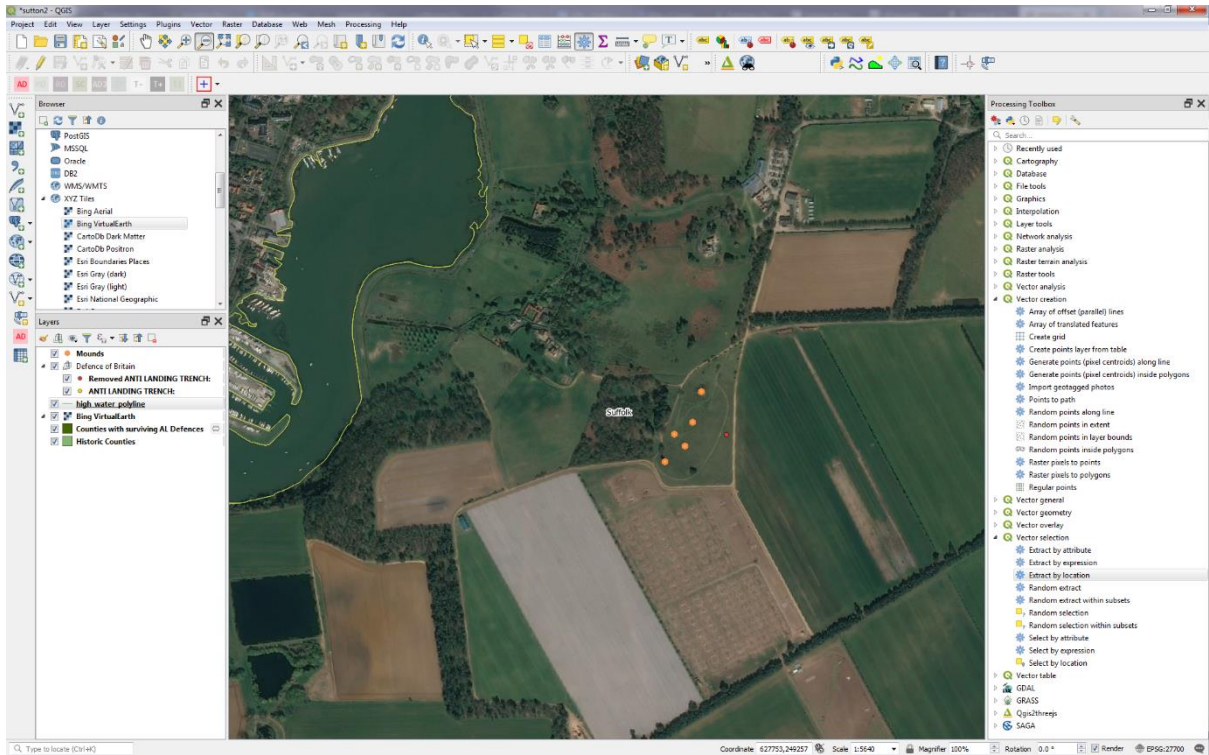We now have point data of the Sutton Hoo mounds overlaid on modern Aerial Photography.

When you add an Open Layers map to your project, CRS is changed to EPSG:3857. Go to Project properties and change back the CRS to your local projection (and don't forget to enable on-the-fly projection).

That seems easy. But what if the raster we want to use isn't georeferenced? That is, what if it's just an ordinary image file, how does QGIS know where to place it on the map?

In that case we'll need to use the RASTER GEOREFERENCING tool. The georeferencing tool uses point-matching to line-up an <u>unreferenced</u> image against a <u>referenced</u> base-map. It will then create a "metadata" file with coordinates which allows QGIS to plot its position onto our map.

We want to know the extent of the Sutton Hoo excavations; and you will find the information in the folders you downloaded earlier [**Sutton Hoo**]

The full Sutton Hoo Archive can be viewed HERE:

Either use the data in the download or use the windows 'snipping tool' to capture a .jpg of the *Detailed Site Plan* (which is archived as a .pdf) and save into the <u>Sutton Hoo Raster Data</u> folder .

Back in QGIS select the **Georeferencer** Tool in the **Raster drop-down file menu**. And the following window will appear.

Figure 33: Georeferencer window
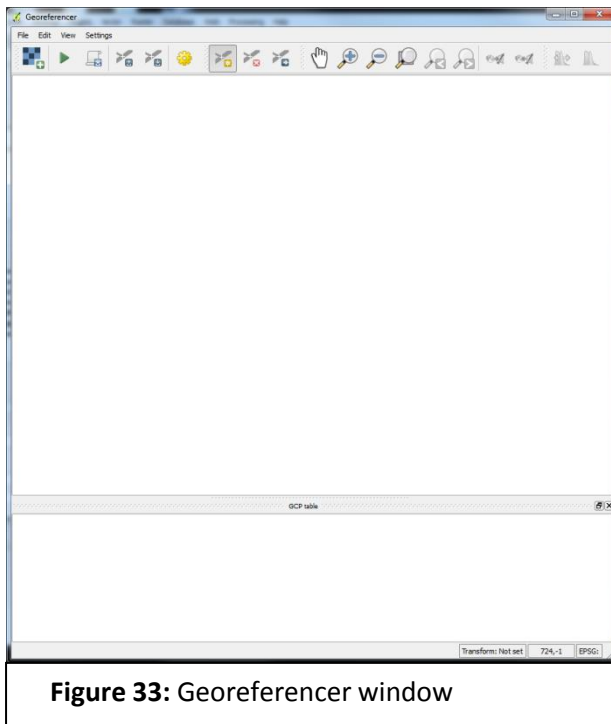
Here you have an interface which will allow you to load and georeferenced images by point-picking. Basically you choose a point on the image you need to reference, and the corresponding point on your referenced base-map. You need at least three points to reference an image, though four or five will usually work best - and they should be well distributed around the image i.e. not all in the same corner! Let's start by loading the site plan image.

1) Click the Add Raster button at the top left-hand corner of the menu.

2) You will be asked to confirm the CRS, choose OSGB36 [27700].

The new image now appears in the main box.

You'll see a number of grid coordinates on the plan which refer to the site grid. Luckily we know the transformation for the Sutton Hoo site grid, so we can type the new coordinates straight into the dialogue box.

3) Left click on the grid point labelled **50/50** and you will see this box; (note that you can also pick from map (which allows you to match map points with the same locations on the image you are trying to georeference
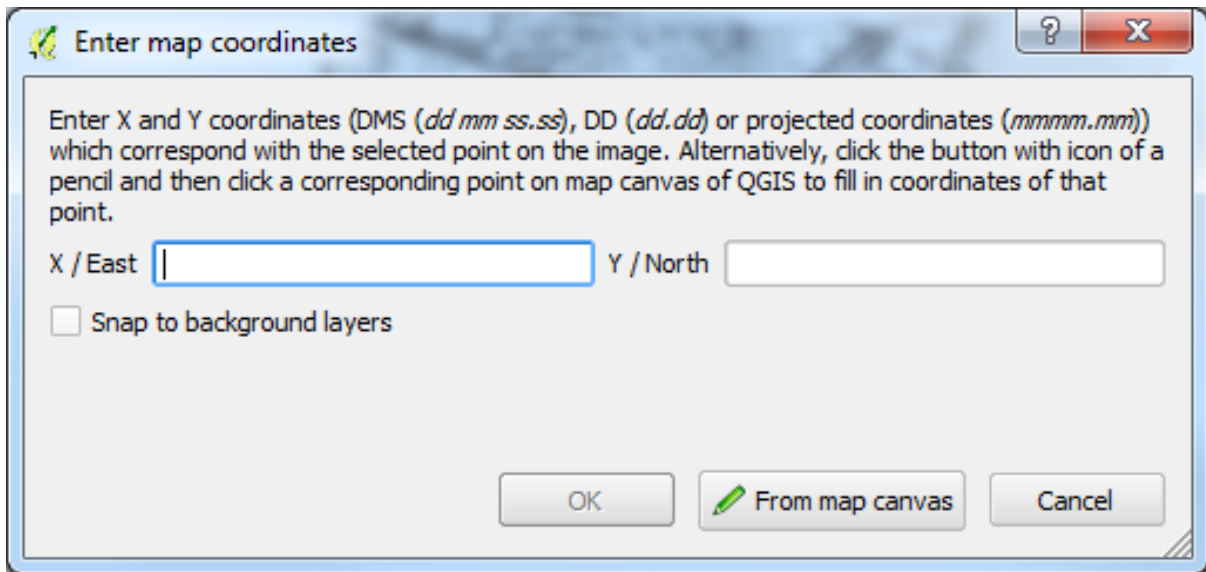
Figure 34: Coordinate Dialogue Box.

4) Set the following coordinates for this point, and for the other four visible grid points.

50/50	628775	248655
250/50	628975	248655
250/200	628975	248805
50/200	628775	248805

5) Click the **Play** button to start the georeferencing process. Another dialogue box will open and ask you to set the transformation type, choose linear.

6) Now chose an output raster for your georeferenced plan to be saved as (in the Sutton Hoo Raster Data folder) and press **OK –**
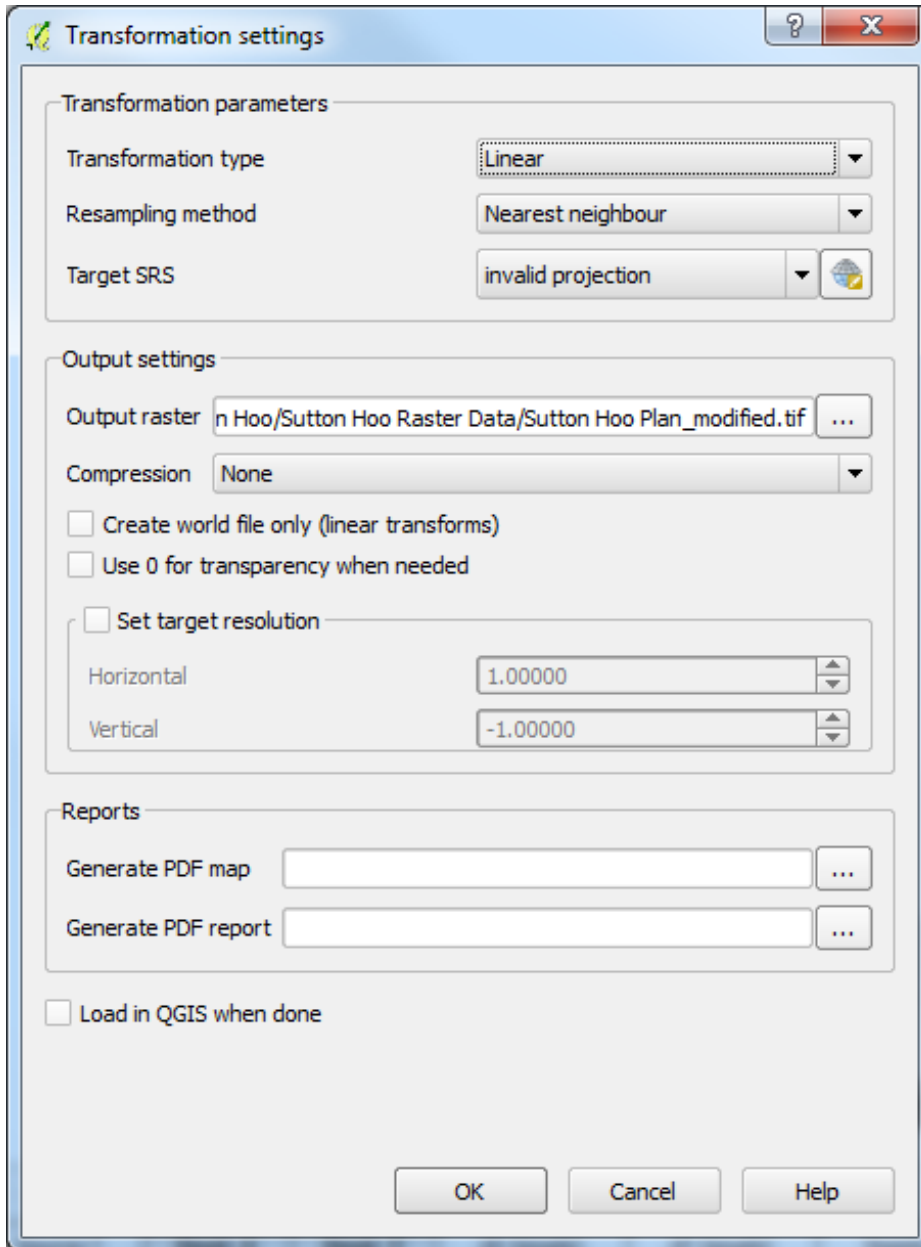
Figure 35: Transformation Settings

7) Quit the georeferencer and **SAVE YOUR GROUND CONTROL POINTS (GCPs)** !

8) You should now see the plan which we downloaded from the excavation archive fully georeferenced and loaded as a layer in you GIS project.

For learning more on how to georeference from points you can recognise on the aerial photograph and the image you want to georeference – Read this excellent instruction Tutorial.
https://www.qgistutorials.com/en/docs/3/advanced_georeferencing.html
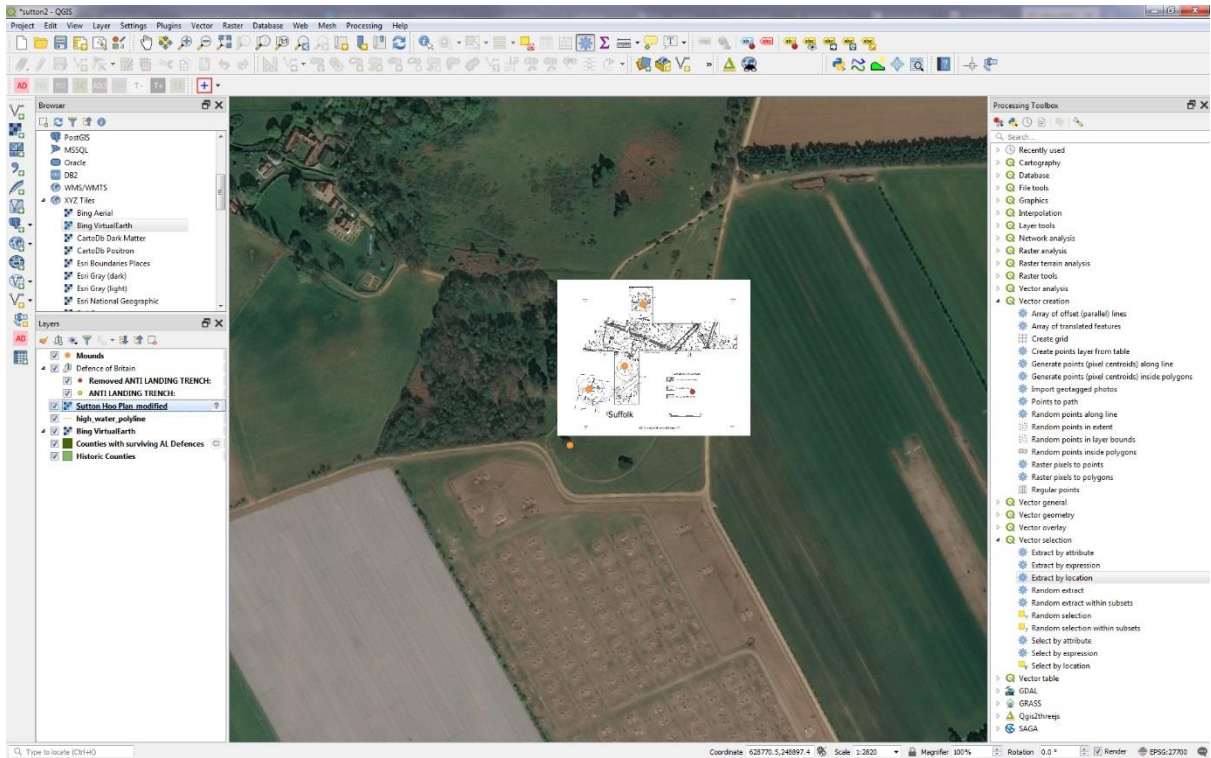
Figure 36: The loaded original site plan, georeferenced

With the image now georeferenced you could use the '*create vector layer'* tool to make a vector version of the site boundary, or perhaps vectorise all the excavated features as polygons with associated metadata which you could then interrogate further and create even further shp file layers based on the results – such as location of specific types of artefact ; The capability is all there within QGIS as long as you can input the data.

9.   The Power of the Grid!

Lidar - most people will have been anticipating this section, and the good news is that QGIS is fully equipped to handle Lidar digital surface and terrain models (DSMs and DTM's).

9.1.   Get Data

Lidar is available free of charge (mostly in England and Wales) through the government open data portal:

https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

Find Sutton Hoo, (grid square TM 24) (from the top left dropdown) select the area using the Polygon tool in the left menu – then Download Data tiles – Select and download the **Lidar Composite 50cm DTM** data (**not** the DSM (Digital Surface Model) **TM24 NE**). You will have to download a complete ten kilometre square, so once the .zip file is downloaded, look for TM 28 48 it is in an .asc file format.
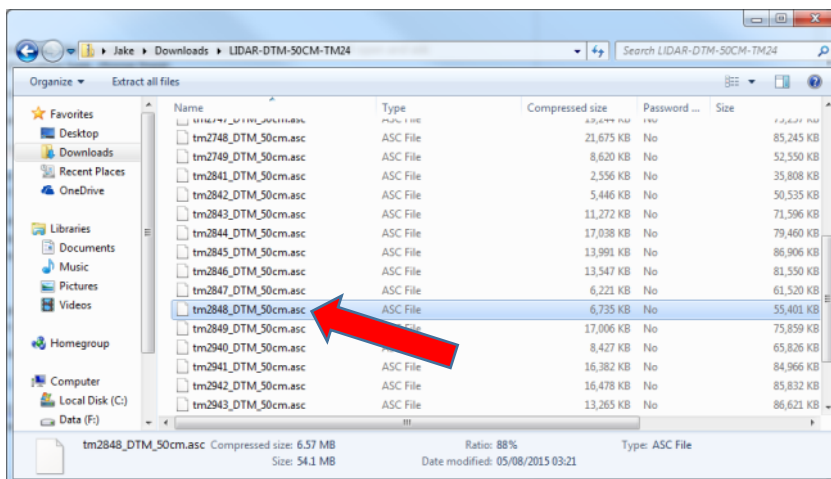
Figure 37: Map square TM2848

Drag and drop the .asc file for grid square 2848 into *Sutton Hoo Raster Data*.

Now, add this as a new layer, it's already georeferenced so should be simple, just choose the coordinate system.

Now you should see something like **Figure 38** (left) – the Lidar data is loaded, but doesn't show much, it's in its raw form. To make it useful we'll have to put it through a process called *Hillshade Analysis.* This will bring out the detail.

Hillshade analysis works by simulating a raking light source falling across your terrain model, which produces shadows, picking out earthworks and other potentially archaeological features.

9.2.   Applying Hillshade

In the *Raster* drop down menu, select **Hillshade** from the *Terrain Analysis* menu.

In **Figure 39** you can see the options for running a Hillshade analysis – choose *tm2848* as your elevation layer, and name a new layer as your output layer. Call it Hillshade, and make sure it's saved in the Sutton Hoo Raster Data Folder.
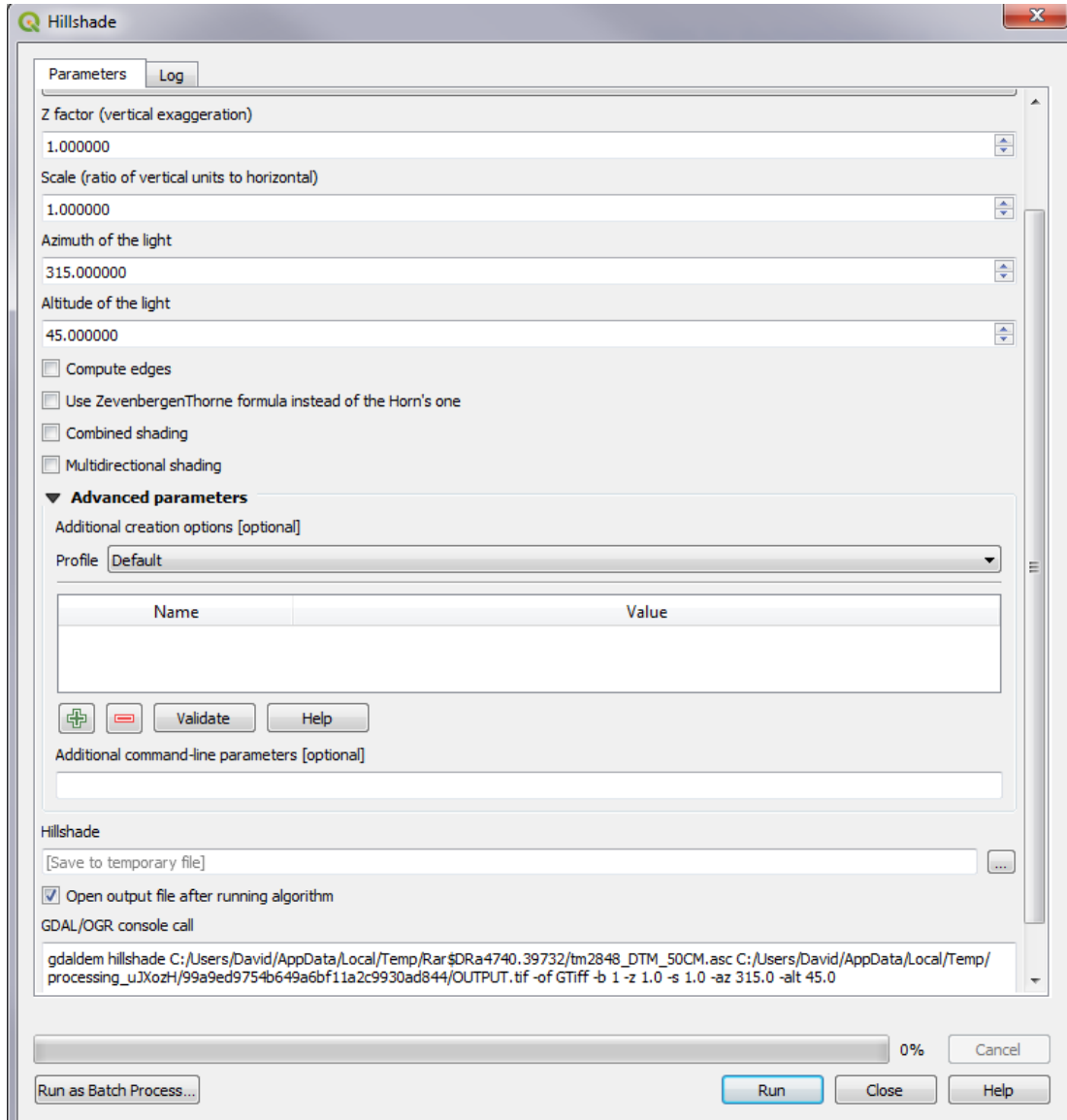
Figure 39: Hillshade Analysis

Changing the Z factor (vertical exaggeration) allows you to exaggerate subtle changes in topography, bringing out small features which might otherwise be missed.

The azimuth and altitude boxes control the position of your light source. Play around a couple of times with the hillshade tool to see the effect of changing these settings. In the hillshade field - enter the name of the final result file - you can just play about without saving, by leaving this empty, until you get exactly the results you like .

You should see something like **Figure 40** (next page)
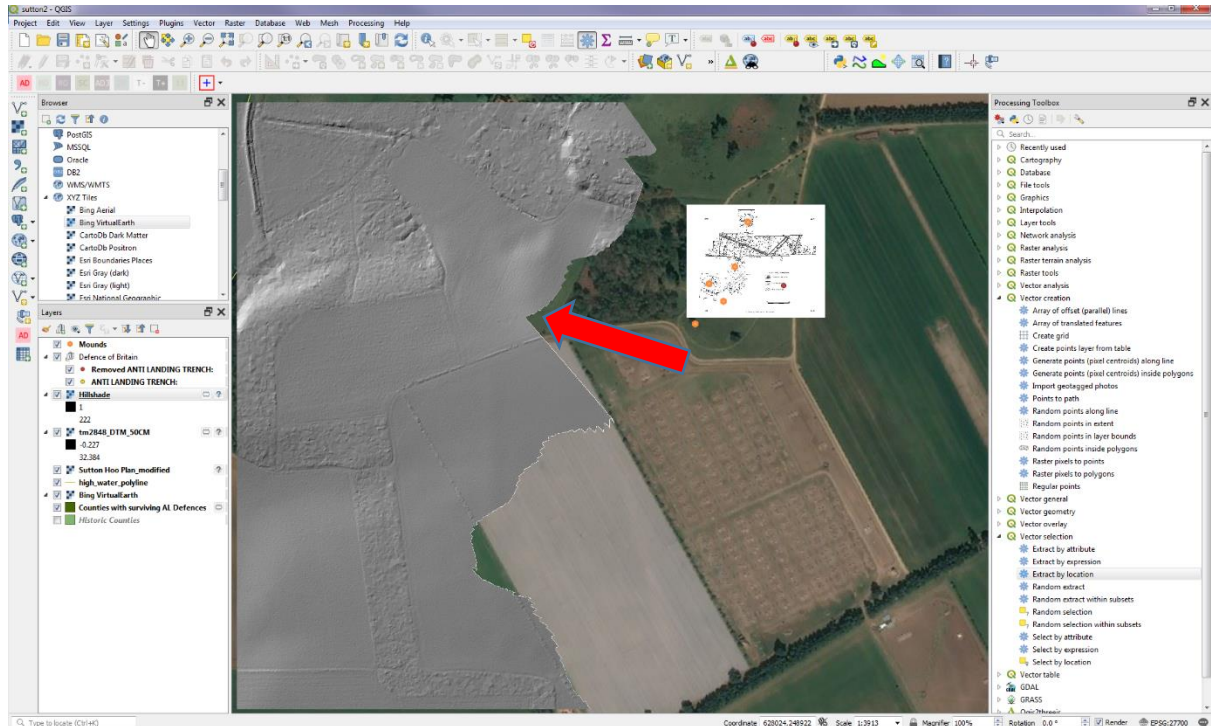
Sorry the Lidar doesn't reach the extent of the mounds, we were kind of building up to that, only to let you down – but this is the real world!   Perhaps the new UAV Lidar mounted pods will let you fill in this gap!

(If you want to see the lidar data for Sutton Hoo you'll have to go back to the EA downloader and pick the 2m data.)

A note from a lidar pedant: hillshades are a great first step to visualising lidar data but they pose some significant problems for mapping microtopography, namely that the features you will see are dependent on the direction and angle of the illumination you choose. The process of using light to highlight and shade areas is also problematic – what are you seeing / mapping when you look at the light and shade? Is this in the same place as the monument or has it been translocated by the hillshade visualisation?

If you'd like to know more about other, more appropriate visualisation techniques to highlight microtopography from the Relief Visualisation Toolbox webpage developed by the Institute of Anthropological and Spatial Studies, ZRCSAZU Slovenia. You can download their stand-alone processing genie, the Relief Visualisation Toolbox, along with a detailed manual and even a powerpoint presentation about the visualisation techniques from this link (**RVT** https://iaps.zrc-sazu.si/en/rvt#v).

10. Lidar 2 – An exercise in working with the data

10.1. Using a raster catalogue

For the following exercise, let's actually add something to the archaeological record. Start a new QGIS project in a new project folder.

1) Name the project "**Dales Lidar**", make sure that the working coordinate reference system is OSGB1936 [27700] and the file paths are relative. .

We're going to head to the Yorkshire Dales, where there's some 1m resolution Lidar data, which we can use to spot archaeological sites such as earthworks and field systems. I'll also introduce a new technique called de-trending which will help to reduce the amount of background noise from very hilly terrain.

2) Head back to the Environment Agency website and download the composite Lidar Composite DTM (Digital Terrain Model) for map square **SD87 DTM 1M** https://environment.data.gov.uk/DefraDataDownload/?Mode=survey

3) Once you've got it downloaded, extract the tiles into a suitably named sub-folder in the project folder

There's a lot of tiles - importing them all individually is a really bad idea, as you'll have to go around changing the CRS for each individual hectare tile and that will drive you mad, as well as taking hours!.

Also, there will be noticeable breaks around the edges of each tile, as each one will have its own histogram, controlling how black and white each pixel is rendered.

4) Fortunately the solution is to build a *virtual raster catalogue*. A tool which you can find in the *Raster: Miscellaneous* drop down menu.

5) You can choose a directory for your input, then you'll have to name the output file. Every other option should be unchecked – except adding the layer to the project.
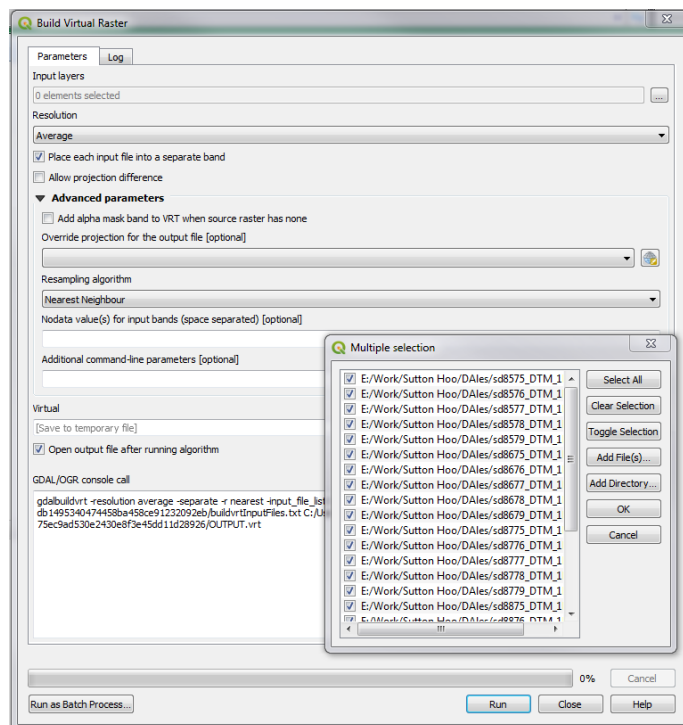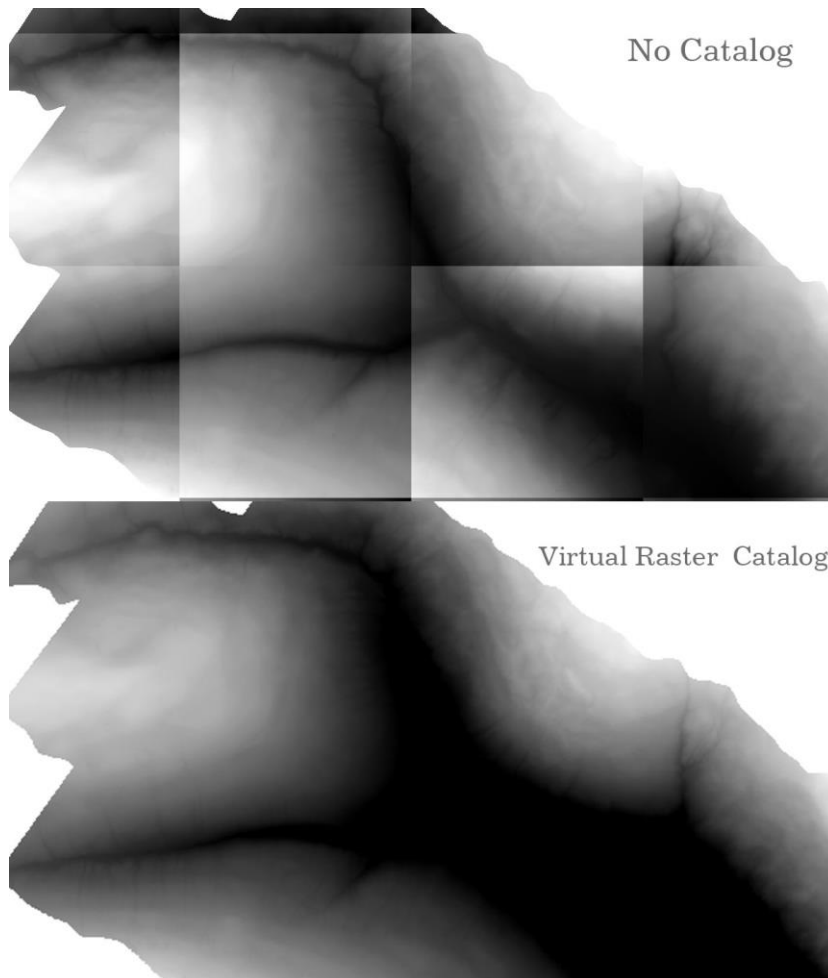

Figure 41: Build Virtual Raster Catalogue window

6) Load the result into your project,], the result should be something like the bottom image rather than the top (note how you can't see the squares now. :

Figure 42: Loaded results
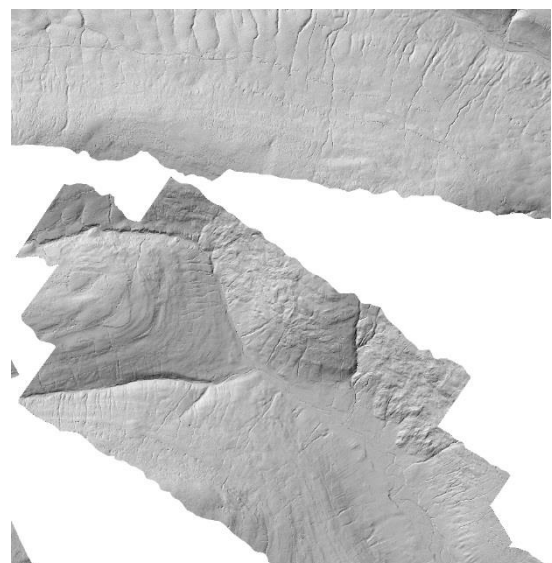
10.2. Hill shading

Let's get started with a basic hill shade: We covered this already in section 10.1 above.

Make sure the resulting GeoTiFF is in the correct CRS (OSGB36 [27700]).

Beautiful!.

Time to load some aerial photography which will help our interpretation of any anomalies we want to record. (see the section 7.2 above)

Figure 43. The new GeoTIFF with hillshade applied

Let's also create a vector grid, so we can keep track of where we've looked. Grid creation is via *Vector: Research Tools: Vector Grid*
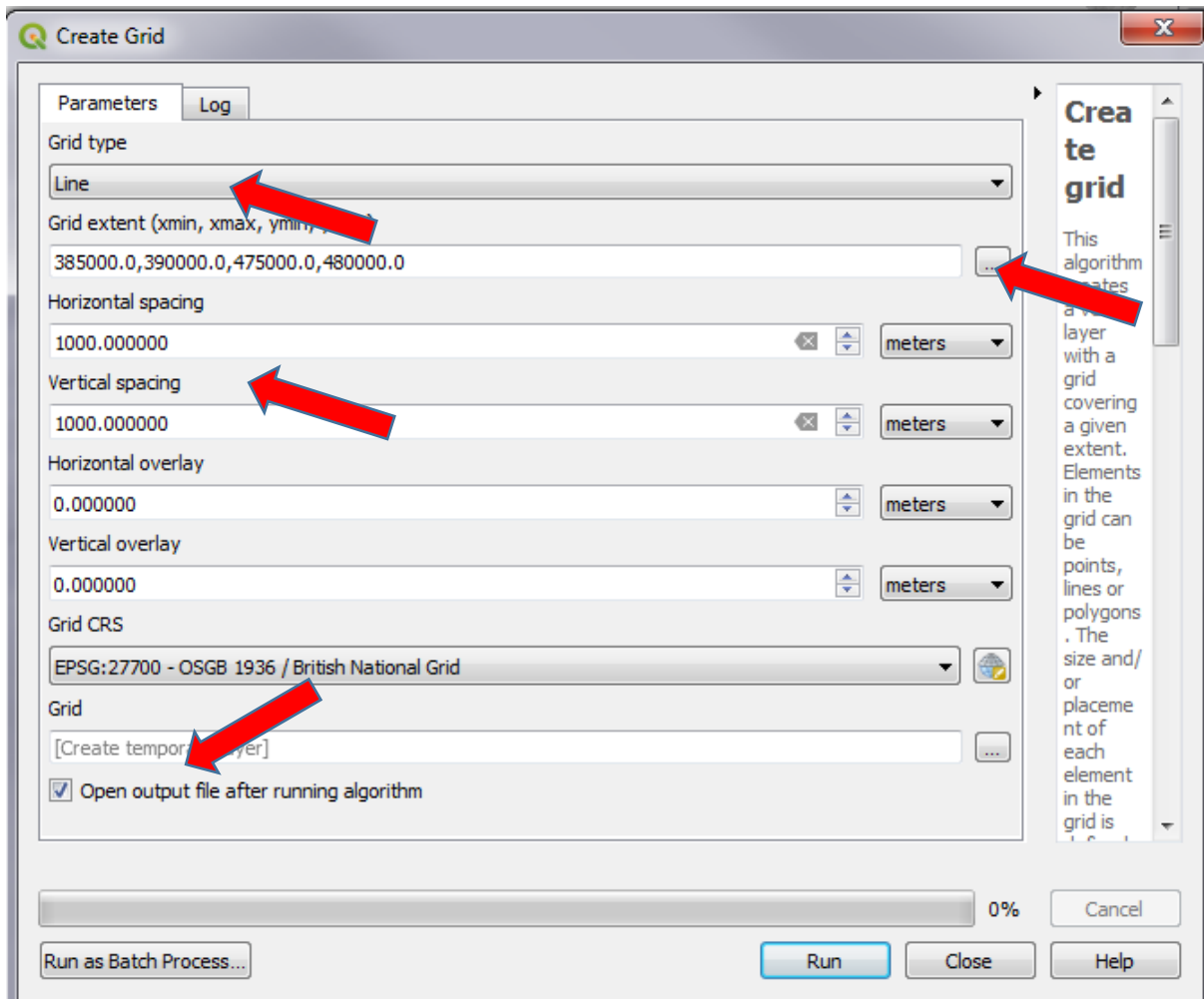

Figure 44: Grid extent should be the hillshade raster file

1)   Grid Type = Line

2)   In Grid Extents, click the **USE LAYER EXTENT** – then choose the Hillshade Layer

3) In the parameters box, set the grid size to 1000 metres (1km) and output the grid as lines. This is also really helpful when you look at the hillshade alongside an Ordnance Survey map, as the grids will match exactly!

4) Name your output shapefile (within the vector data folder of your project), and select Open outfile after running algorithm.

We now have our massive hill-shade file split into manageable chunks. Spend the next hour searching away on this hillshade file and see what you can find. I would recommend looking at the area around Nether Hesleden (use the aerial image from Bing to find this village) – as there's a known Romano British settlement marked on the Ordnance Survey. See if you can trace the extents of the field system. It's very different from the larger, more pronounced medieval ridge and furrow.

10.3. De-Trending (With many, many thanks to Dr. Crispin Hambridge)

When you've finished, you might have noticed that the areas of the map with extremes of relief are difficult to search.
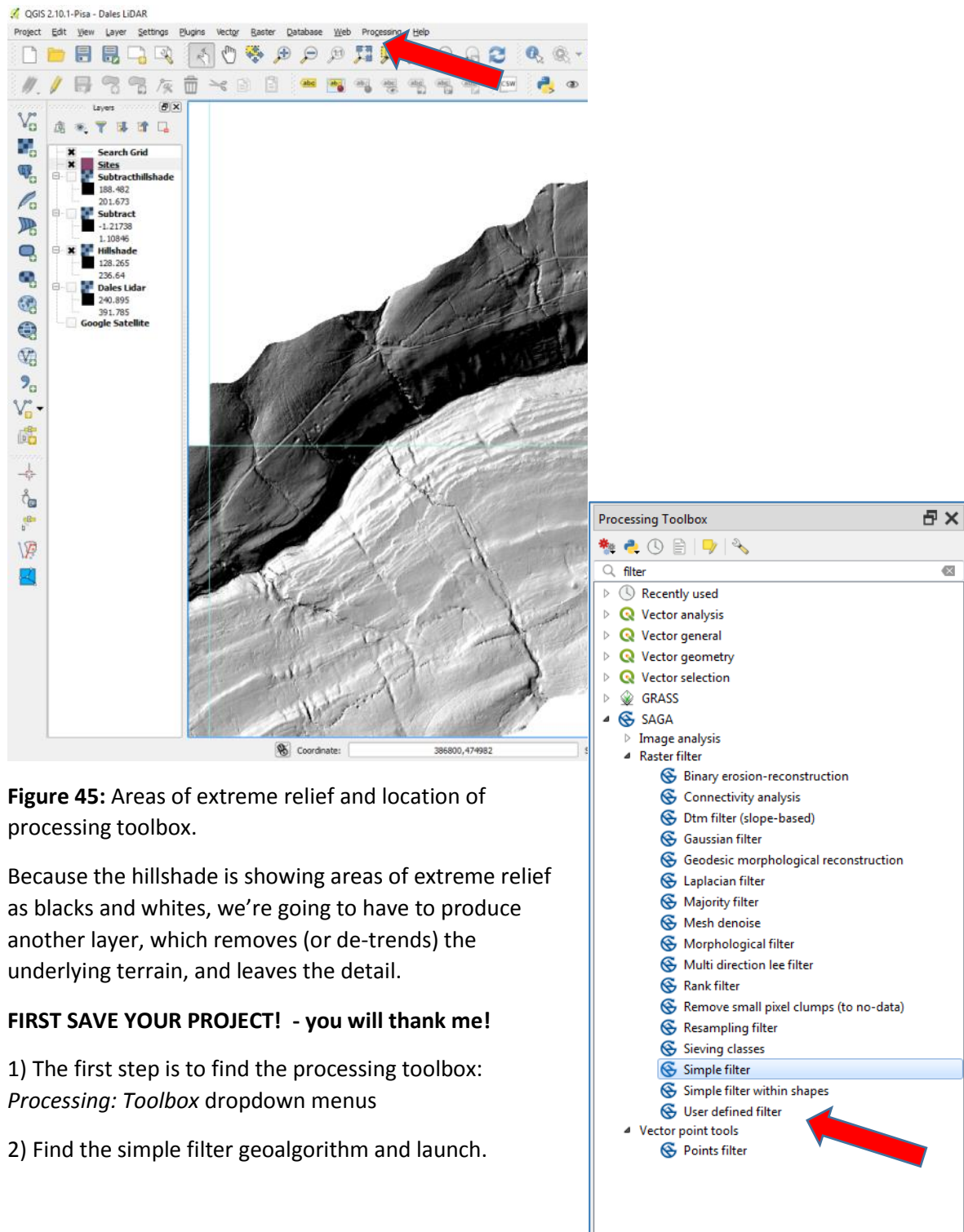
Figure 45: Areas of extreme relief and location of processing toolbox.

Because the hillshade is showing areas of extreme relief as blacks and whites, we're going to have to produce another layer, which removes (or de-trends) the underlying terrain, and leaves the detail.

FIRST SAVE YOUR PROJECT! - you will thank me!

1) The first step is to find the processing toolbox: *Processing: Toolbox* dropdown menus

2) Find the simple filter geoalgorithm and launch.

The interface looks like this:
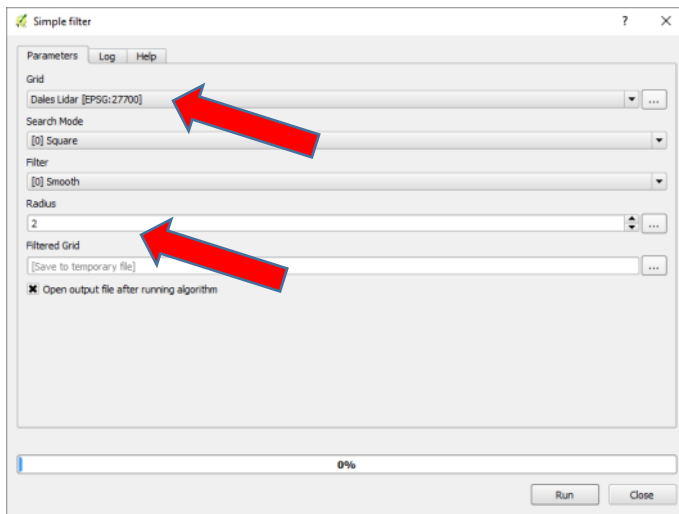
Figure 47: Simple filter geoalgorithm

3) Ensure the Lidar data layer is setfiltered grid
4) ected. Keep *Search Mode* and *Filter* set to [0] Square and [0] Smooth respectively.

4) Set the Radius to 25 (for 1m datasets – 12 for 0.5m and 6 for 0.25m)

5) Save the filtered grid to a file in your project folder and check open output file in the checkbox.

6) Press *Run*

> **NOTE** My version of QGIS throws error: 127 in the Log window, but the algorithm appears to work just fine without the dll which is apparently missing.

7) After filter process has been completed, there should be a new layer in your layer menu called *Filtered Grid*.   If it fails, then check the folder…   you will have to open up the project again.. and load the **filteredGrid file**

8) Next, go to Raster: Raster Calculator

Figure 46: Processing toolbox
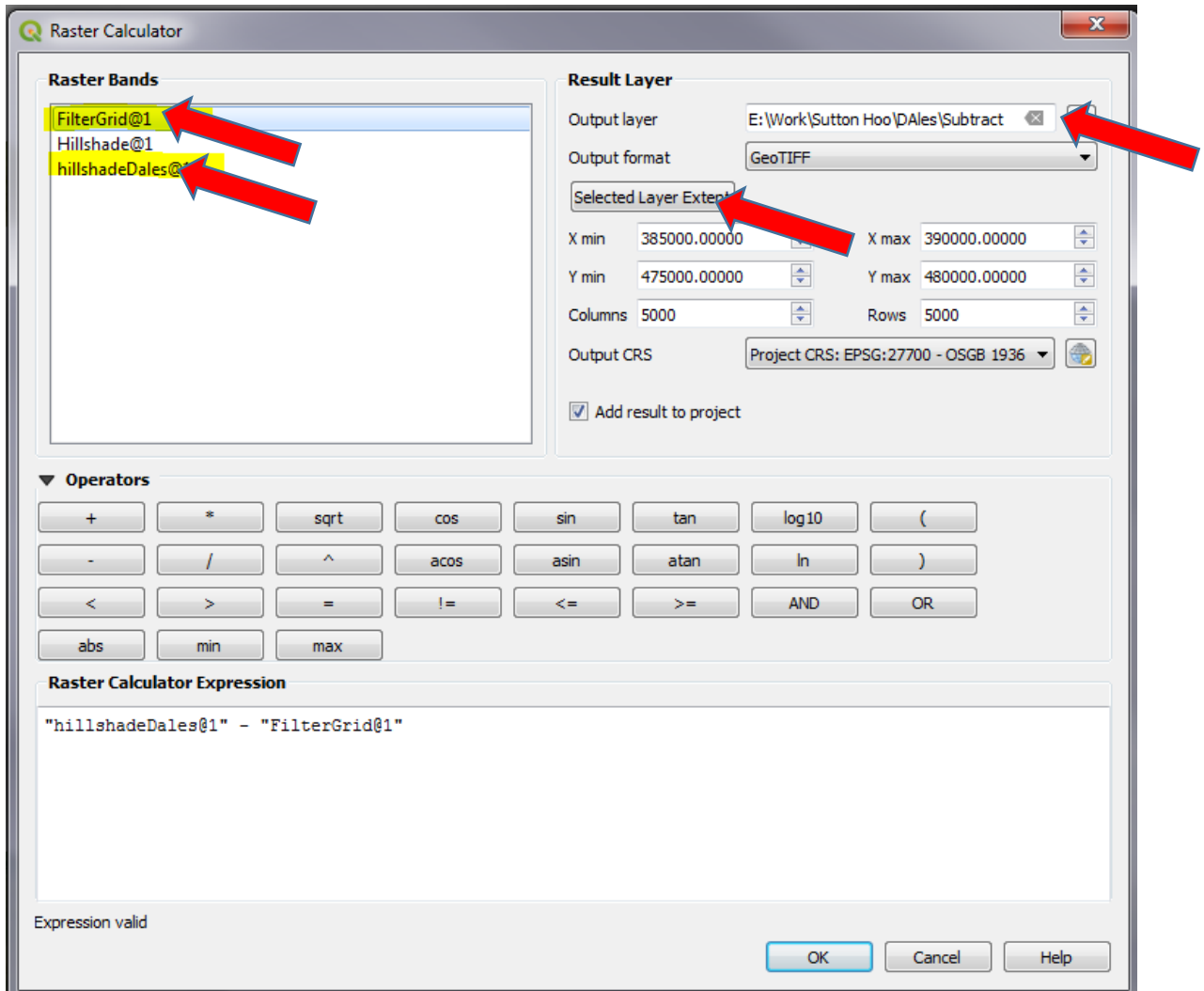
Figure 48: Raster Calculator

1) Name your output layer (click on the ". . ." button) we called ours "Subtract"

2) Now make sure the output CRS is set to OSGB36 [27700]

3) Click *Current Layer Extent* to update the extents of the output layer

4) Make sure Add Result to Project is checked.

5) In the Raster Calculator Expression box, add this you can double click on the layers you need rather than having to write it manually :

"hillshadeDales @1" – "Filtered Grid@1" (ie the original <u>dem</u> minus the <u>filtered grid</u> layer)

6) Press ok, sit back and wait for the process to run.

7) When the *Subtract* layer is loaded give it a spin around and have a look. The DEM is already a lot more detailed. Have a look at this:
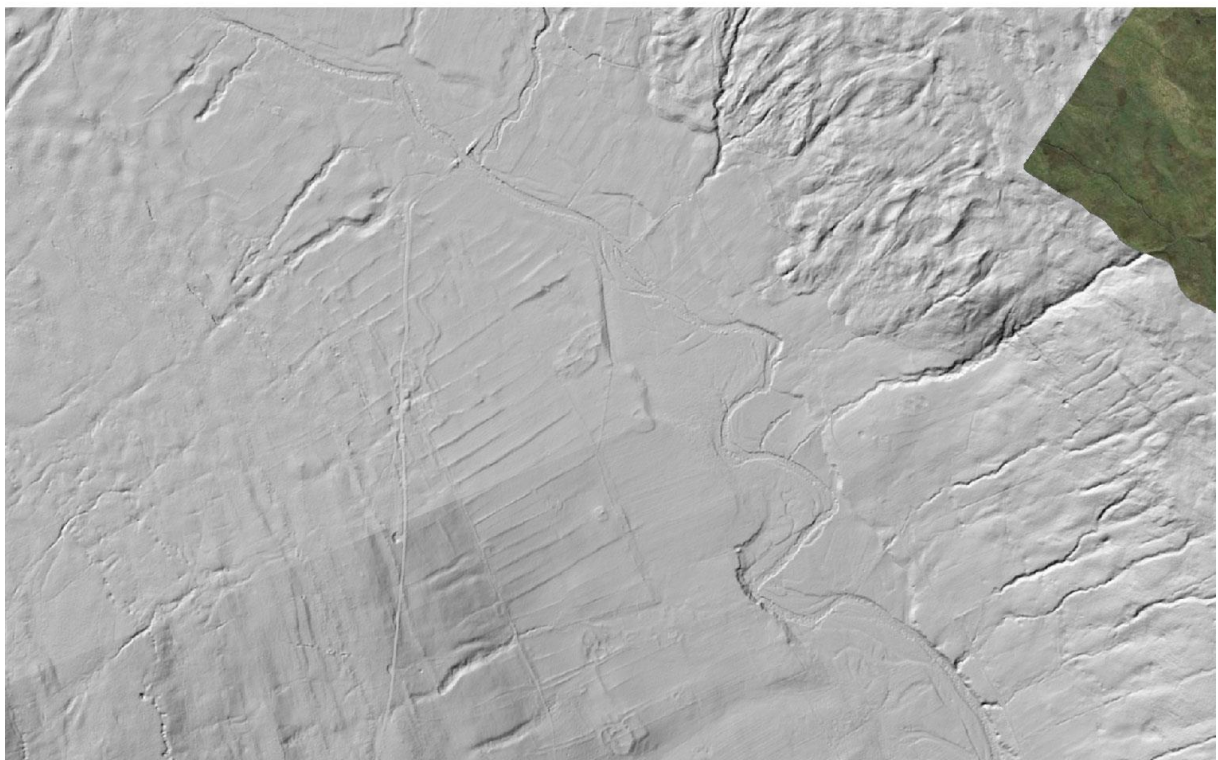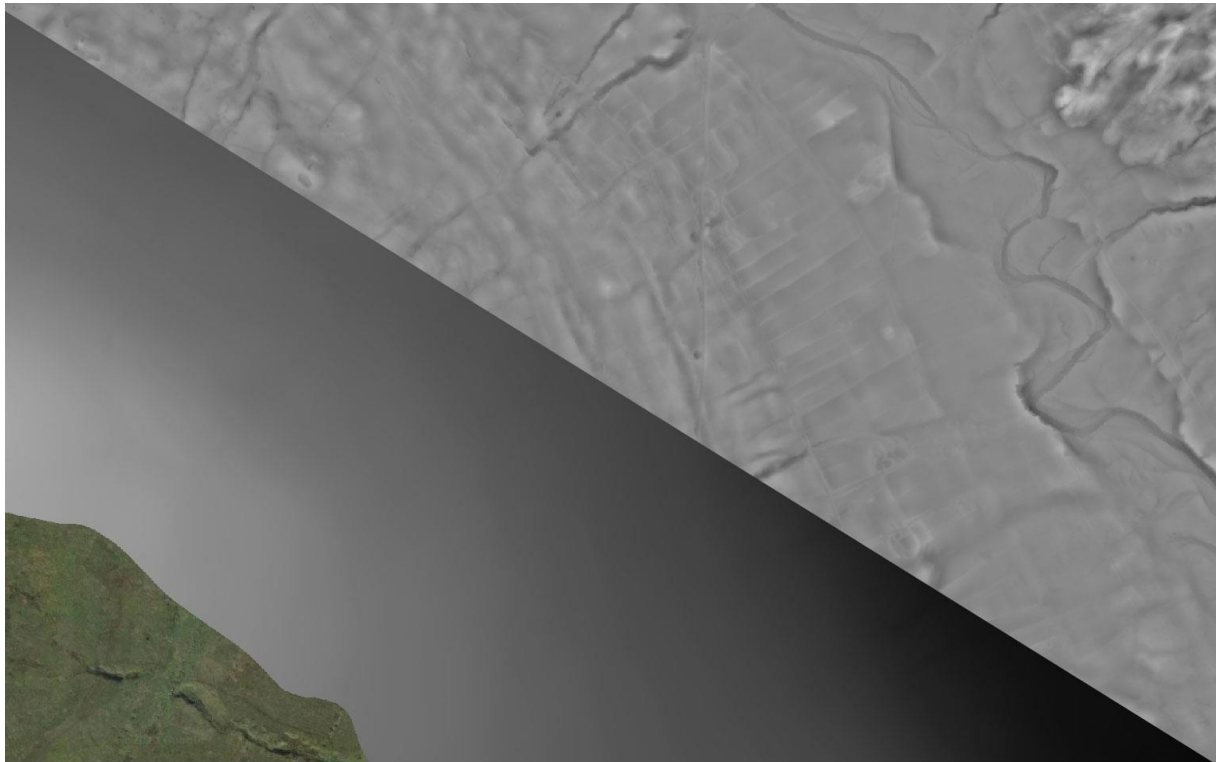
Figure 49: Top: Original Dem / New Shaded DEM So the de-trended DEM is on the top right hand side, and the original DEM is on the bottom left hand side. Much more detail is visible. This is the Romano British settlement at Nether Hesleden.

 Below -   Hillshaded version from New Shaded DEM / Original Dem note how the hills have smotthed out, but the fine detail is more pronounced

So to recap, we've created a filtered version of the DEM, smoothing it out and removing all the detail. We've then subtracted the filtered version from the original DEM, which removes the large features like hills and valleys, and leaves the detail.

So now, if you create a hillshade from the de-trended DEM, more detail should be visible in areas of extreme relief.

Try other commands

Why not also try the contour command from the Raster >> Extraction >> Contour
Using a 1m contour interval
Or add the Viewshed Plugin from the Plugin manager and watch this video

https://www.youtube.com/watch?v=NImNMWSswjA   There are many video and text tutorials for all the functions you may need while using QGIS – *Google is your friend*.

11.   Getting your Message Across – The Map Composer

Let's go back and open the initial project that had the counties and anti landing trenches

1) In the **PROJECT MENU**, create a **new print composer** and call it *Anti-Landing Trench Distribution*.

The Print Composer Window looks like this:
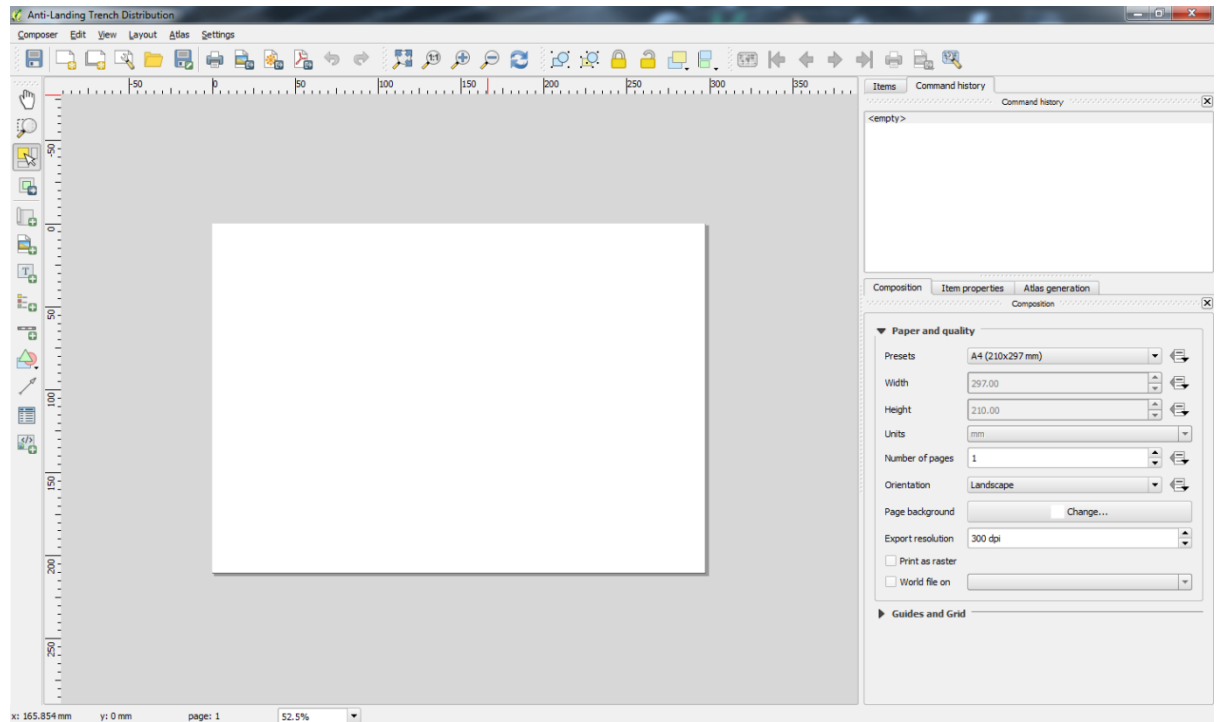
Figure 50: Print Composer Window

There are several tools along the left-hand edge of the window, these allow you to insert and modify objects in the print composer.

The print composer always starts with a blank canvas, so we'll have to add some objects to start creating our illustration. First though, lets' adjust the canvas to suit our needs. We're going to create a map of the United Kingdom. It's pretty tall and thin, which means the best canvas orientation will be portrait.

2) On the drop-down menu, select **Composer** and then **Page Setup**…

3) Set the orientation to *Portrait* and then exit the menu.

4) Nothing has happened – Don't panic
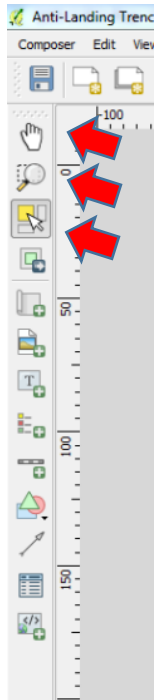
On the **right hand side** of the screen, you should see a number of tabbed menus. One is called *Composition*. In the paper and quality settings, choose *Portrait* and the canvas should change its orientation.

Now we're ready to add some objects to make our map.

So, the tools down the left hand side will allow you to **add** and **modify** objects appearing on your **map canvas**. The **modify tools are the three at the top** – Pan, Zoom, Select/Move Item and Select/Move item content.

The add tools are further down below.

Select the fifth tool down – if you hover over it with the mouse it should say *Add New Map*

Figure 51: Composer Tools

11.1.   *Adding the map*

Add the new map by clicking in the top left-hand corner of the canvas, and dragging down to the bottom right-hand corner – press enter and the map should now appear on the canvas.
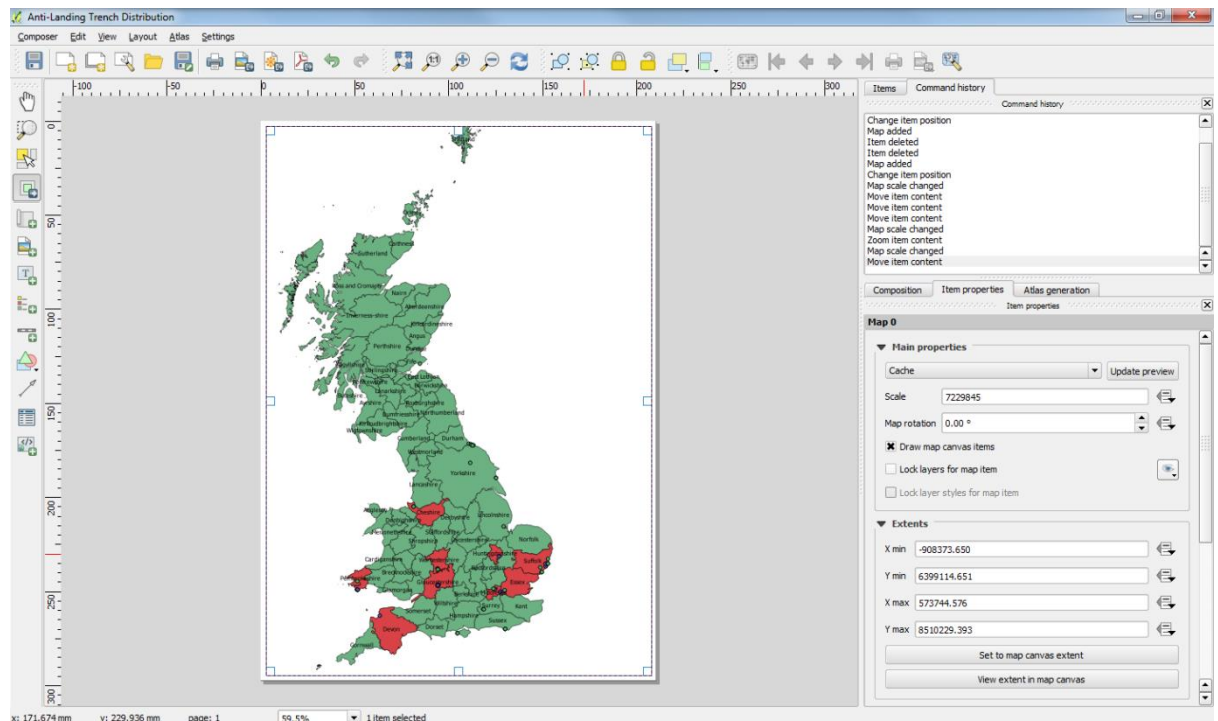
Figure 52: The map is shown on the canvas

Now for the modify tools

The first two allow you to change which part of the canvas you're looking at.

Select/Move Item allows you to select and move objects on the canvas

Select/Move Item content allows you to move the actual information within the object – for instance panning to another part of the map.

Let's give it a go – make sure your map is centred within the canvas – use the **Select/Move Item tool** and click-drag the map until you see two red lines at crossing the centre of the canvas at 90 degrees – this indicates the object is centred.

The next thing to do is to change the scale at which the map is being rendered on the canvas. With the map object selected, click on the **Item Properties** tab on the right-hand side of the screen. See the scale? At the moment it reads somewhere around 7229845.

1:7,229,845 isn't a very helpful scale, so let's change it to something slightly more manageable… let's try 1:5,000,000
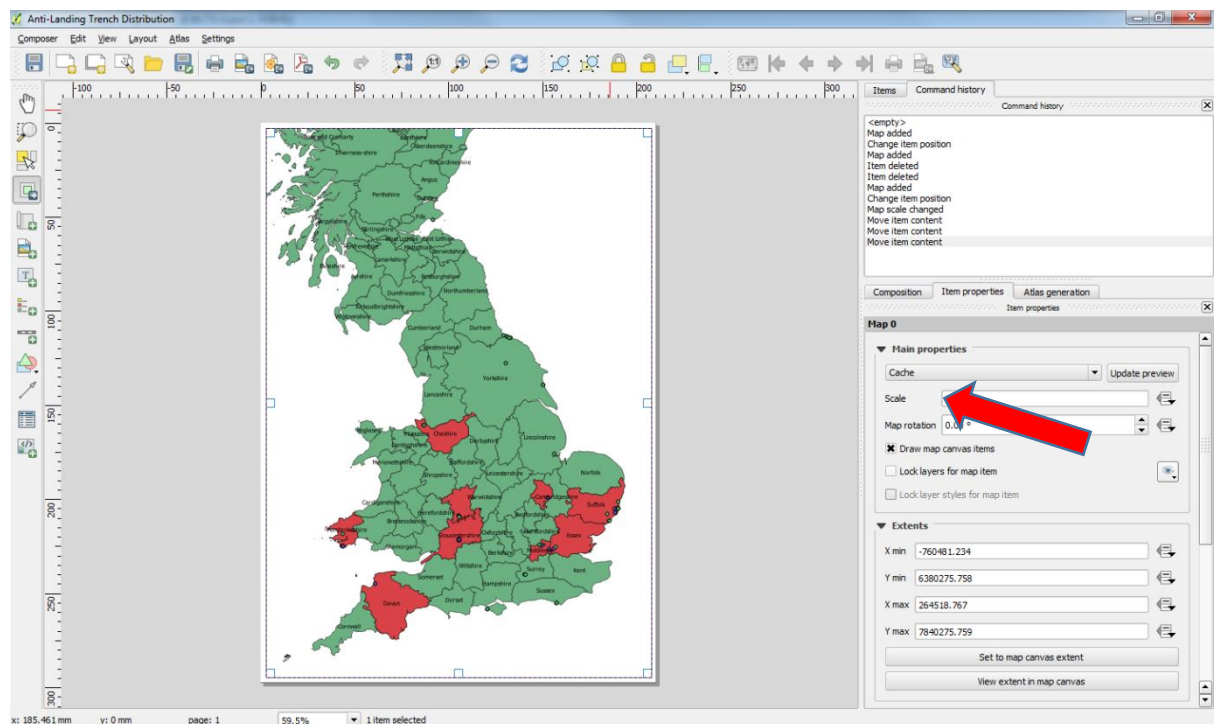
Figure 53: The 1:5,000,000 scale on the centred map

Ok, that's a little too zoomed in, let's try 1:6,000,000 – now we

Now use the **Select/Move Item content** tool to move the content of the map until the whole of the mainland is displayed on the canvas.

Now you've finished modifying the map, select the closed padlock icon from the top toolbar to lock it up. This will prevent any accidental changes being made while you continue working on your map.

It's a good idea to keep objects you're not working on locked up, and saving the composer every time you finish working on an object.
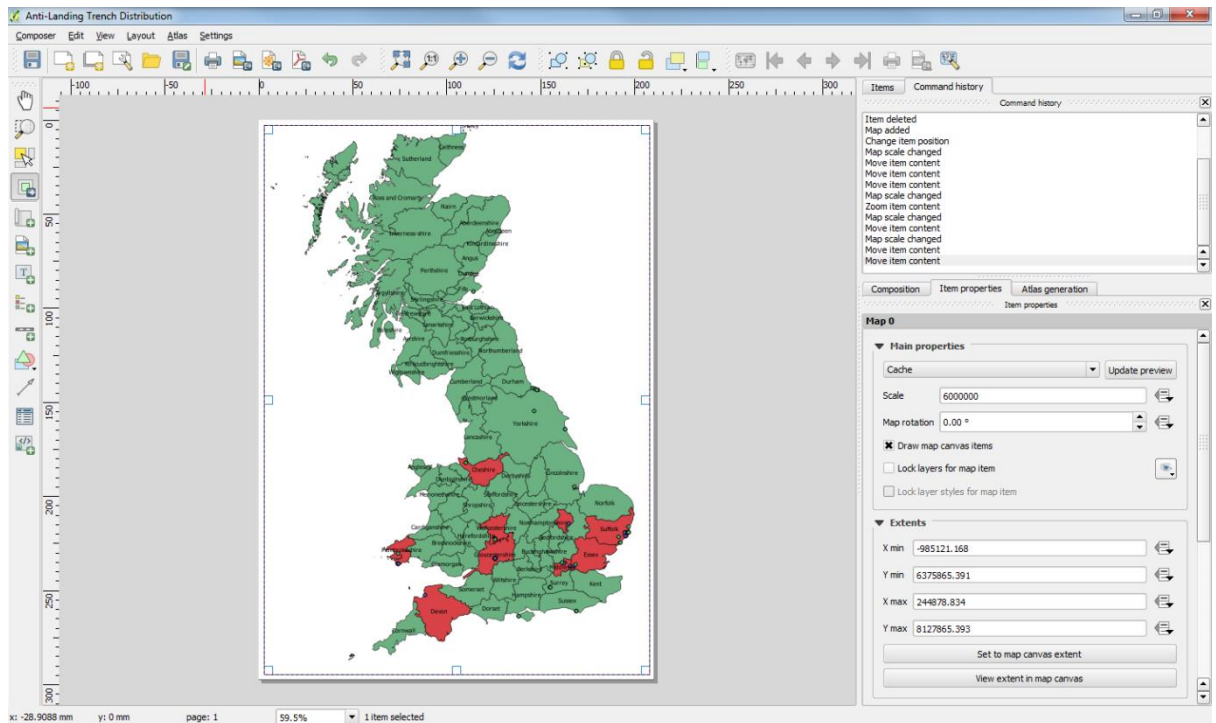
Figure 54: 1:6,000,000 map

We now have a map showing the distribution of Anti-Landing Trenches across the UK mainland, and counties in which Anti-Landing Trenches are preserved.

However, if someone was coming cold to this map –they wouldn't have a clue what it was about.
To sort that out, let's add some more map objects and make our data more accessible.

11.2.   *Adding a scalebar*

First, let's add a scale to the map. The **add scale** tool is on the left hand side of the screen.
As a default, the scale will have four large sections to the right of zero and two small sections to the left.
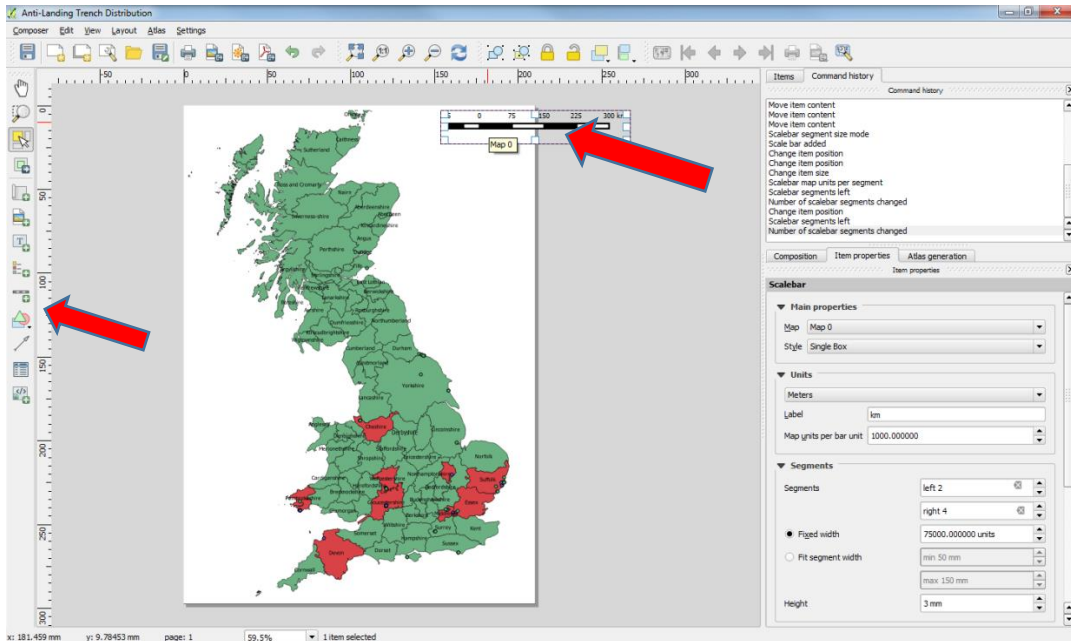
Figure 55: Adding the scalebar

You can modify this in the tabbed menus on the right hand side of the screen – with the new scalebar selected, go to **Item Properties.**

The number of segments on the bar makes it a little unwieldy, and we want to avoid objects on the map clashing with each other, so let's reduce this to two sections to the right of zero, and change the fixed width to 100,000 units (1 unit = 1 metre (which is the default value for the OSGB36 coordinate reference system) so 100,000 units = 100 kilometres).

With the scale bar resized, move it to a corner of the map where it won't clash with the land – look out for the red lines to make sure the box is properly lined-up with the edges of the map canvas.

Figure 56: Scale Bar Added and modified
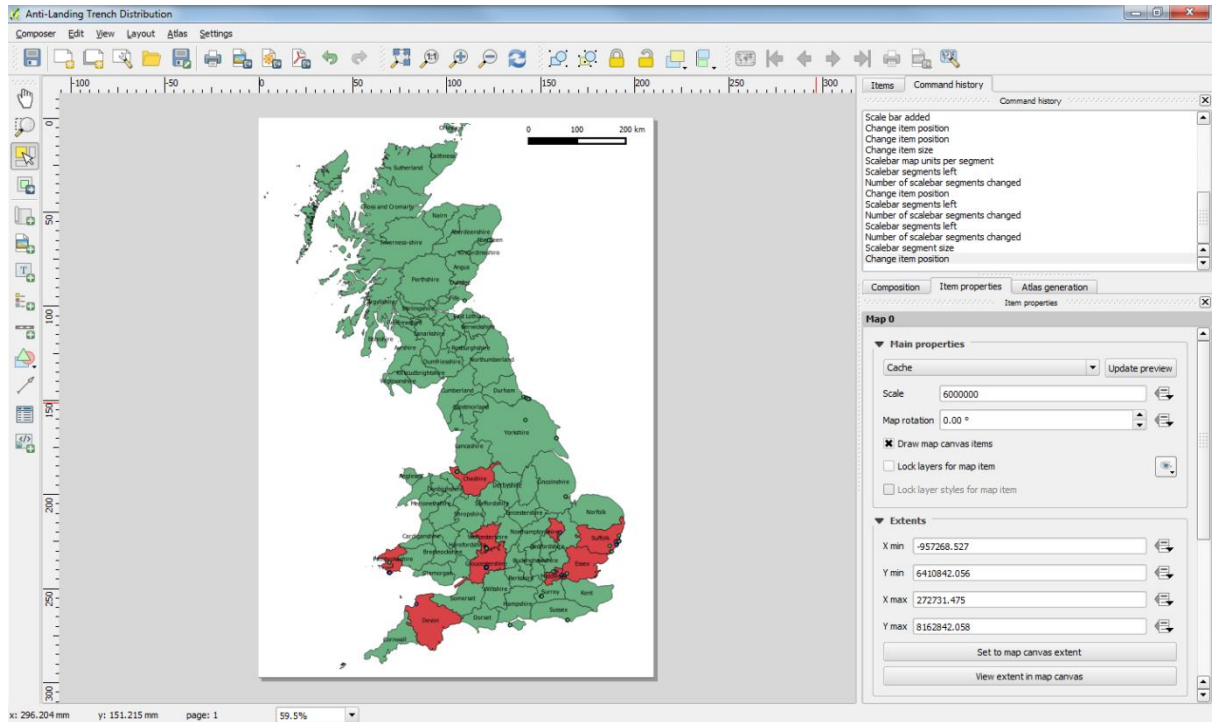
11.3.   Add a Legend / Key

Now let's add a Legend to our map, showing the meaning of the different objects and layers.

The **ADD LEGEND TOOL** is on the left hand side of the screen above the add scale tool.

Click-drag the new legend into place (tip: if you hold down the *shift* key, while clicking and dragging, any object you're adding to the canvas will stay as a regular square).
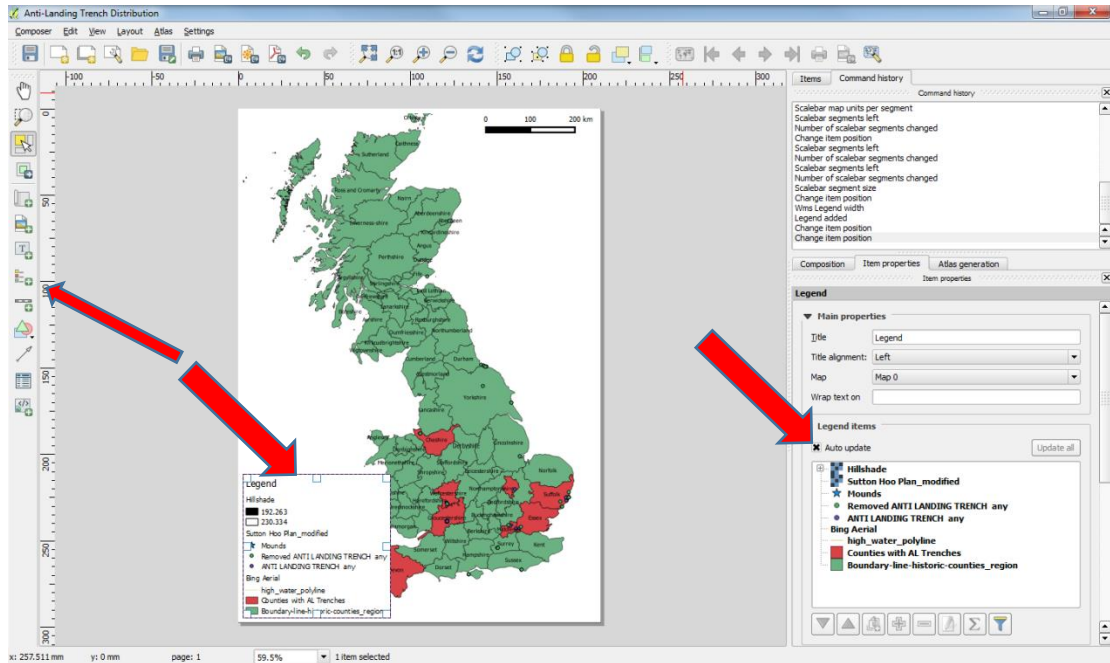
Figure 57: Legend Added

There are now a lot of items in the key which aren't being displayed in the current map view. This is because the list of items in the key is being generated automatically from the layers list of your project. To make things tidier and clearer, let's get rid of some of the layers from the key.

In the **Item Properties** tab there is a box called *Legend Items*, find the check-box marked *Auto update* and uncheck it. You can now change which items appear in the key, and also the order in which they appear, and their titles. The buttons under the legend items box control how the key headings are displayed. The blue arrow buttons control the display order and the **plus** and **minus signs** allow you to add and delete layers from the key.

Get rid of everything except the two anti-landing trench layers, and the two historic county layers.
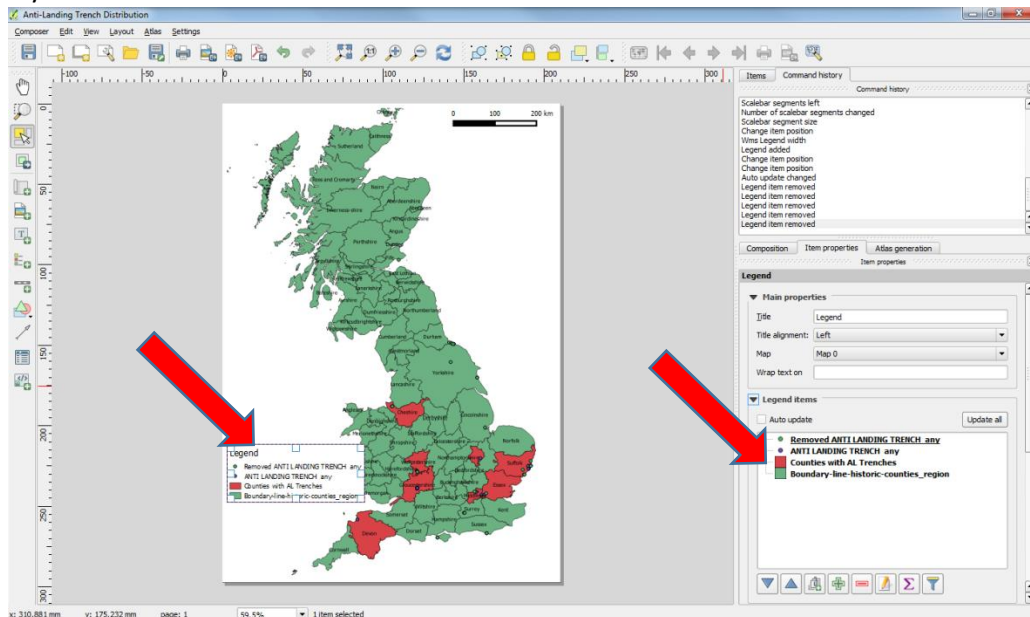
Figure 58: The selected layers on the legend.

The key is shorter, but the headings within the key still don't appear to make much sense. Let's modify the headings. From the buttons below the *Legend Items* box, select the **Pencil/Paper icon** and rename each layer so it represents the layer clearly and concisely.
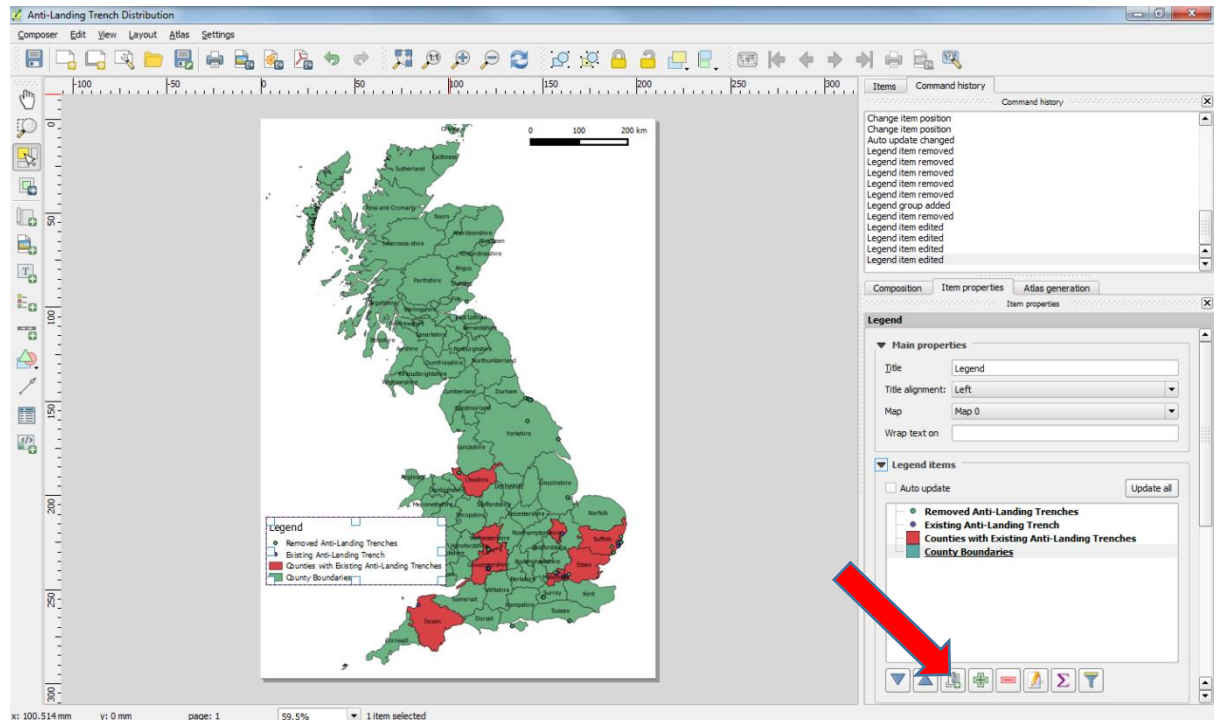
Figure 59: the Legend/Key with renamed layers

Move the key so the box isn't clashing with the map. You can make this easier by changing the transparency of the legend bounding box – In the *Item **Properties*** tab, scroll down to a check-box named *Background* and un-check it. Any clashes between the map and the legend background should now disappear.

11.4.   *North Arrow and Title*

Ok, north arrows are really important for site-plans, so let's add one of those as well.

Select the arrow tool from the left-hand menu and add it by clicking and dragging (tip: if you hold the shift key while click-dragging the arrow tool, the arrow will default to 45 or 90 degrees (across, up and down, or diagonally across the page).

To add a title to the illustration – use the add text tool and click-drag a box in the bottom right-hand corner of the canvas.

The text for your title can be typed into the *Main Properties* in the *Item Properties* tab. Below the text-box, you can control the font, alignment and
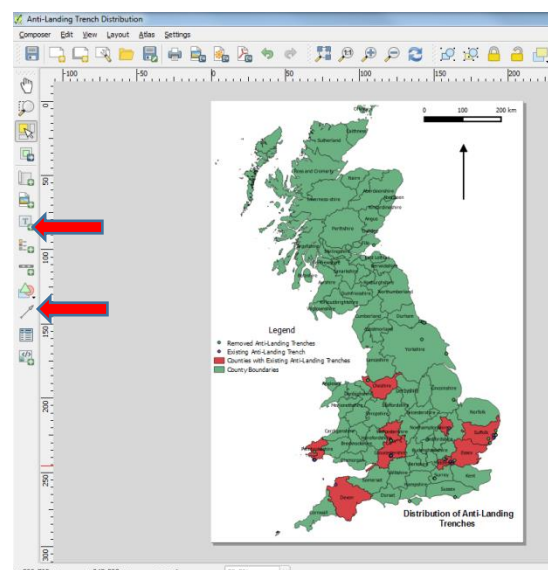
margin size for your title text. In this case it is Arial, size 16 and bold.
Figure 60: North Arrow and Title added

We have just created a map, that we can now export to a file and include in a report.

In the top toolbar, there are a number of options for exporting maps. You can choose to export as an image file, a scaled vector graphic or a pdf. I would recommend pdf, as it's accepted and readable by everyone, and there won't be issues with scaling and re-sizing images further down the line. Choose the .pdf icon, and a file-name for your new pdf.

You can also import this into vector programmes like Corel or Illustrator and work on it further.
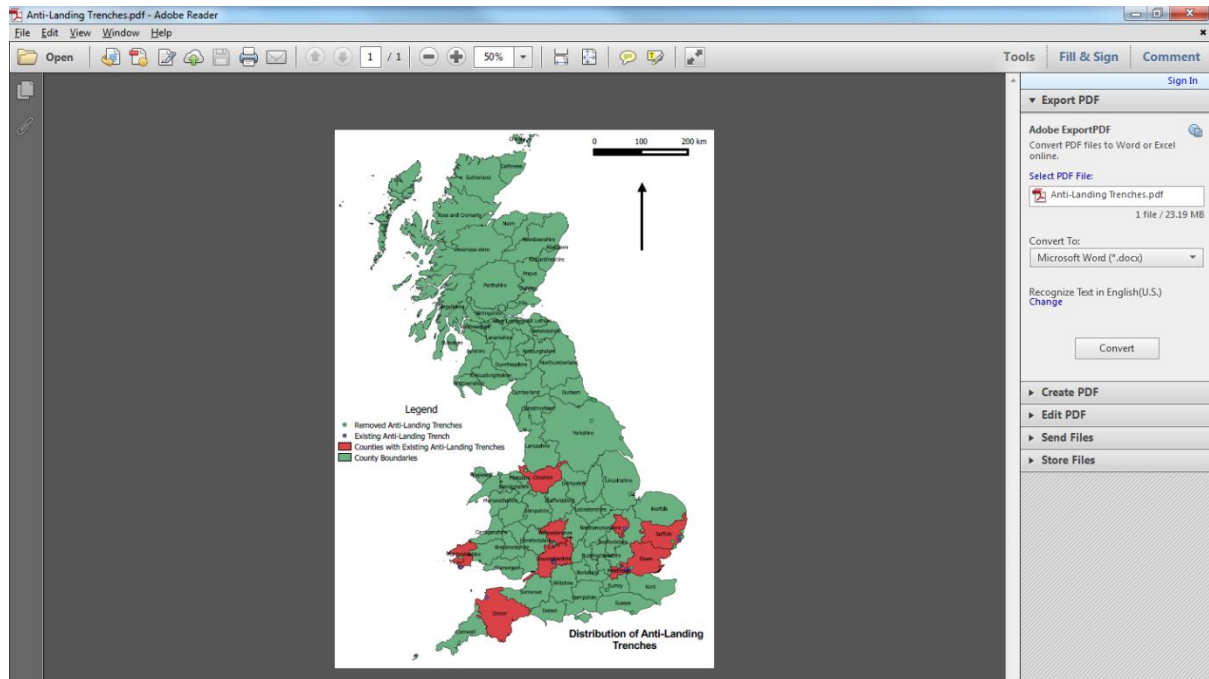
Figure 61 - Finished

12.   Exercise – Forgandenny Community Archaeology Project

This project uses a __hypothetical__ community archaeology project as the basis for creating, analysing and sharing data from small scale archaeological projects in QGIS.

The scope of the project will take us through the following steps;

1. Combining spreadsheets and spatial data, making stake-out files
2. Digitising data from records and plans
3. Uploading data to a friendly HER

The **Strathearn Archaeology Group** (SAG) has identified a number of cropmarks in fields below Forgandenny, next to the River Earn. You are their volunteer Geomatics Officer, feeling the awesome responsibility now placed on you. This area is known to have been significant in the Mesolithic and Neolithic periods, as there are a number of raised shore-lines left behind as the sea-level fell after the last glacial maximum.

The shoreline is even visible on Google Earth in a field with coordinates NO 0890 1929 in the south eastern corner. SAG have checked with the landowner for permission to undertake fieldwalking before the new crop is sown.

They find 50 artefacts during their fieldwalking, all have a unique ID from 1 to 50. ID, material type and a provisional date have been recorded in a spreadsheet. Grid references have been recorded in OSGB coordinates on a hand-held GPS, with accuracy +- 3m… The spatial data has been downloaded and converted to a simple shapefile.

SAG would like you to help analyse their data. They're very excited because a concentration of Neolithic flint has been recovered from the centre of the field. Their goal is to put together an application for a lottery funded project which will involve the community excavating a trial trench across the flint scatter.

Make sure you have the Forgandenny Fieldwalking Data: (it includes completed files as well as the NO grid square data) **http://www.bajr.org/BAJRGuides/42_QGIS_StarterGuide/Forgandenny.rar**

The **Forgandenny Fieldwalking.qgs** is a completed version… so you can see the end result.

12.1.   Starting Out

Let us first assemble our available data, download the fieldwalking spreadsheet and shapefile, as well as some **Open Map** layers from the **OS Opendata website** **https://www.ordnancesurvey.co.uk/opendatadownload/products.html** – grid square **NO**.

While waiting; Create a **project folder**, with a **vector data** sub-folder and a **spreadsheet** sub folder. Once download is finished, create a new QGIS project and place everything in the appropriate folders.   Now add Railway tracks, Roads, Woodland, Surface Water, Surface Water Area, Tidal Water and Building from the OS data folder.

With the background mapping restyled (use the **symbology** tab in the **properties** of the layer) appropriately (play with the styles) , The GPS Survey layer should also be visible it should look something like this:
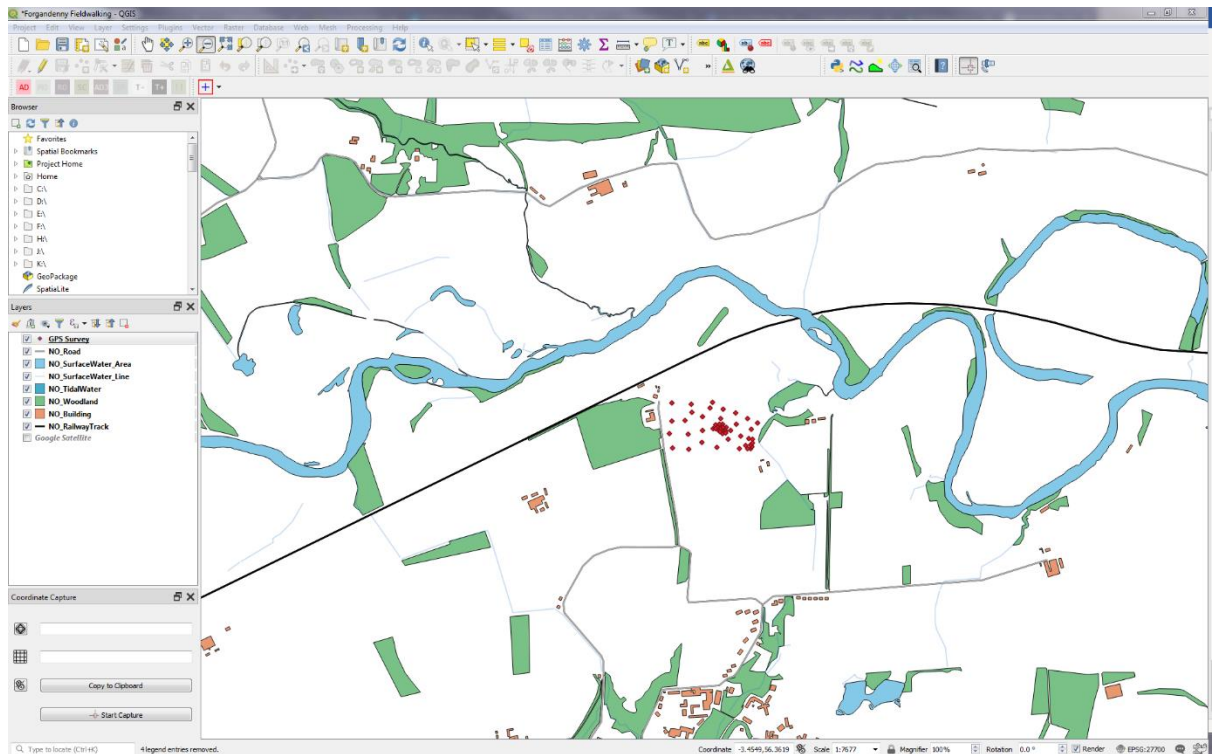
Figure 62 The First Map

So, only points are visible, if you go into the **attributes** table of the GPS Survey layer (right click and choose attributes), there is no **meta-data**, such as material type or date; only the ID field so the concentration could be misleading.

Figure 63: GPS Survey Attribute Table

Next step is to add the spreadsheet as a delineated text file. Save the spreadsheet as a **.csv** and then load it up – just like the smaller .csv file for the mounds at Sutton Hoo
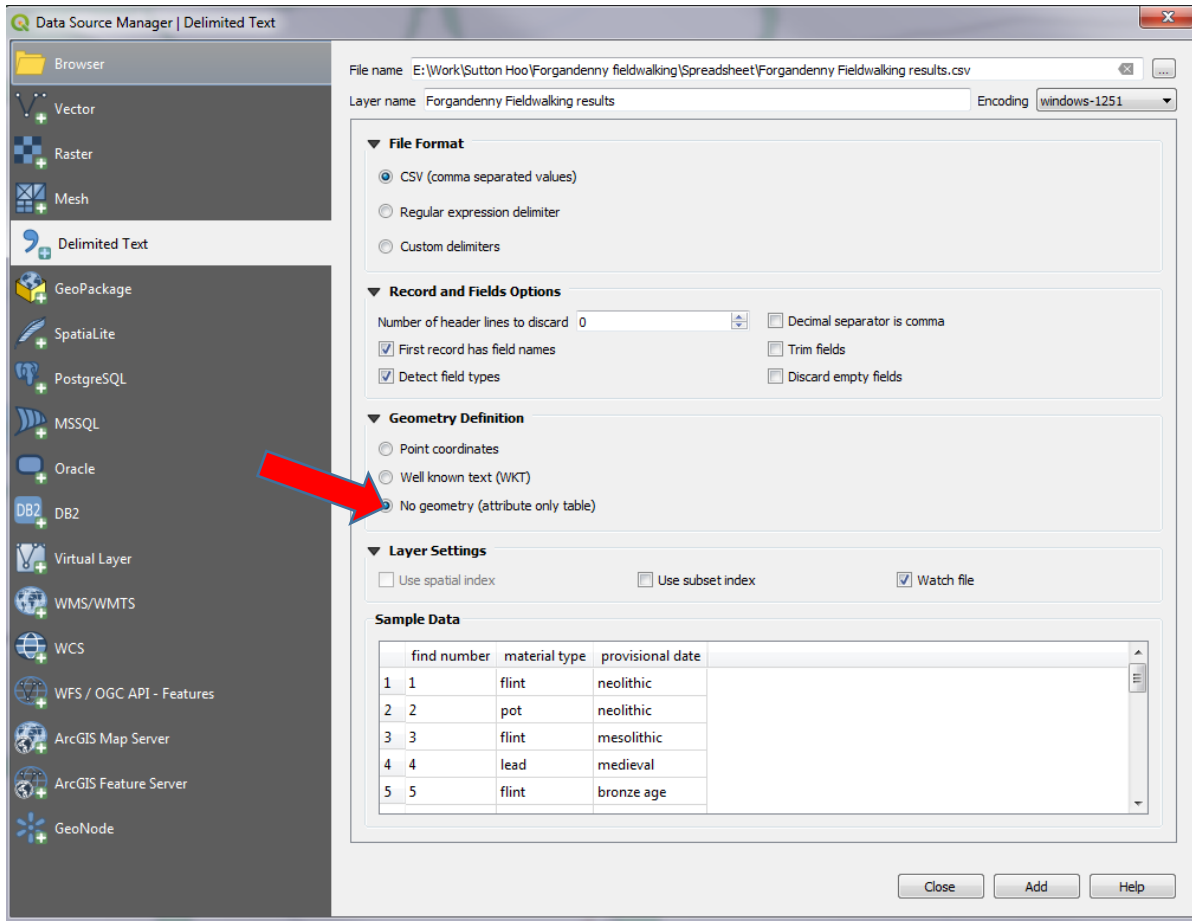
Figure 64: The csv file with find number, type and date – but no locational data

Make sure that the geometry definition is set to *No Geometry as* there is NO spatial data in the spreadsheet. Click **ADD then Close**

Now select GPS Survey Layer (Right Click) >> Properties: >> Joins

Click the green + sign to add a new join.   Make the join layer *Forgandenny Fieldwalking results*.

Make the join field *find number.*   Make the target field *ID*

Check custom field name prefix and delete the text in the box below and press *OK then OK*
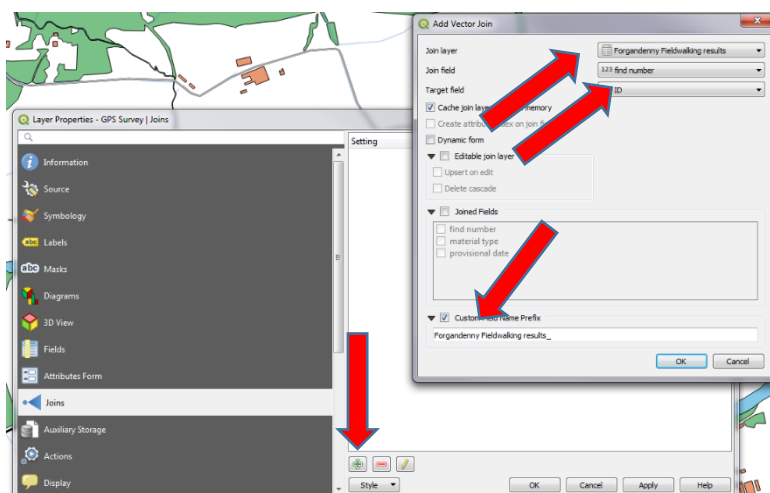
Figure 65: The joins window.

Forgandenny Fieldwalking Results should now be joined to the GPS Survey layer.

You can now characterise the fieldwalking finds by date and material type, and end up with a map like this.

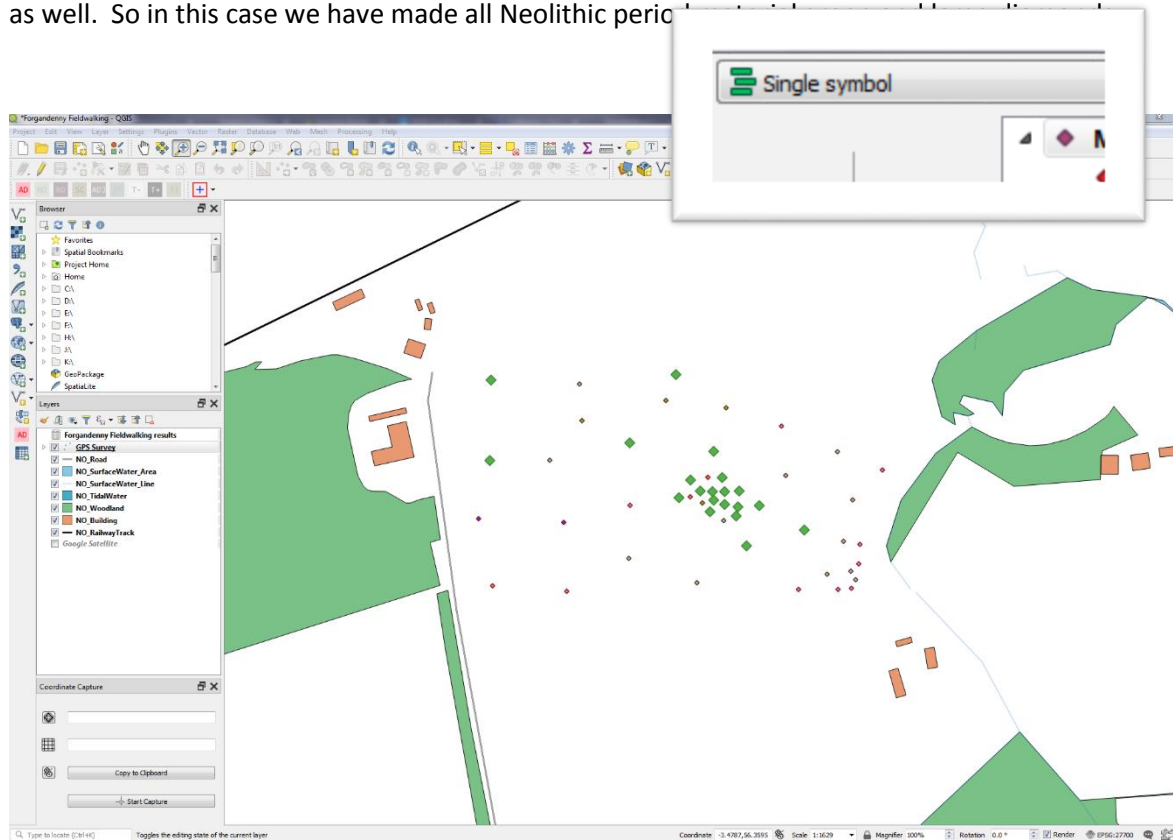Explore the Symbology tab of the layer properties for <u>GPS Survey</u> to get different colours depending on dates. - Click Categorised , then Value = Forgandenny Fieldwalking results_provisional date then the Classify button (you can play with colours and sizes if you want as well. So in this case we have made all Neolithic period material recovered by radion and re-

Figure 66: In the Layer Properties symbology, click the top left Single symbol, and change to Categorised to create the Final characterised map

That Neolithic flint scatter looks a fairly convincing target now! You now have put together a figure for the fieldwalking report which will be submitted to the funding body, remember all the important stuff like the key, north arrow, scale and location map!

Print it out on paper – How does it look?

12.2. *Locating the site on GIS and then into the field (STAKING OUT)*

Great news! SAG has been given funding to undertake a reconnaissance excavation involving the excavation of a 100 metre trial trench across the flint scatter and the old Mesolithic shoreline. The project will be undertaken by members of SAG supported by a team from the local commercial unit, Badger Archaeology Group Ltd (BAG), who are giving a week of their time as a CPD building exercise!
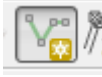
Badger Archaeology Group have a survey grade GPS unit available to set out the trench, but can only spare it for one day meaning that you can stake out the trench in the right place, and record the limits of excavation once the machining is finished. Thereafter, the recording will rely on producing hand-drawn plans, which you will then digitise and place onto the GIS map.

In addition the BAG health and safety officer has been in contact to say that the electricity distributor confirmed it is safe to excavate under the overhead power lines crossing the site, as they are redundant.

Let's set up a stakeout file for BAG's Project Officer, so she can excavate the trench in the right place.

Add two new vector layers to the project, One set to LINE, and called **StakeOutLine**, and one set to POINT, and called **StakeOutPoint**,   making sure the layer CRS is set to OSGB36 27700

Click Edit the **StakeOutLine** layer (the pencil symbol   ) then New Line

Click the Advanced Digitising Toolbar (see Below (Figure 67) – If it is not visible, Right Click the Menu Bar and add it), Click on the map screen to start the line now type 100 into the d box and hit ENTER – this means that you have a line that will be 100m long, and you can now choose angle for the end click the end NOW - Right click and you have a single line 100 m long

Make sure it is bisecting the scatter of Neolithic material and the old shore line – to the north west.!   (Figure 68)
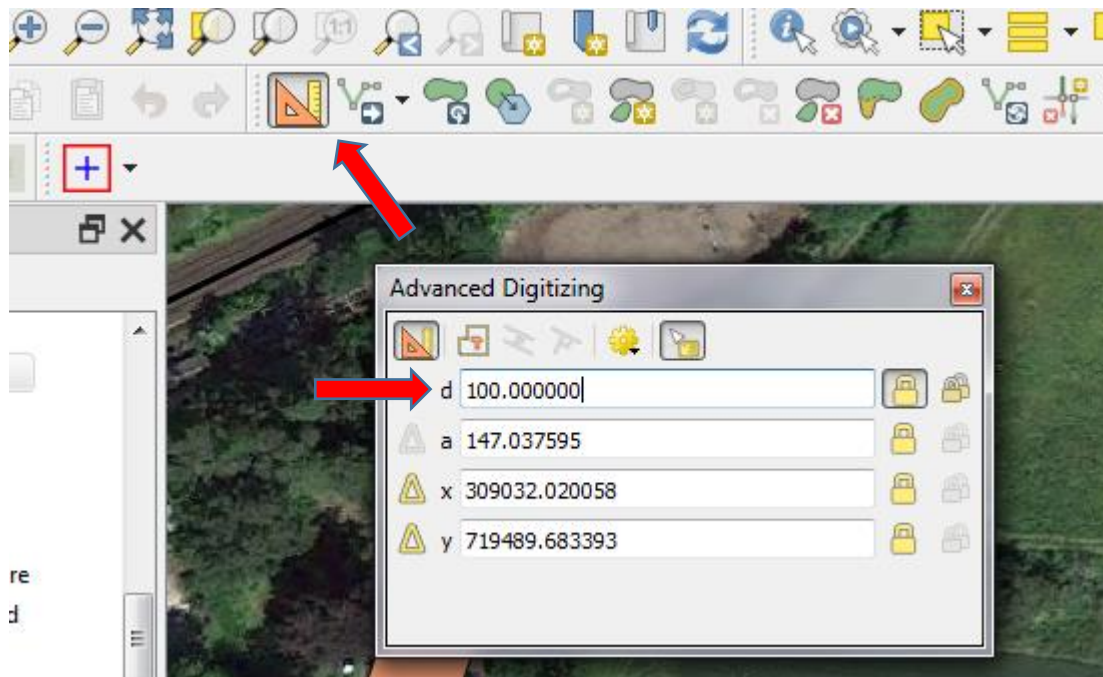
Figure 67: Use the Advanced Digitiser to create a 100m measured line

Now click the *StakeOut*Point layer and open the **editing** mode (the pencil symbol) - zoom into each end of the line and add POINTS to both ends of the line.
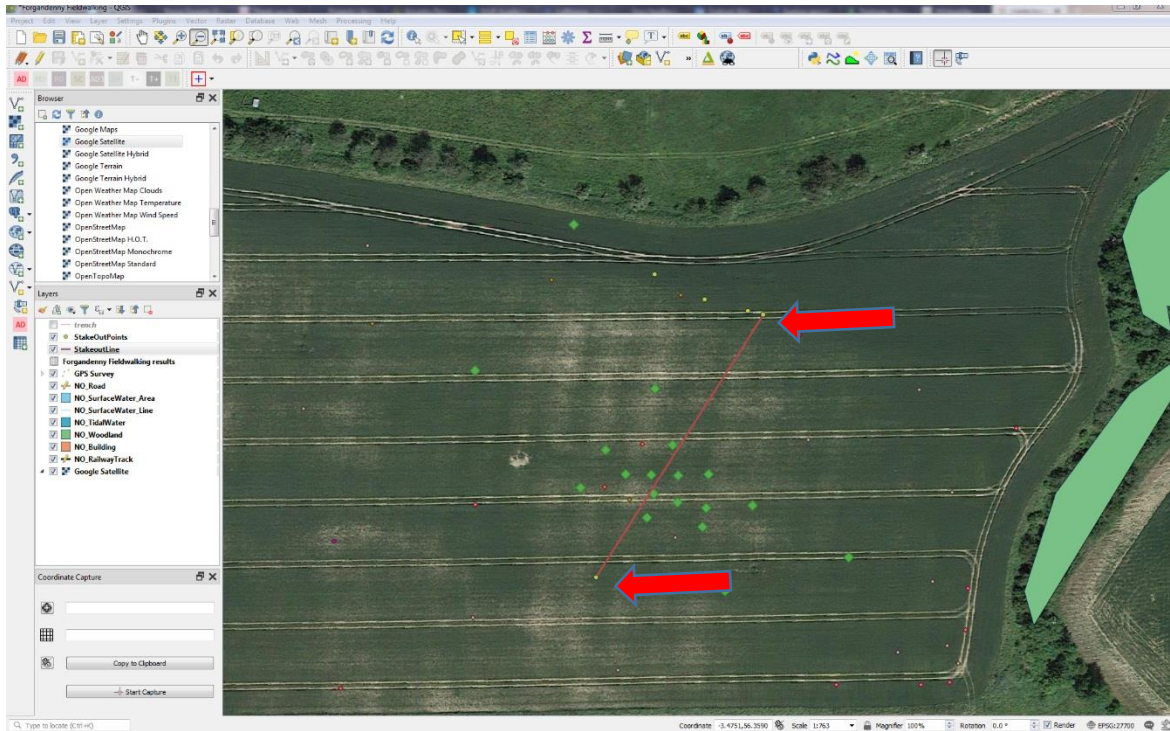
Figure 68: The 100m measure line with points added at either end.

Now we can save the layer as a .gpx so it can be loaded into BAG's GPS…

Right click on the StakeOutPOINTS layer in the layer menu, and find *Export As…* make sure it's in OSGB36 [27700] and then save. And choose Format of GPS eXchange Format (**gpx**)

You can now go to these exact coordinates in the field (even with a handheld device) and locate either end, before laying out the trenches and recording the trench corners.   Looad them onto your mobile device or GPS device.

12.3.   Digitising Plans

After a joint effort by SAG and BAG, you've uncovered a fantastic series of Neolithic features which may be associated with the old shoreline.

Three features are listed on the context register, which records the ID, context number, brief interpretation, dimensions and a spot date

We also have a site plan (looks a little rushed and sketchy) which has been drawn @1:100

Let's start by georeferencing the site plan.

The limits of excavation of the original trench, as well as a modest extension to the west have been recorded with the GPS kit and converted to a shapefile called *trench*

The site plan is saved as a jpeg called Site Plan

Use the georeferencer tool in the raster menu to georeferenced the site plan.

It should now look something like this:
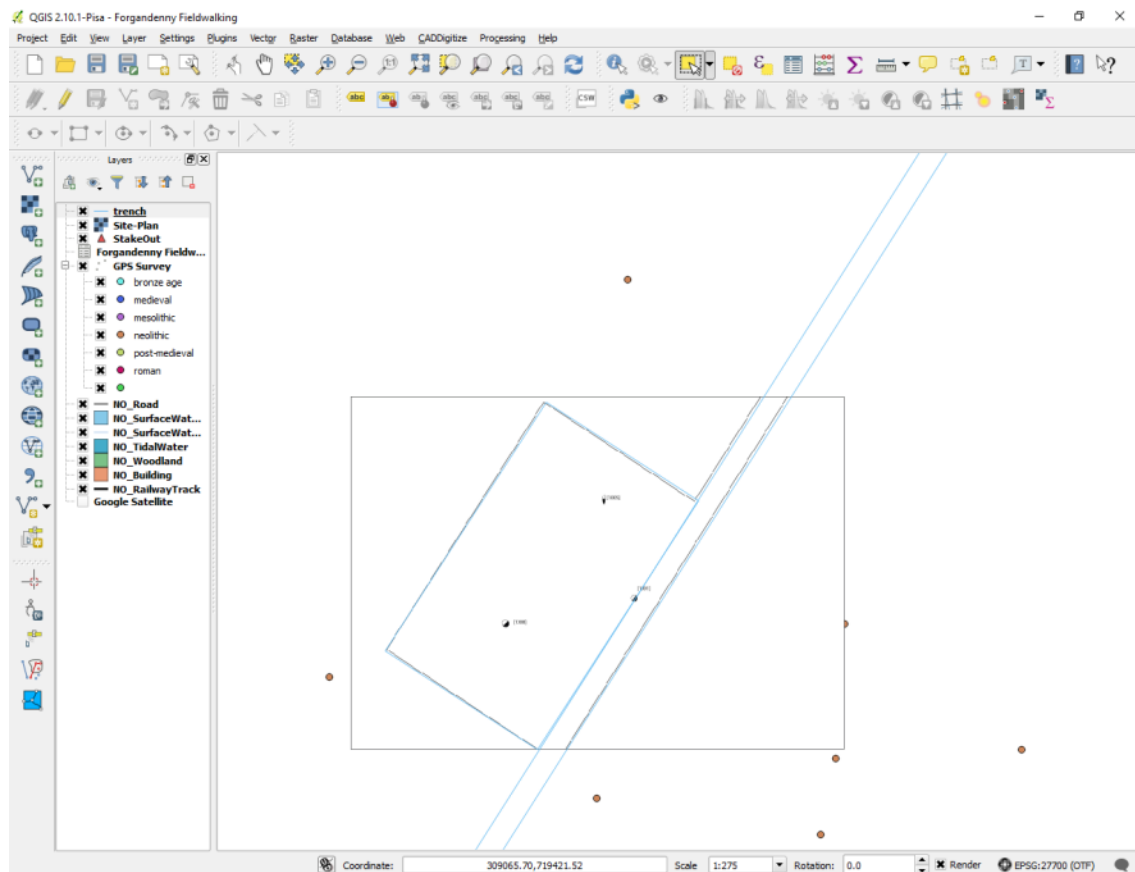
Figure 69: Site plan georeferenced onto the trench outline.
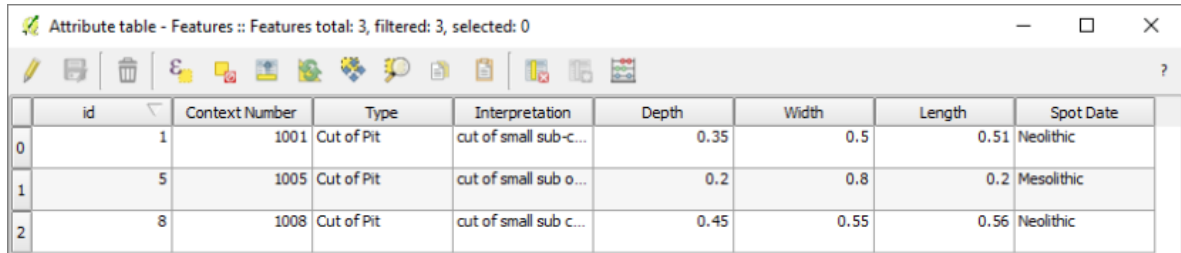
Now to digitise the features - create a new polygon shapefile with CRS OSGB36, call it *Features* and trace around the three features.

In a real life scenario, we would recommend having real hand-drawn plans at a scale like 1:50 or 1:20 this will make digitising much more precise and accurate. Of course this is easier if you have a fully georeferenced site grid!

In the same way as with the fieldwalking results, we're going to upload the context register as a .csv file, and perform a table join. Have a go yourself, referring back to the earlier section if needed. Think about the field that would create the join attribute.

Now, with the tables joined – the attribute table should look like this

	id	Context Number	Type	Interpretation	Depth	Width	Length	Spot Date
0	1	1001	Cut of Pit	cut of small sub-c...	0.35	0.5	0.51	Neolithic
1	5	1005	Cut of Pit	cut of small sub o...	0.2	0.8	0.2	Mesolithic
2	8	1008	Cut of Pit	cut of small sub c...	0.45	0.55	0.56	Neolithic

Figure 70: The completed join

Now you can make the table join permanent by saving the features shapefile with the table join as a new shapefile.

12.4.   Uploading and sharing data

Now you've created and digitised spatial data, and saved it as a shapefile, with metadata. You've created an incredible resource.

GIS is a fantastic tool throughout the process of writing up a site, managing data through post-excavation assessment and finally the production of illustrations for publication. Increasingly, the GIS project files, including all that vector and raster data are becoming a vital part of the site archive. Having your data available for future researchers in the form of GIS is going be vital for understanding and re-evaluating your findings.

So how and where do you deposit your data?

First of all, it's best practice to find your local "*County Archaeologist*" is based and discuss your research design beforehand.

BAJR Directory of County Archaeologists [**http://www.bajr.org/WhoseWho/Curator.asp**]

There is also a list from the Association of Local Government Archaeology Officers - **ALGAO**

http://www.algao.org.uk/membership

In England, Scotland and Wales, County Archaeologists and Historic Environment Record officers will be able to advise on what types of data are suitable for inclusion in the HER.

This may only be the site boundary, or it may extend to include trenches or excavation areas, even archaeological features with their associated metadata that you've just created. It all depends on what your local HER thinks is necessary in order to make the best use of your findings.

> However, one golden rule to stick to is that, if you're working in the UK, your data must be georeferenced and in National Grid OSGB36 [27700].

13.   References

Chapman, H. [Main author], 2006. *Landscape archaeology and GIS*. Tempus, Stroud.

GIS Guide to Good Practice. Archaeology Data Service, n.d. . Oxbow Books.

Wheatley, D. 1965-[Main author], Gillings, M., 2002. *Spatial technology and archaeology : the archaeological applications of GIS.* Taylor & Francis, London.

Wheatley, D. [Main author], Gillings, M., 2013. *Spatial Technology and Archaeology : The Archaeological Applications of GIS.,* 1st ed. CRC Press, London.

14.   Appendix

Links to other useful tutorials

- **QGIS Video Tutorial for Archaeologists**
  https://www.youtube.com/watch?v=0y6UN3JEXVw
- **Basic map tutorial**
  https://multimedia.journalism.berkeley.edu/tutorials/qgis-basics-journalists/
- **Data visualisation Mapping for Journalists**
  https://datajournalism.com/watch/mapping-for-journalists
- **SWALEDALE AND ARKENGARTHDALE ARCHAEOLOGICAL GROUP**
  QGIS in Basic Field Archaeology
  https://eastmead.com/QGIS-LIDAR.htm
- **South Leeds Archaeology - A Community Archaeologist's Introduction to Geographical Information Systems**
  http://www.southleedsarchaeology.org.uk/digging_into_qgis/
- **QGIS Tutorials and Tips**
  https://www.qgistutorials.com/en/index.html
- **Stuart Ladd - QGIS Level 2**
  https://jigsawcambs.org/images/Guide%20to%20QGIS%20Level%202.pdf
  > This guide will go through the following tasks:
  > •Exercise 1: Digitising site plans. Converting a hand drawn site plan to a digitised GISproject with data attached.
  > •Demonstration: Digitising aerial photos. Tracing features from aerial photographs into aproject.
  > •Exercise 2: Field walking. Setting up a field walking grid and logging finds data.