Redistricting

QGIS

Document by: David Crowther

redistrict

verb
redistricting

1. divide or organize (an area) into new political or school districts.

This term is often used in the US with regards to re-organising electoral boundaries – ***"Redistricting is the process of drawing the lines of districts from which public officials are elected"*** – https://www.aclu.org/news/voting-rights/what-is-redistricting-and-why-should-we-care

And in the UK, this is undertaken by the **Boundary Commission and Electoral Commission** - https://boundarycommissionforengland.independent.gov.uk/

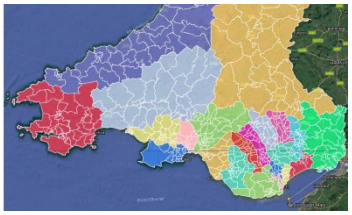
https://www.electoralcommission.org.uk/

In the last few days, Cadline has been working closely with a Local Authority customer to review its existing Round boundaries with regards to the collection of Refuse, Garden and Food Waste. As part of that process Cadline has implemented its **ROUNDS Application** to enable the Local Authority to generate lists of addresses for each Round Service. This consultancy work has taken me back to previous roles where GIS was used heavily for these tasks.

1 – Boundary Commission and Electoral Commission – many 'Boundary Review' staff use GIS to review and then reshape UK electoral boundaries. In the mid noughties I helped train staff at these organisations to use GIS for these tasks, where they commonly used MapInfo to digitise the changes to these boundaries.

Boundary Commission for England

The Electoral Commission



2 – Round and Leg generation for Street Services – In another previous role we used GIS, Routing algorithms, and ETL software to more accurately model both Rounds and individual Legs to optimise the collection of Refuse, Garden and Food waste for Local Authorities. Where in some cases, utilising mathematical models and geospatial logic, enabled several Local Authorities to reduce their fleet of collection vehicles and therefore their working week from 5 to 4 days.

Which brings us back to today and the task I was given to help our customer **re-organise** and then **split** their current Rounds.

…. **but <u>why</u>** was there a requirement to update their current Round boundaries?

Several reasons should be considered when looking to review your Round boundaries:

- ***population*** – where changes in population need to be reviewed to ensure that Rounds don't become unevenly balanced. These could be due to population migration, or simply that a new housing estate has been built and current Rounds have become unbalanced.
- ***vehicle counts*** – having fewer vehicles (or the need to reduce vehicle counts) will mean that Rounds will need to be better optimised to ensure collection is as streamlined as possible to allow fewer vehicles to collect waste using more optimised routes.
- ***Subscription rates*** – as more (or less) people sign up for these Service e.g. Garden Waste subscription, you will need to ensure that the Rounds you have modelled are optimised for your current and planned future subscription levels.

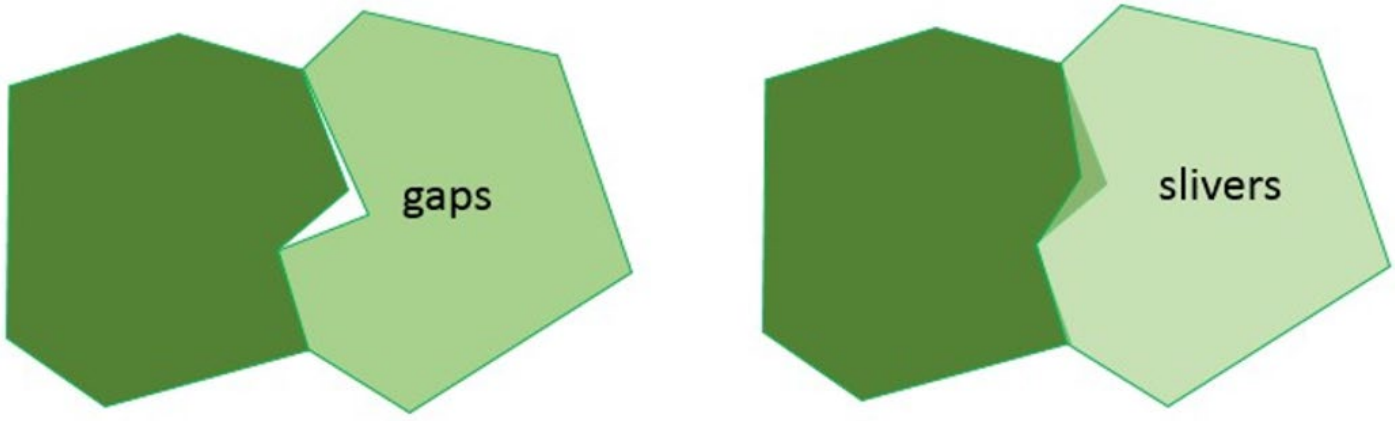
… so **<u>how</u>** can Rounds be effectively planned and re-modelled?

These are some techniques you could implement as outlined below, where some options are likely better than others!

- ***Do nothing*** – leave the Rounds as they have been historically and let your vehicles collect as much as they can, with uneven splits overs days of the week and across your fleet of vehicles.
- ***Paper maps*** – revise Rounds, day splits and even the individual collection legs using paper maps on walls.
- **Digital data** – integrate your Subscription lists, Address databases and Ordnance Survey mapping, including ward boundaries and road networks to better revise boundaries into more optimised areas.

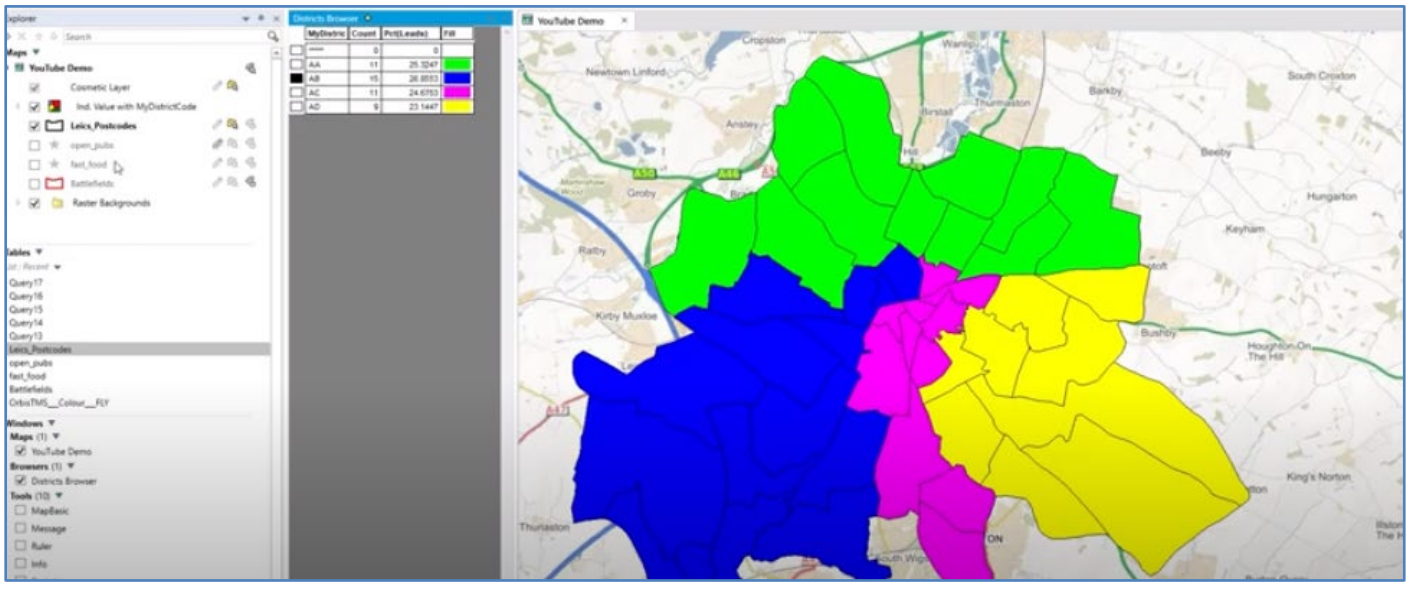
While the **third option** above is likely going to generate you optimised Waste Collection Services, **how easy** is it to simply **redraw or reshape existing boundaries** to better represent changes in local level datasets?

Well, you could simply start to **reshape the current boundaries** in a GIS, moving vertices manually to reshape Round Areas along roads to collect waste in new neighbourhoods. Good luck with this…. it's tedious, it's difficult and you will most likely generate imperfect topology by introducing **gaps, overlaps and slithers** into your digital boundaries.



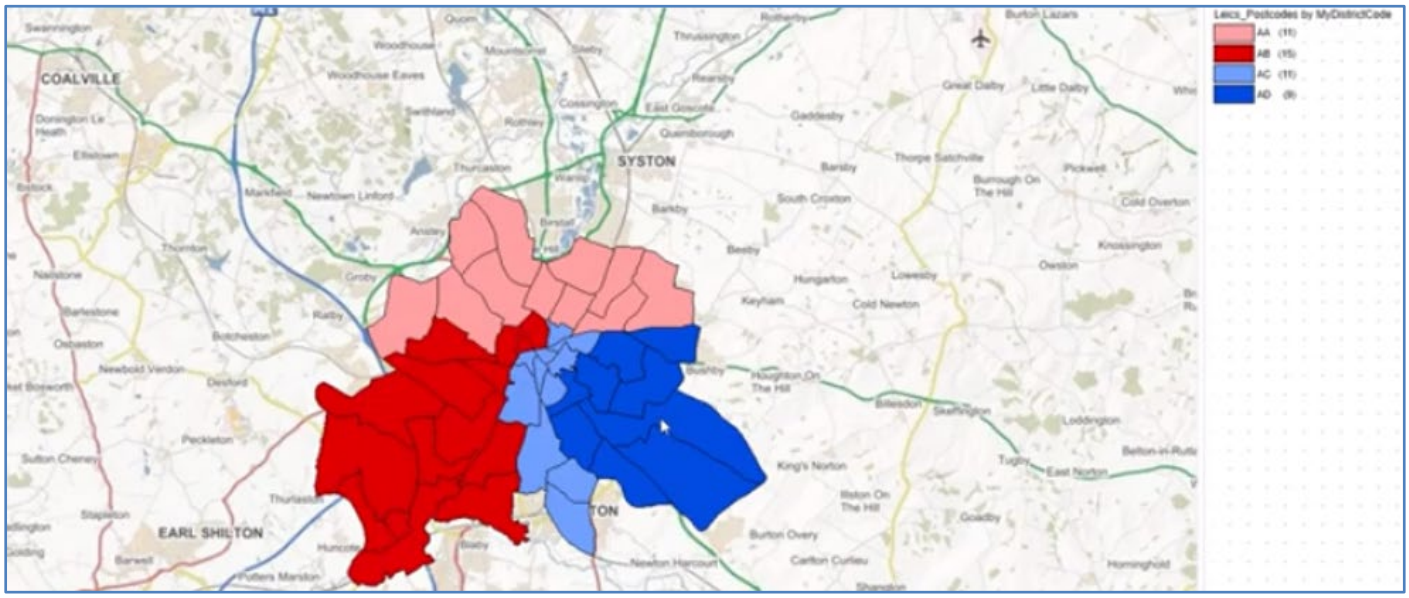
And even when you have successfully reshaped a boundary to generate 'topologically correct' polygons, as soon as someone asks you to adjust a boundary to change its shape based on new information or to include a new road, guess what?... yep, you have to manually reshape your polygons again, which will likely introduce gaps, overlaps and slithers!

So, what is the **best option?...** well, I thought back to my previous role and remembered doing these tasks using the proprietary desktop GIS – **MapInfo** – which had a plugin tool called **Redistricting.**



As per the above image, the MapInfo **Redistricting tool** allows you to assign individual geometry (points, lines or polygons) to a District/Area of **higher-level geography**. In the example above, the tool is being used to assign smaller Postcode Sectors to create higher-level Postcode Areas or Districts boundaries.

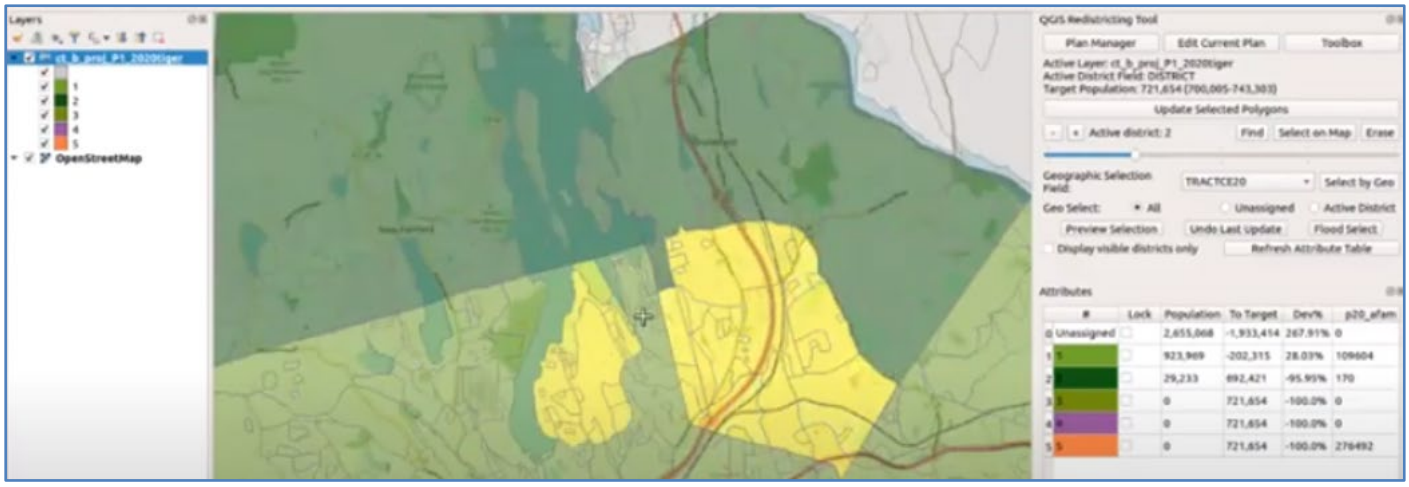
As you assign an area to a District, the Redistricting tool **colours those areas** into their unique District colour and updates a **table** which auto calculates feature **Counts**, as well as options for summing lower-level statistics e.g. Population Counts. Users can then start to redistrict the boundaries and choose to move them between Districts to undertake what-if scenarios. The Redistricting tool simply re-colours the features and auto regenerates the Counts as you continue to re-model the data. Once you are happy with how you have remodelled the features, you can then generate new **District level features** by **merging** the smaller objects using the redistrict value.



Using the **Redistricting Tool** in this case has enabled the user to **quickly change** how the features are modelled based on balancing the Districts, without having to keep manually re-drawing the boundaries!

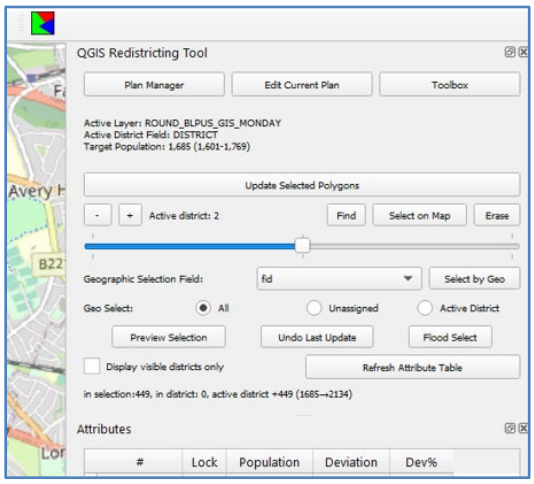
QGIS Redistricting

I thought… 'if there is a tool in MapInfo for this task, there must be a tool in **QGIS!'...** and after a small Google search I found this video - https://youtu.be/W069sT_icQE

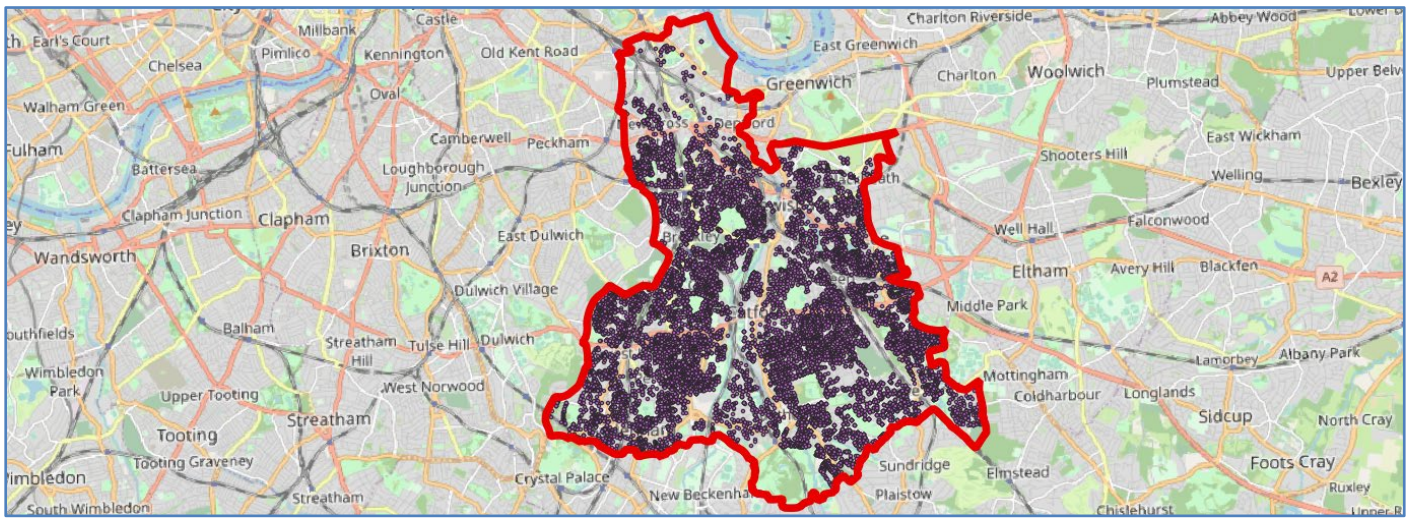


The plugin is called **Statto Redistricter** and is available from the **QGIS Plugin Manager.**

Once installed the tool is opened from the **Plugins menu** and opens into a **Panel** within QGIS.

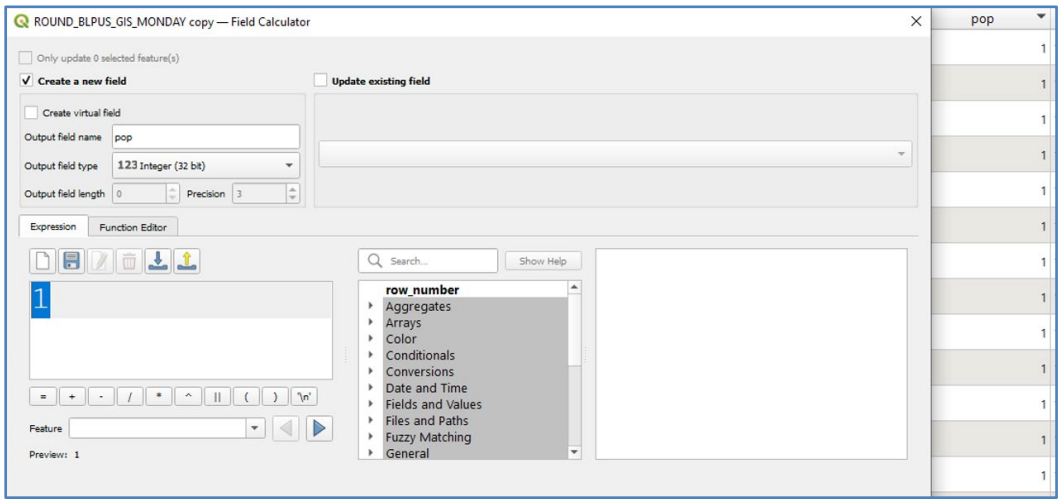


In this example, we used the **Local Land & Property Gazetteer (LLPG)** points as the features to redistrict. Where we need to assign **Districts/Round Areas** with a balanced number of points falling into each area. In the following screenshots we will use the area of Lewisham as an example of how this could be done. *Please note these screenshots **do not reflect** how any Rounds have been adjusted within Lewisham... these are just examples!*



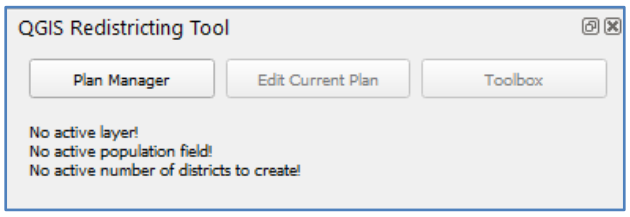
1 – Assign a Population/Weight value to each Property (UPRN) –

Before you can run the Redistricting Tool, the underlying data needs a **numeric attribute** to redistrict against. In the case of redistricting areas of population, you would need a **population** value, or maybe a **count of persons in voting age,** to then numerically SUM the values to ensure that the redistricted areas have a balanced voting population value. In our case, we wish to simply have a balanced number of UPRN Address properties in each ROUND (District) boundary. So, we will add a new **field called pop** to the LLPG data and then assign the **value of 1** to each property. Again, for this example, you could redistrict using a ***waste weight*** value per property for even more accurate Round creation.

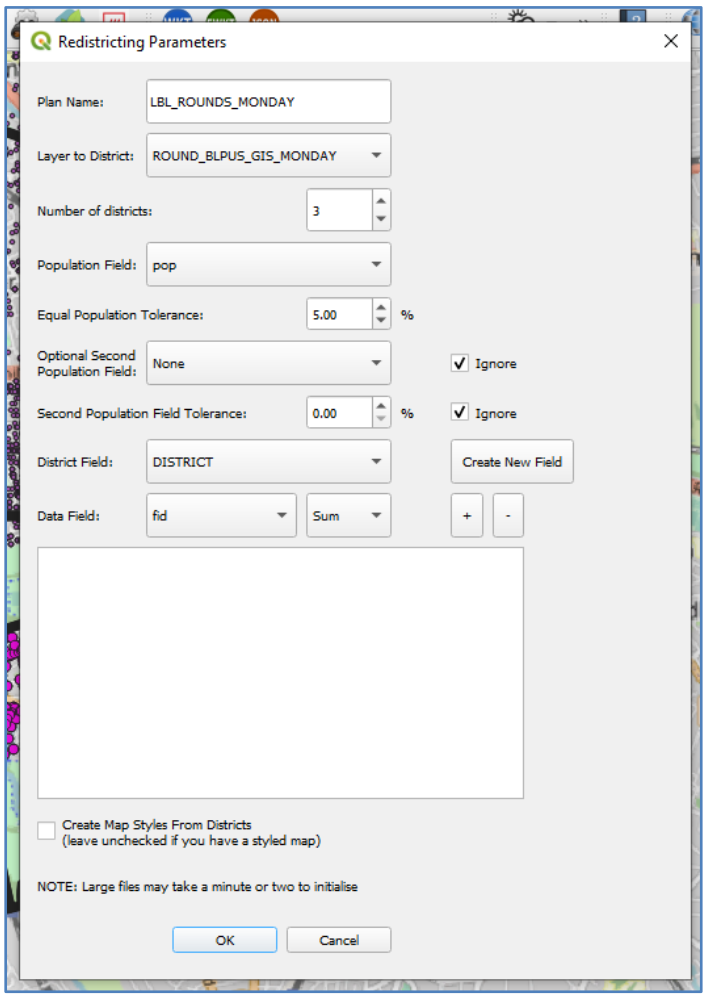


2 – Create a Redistrict Plan –

In the **QGIS Redistricting Tool** panel, simply choose **Plan Manager** and compete the options as below:

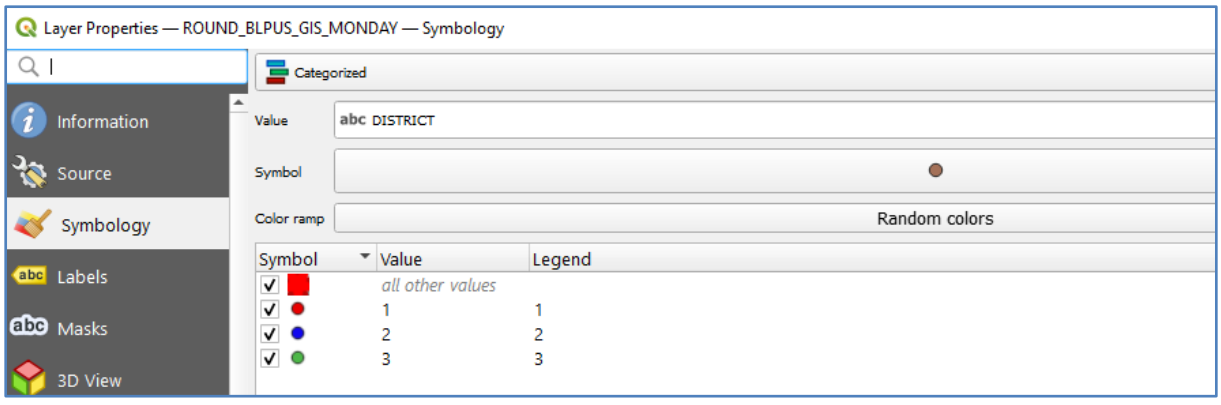


- ***Plan Name*** – give the redistricting job a name e.g., MONDAY_ROUND_REFUSE
- ***Layer to Redistrict*** – choose your **LLPG Address** point layer
- ***Number of Districts*** – how many Round/District regions do you wish to create e.g., **3**
- ***Population Field*** – choose the **Pop field** we just created. This is so, as you assign points to a Round/District, the system can SUM the Pop values (all 1) to ensure it can calculate the deviation from the % required.
- ***Population Tolerance*** – assign a tolerance percentage e.g. 5% so that even if the district is not the exact % of the total e.g. 33.333% for 3 equal districts, the District will be shown as GREEN in the Redistricter if the Pop Count is within the 5% tolerance
- ***District Field*** - choose the field to assign the REDISTRICT value/name. If there isn't a field, the system creates one called **DISTRICT** for you.
- ***Extra Fields*** - at the bottom you can then add extra fields to the output where it can SUM/COUNT etc…. information about the redistricted/grouped points… e.g. number of households/bin weight – assuming that these values exist against the underlying LLPG record.
- ***Create Map Styles –*** these will thematically map the redistrict.



3 – Thematic Symbology –

Having chosen to Create Map Styles, use the **Layer Properties – Symbology** tab for the layer to choose the colours you wisht to assign to each of the 3 Round/Districts.

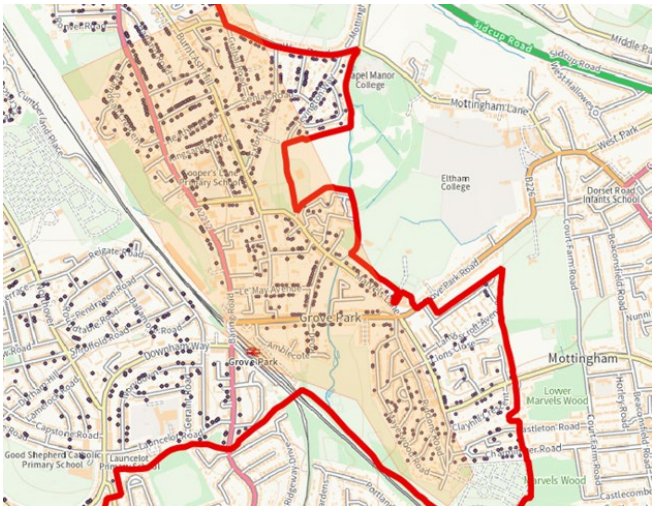


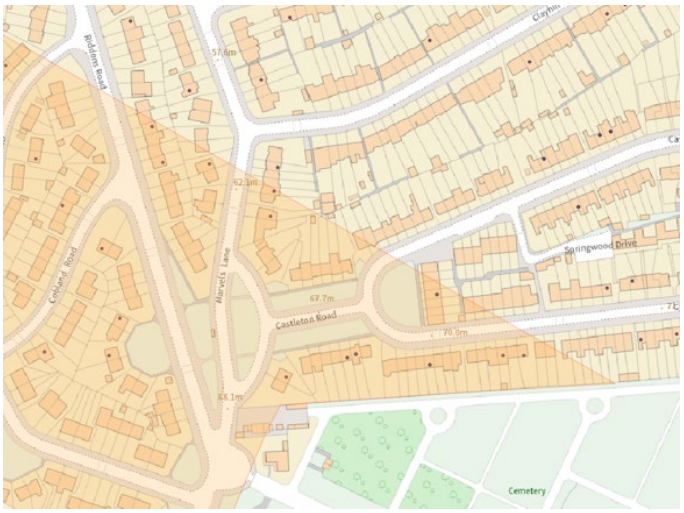
In this example, we have chosen **Red (1), Blue (2)** and **Green (3),** with unassigned points being a **LARGE RED STAR.**

4 – Geographically Select and Redistrict –

To start redistricting, use the **Select tools** e.g. use the **Polygon Select** to draw in the map to select the LLPG Address points that you wish to assign to a Round/District.

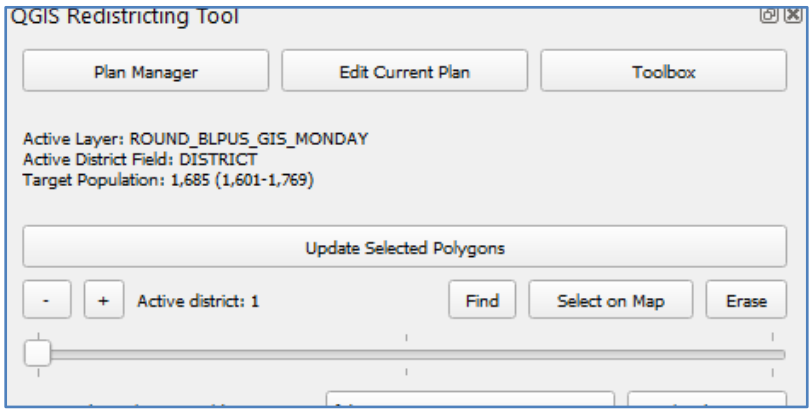
Left click to change direction to draw the area to select within, and right click to finish the shape. While using the Select by Polygon tool you can scroll/zoom into the map and pan to select more accurately, by drawing along the road using the detailed OS Mastermap basemapping.





Once you have selected the LLPG Addresses that you wish to redistrict, they will be shown in the map as **YELLOW** (selected) points.

In the Redistricting Tool ensure that the **ACTIVE DISTRICT** is set to the Round/District that you wish to assign these points to e.g. **DISTRICT 1.**



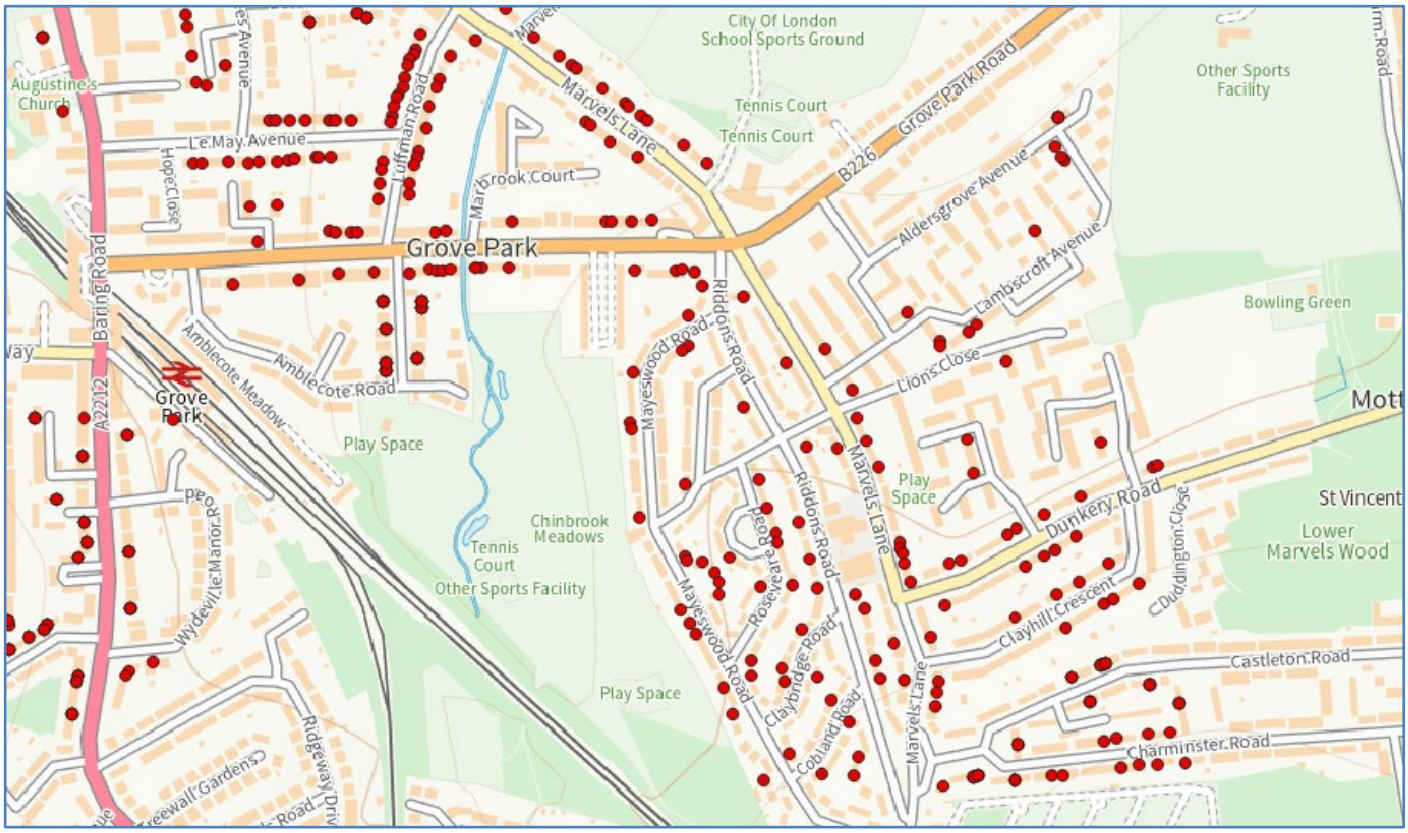
Then choose the **UPDATE SELECTED POLYGONS** button and the Redistricter Tool does the following:

- Colours the selected LLPG Address points **(red)** based on the Round/District that was chosen and the colours that you assigned.

Attributes

#	L
0 Unassigned	
1 1	
2 2	
3 3	

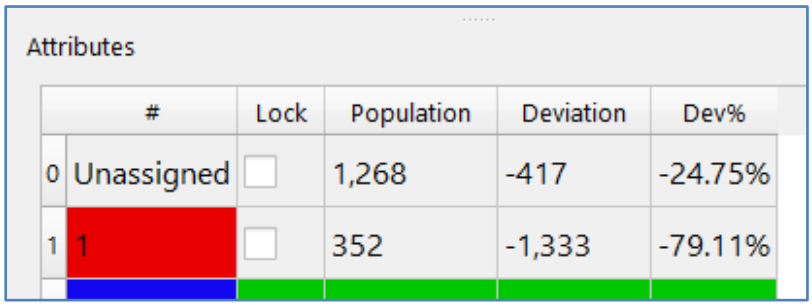
So, in this case, as we assigned these LLPG Address points to Round/District 1, the points are **coloured RED** in the map.



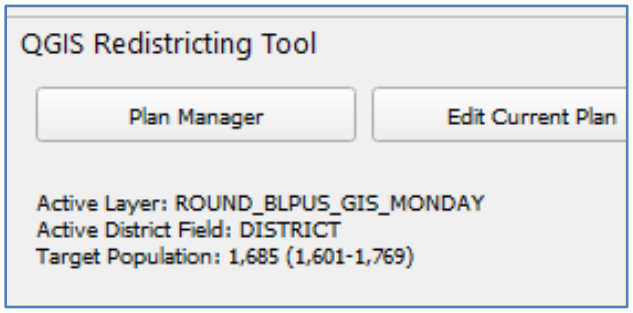
It has also updated the **DISTRICT column** with the District value of **1** in the ATTRIBUTE table for those records.

	pop	DISTRICT
39	1	1
72	1	1
72	1	1
72	1	1
72	1	1
72	1	1
72	1	1

And the Redistricting Tool, updates the ATTRIBUTES window to detail, the **Population** (which is essentially a count of the LLPG Address Points), and the deviation (**Count and %)** that the current Population (Count) is away from the required amount. Here **Round/District 1** is **79%** below the required population.



Note - The top of the Redistricting Tool will tell you the required values. It shows the layer being redistricted and the **target population (Count)** that is needed, with the **5% tolerance** above and below this figure.

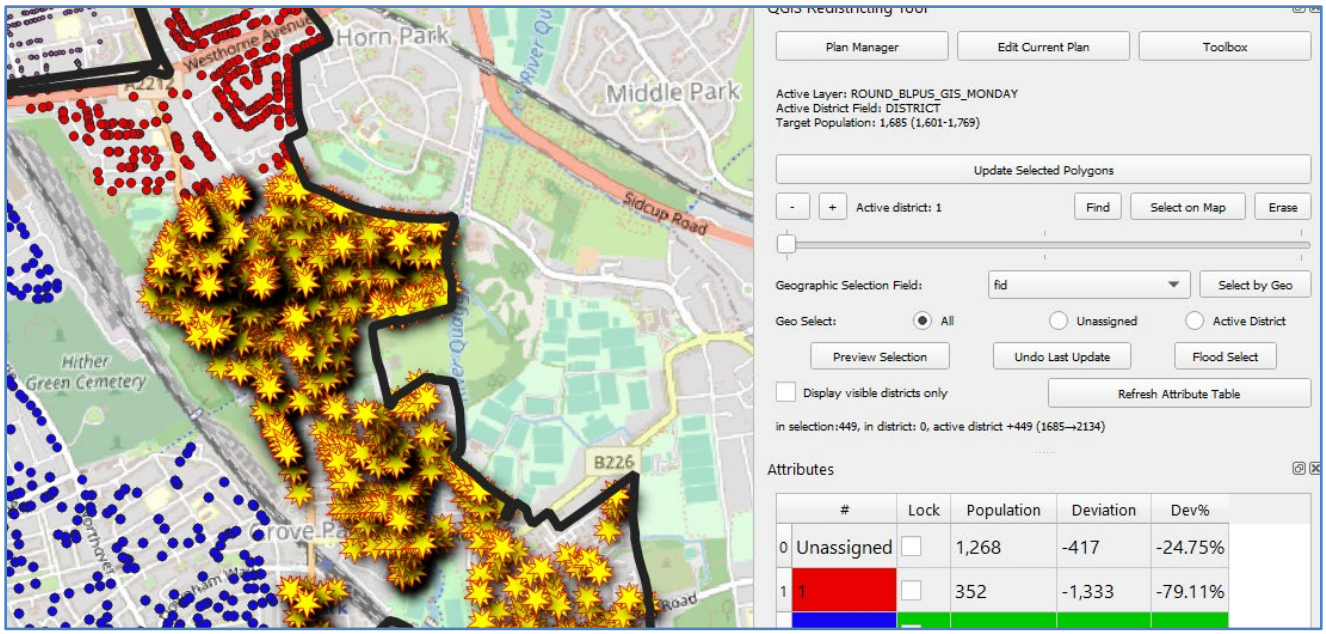


Currently **District 1 (red)** only has **352 properties** in it, which is **1333** below the target value and **-79% deviation**.

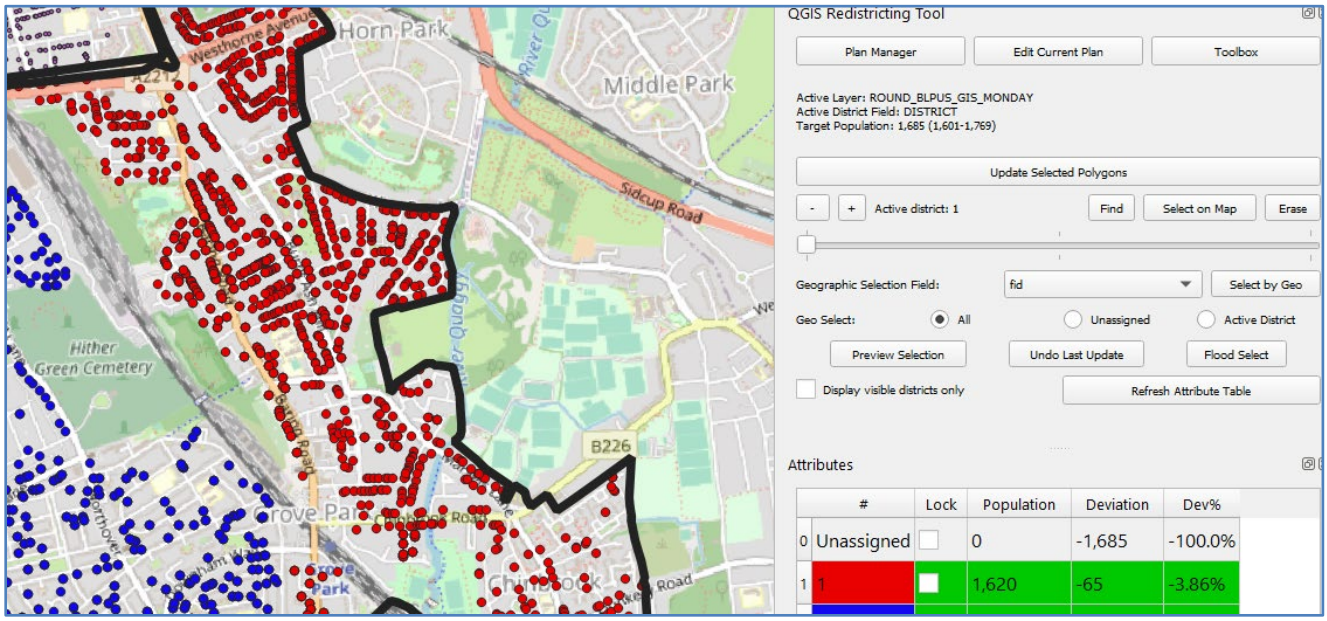
So, you will need to **continue to redistrict** in the map, to select more LLPG Address Points and then assign to this District using the **UPDATE SELECTED POLYGONS.**

Note – if you have set a point style for **UNASSIGNED records,** they can be coloured brightly in the map to show you points that are yet to be assigned. Here I have coloured them as **Bright Red large Stars!**

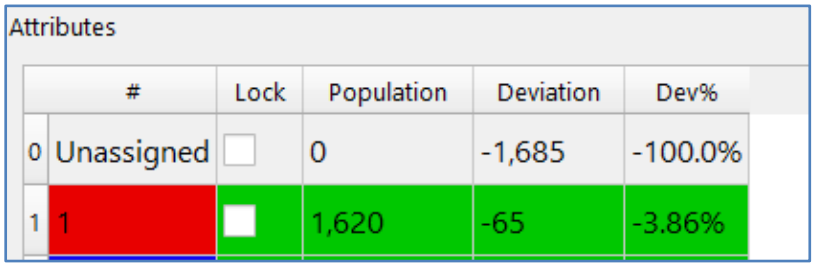
Select all the unassigned ones that you wish to add to Round/District 1, and they will then be shown as **yellow.**



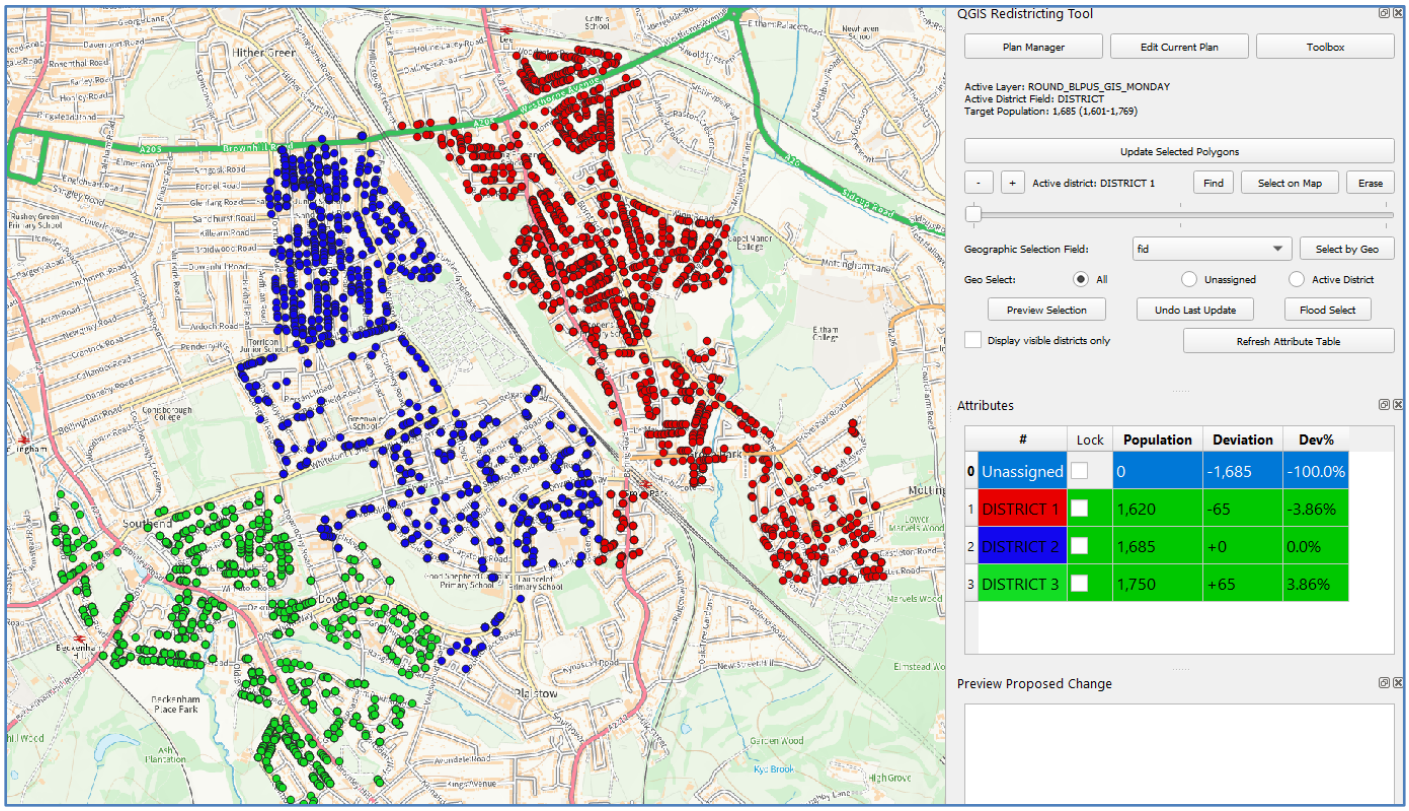
And then choose **UPDATE SELECTED POLYGONS** to assign them to the chosen **Round/District 1.**



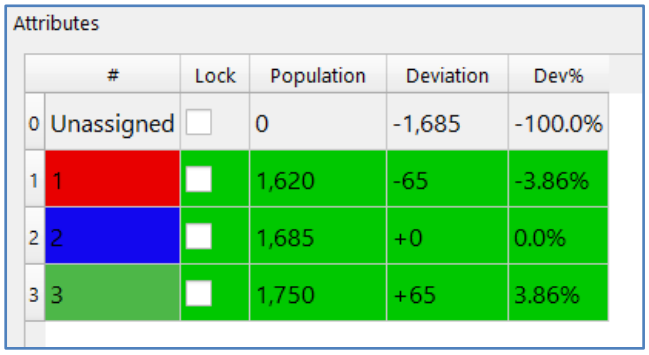
The **Attribute table** changes and now gives us a more balanced set of statistics, where now **Round/District 1** correctly falls within the **deviation of 5%** from the target population/count.



Continue to do the same, selecting **unassigned LLPG Address** points in the map, then ASSIGN them to the desired Round/District e.g. **District 2** and **District 3**. The Points change colour e.g. to Blue and Green, and the Redistrict table updates the Statistics.



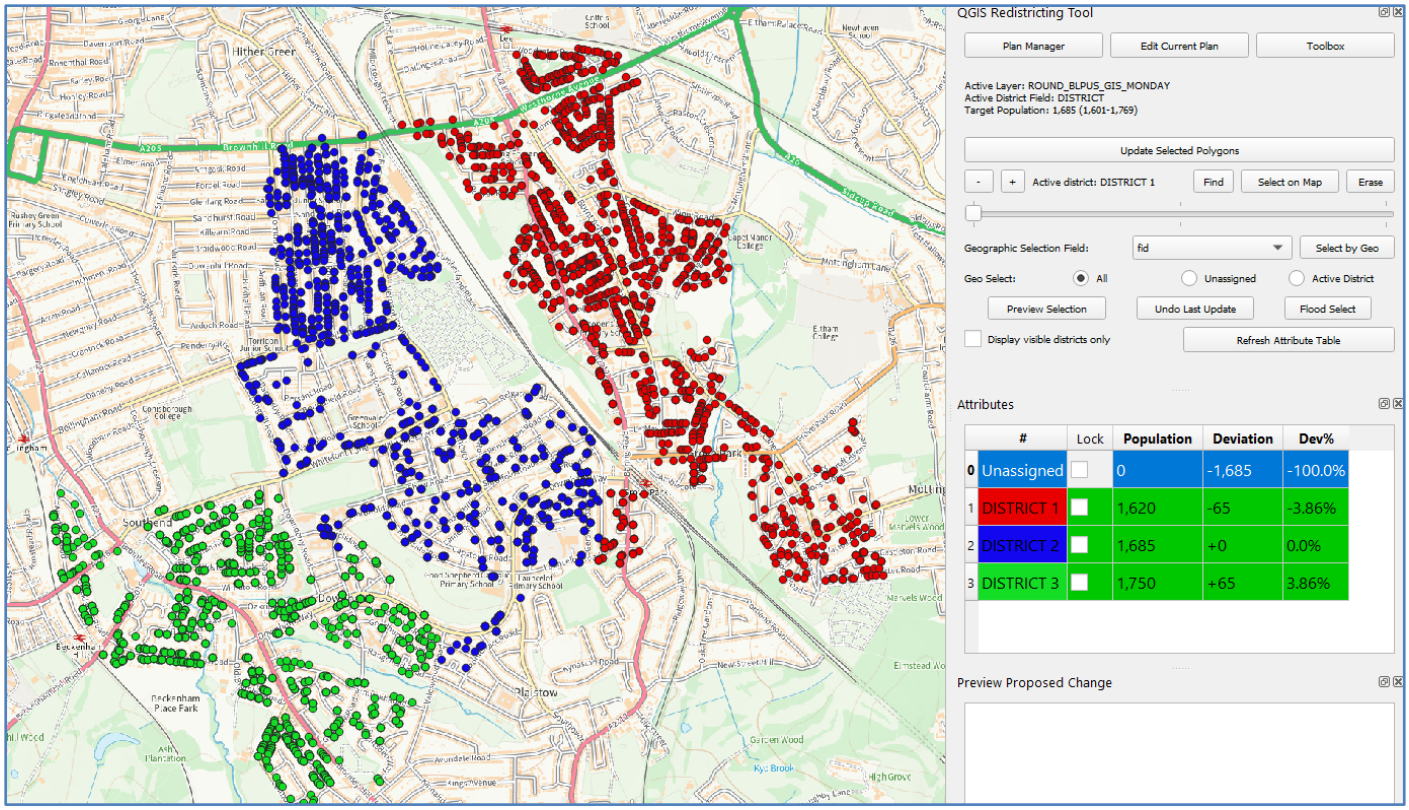
We wish to get each Round/District coloured GREEN in the TABLE, as this shows that each District is now within the **5% deviation buffer** from the target value.



Note – if one Round/District has too many points within it, find an area in the map where those points are near another Round/District which has a lower population (Count), select a group of points and re-assign them from Round/District to another. The table will update and at some point, you will have 3 Round/Districts with a similar count of points within each.

5 – Create Round Boundaries –

Now that you have redistricted the LLPG Addresses to create balanced Round Days, this is the time to then create the **Round/District boundaries.** Simply draw the Round polygons around the coloured points to ensure that each Round covers the points as needed. This is now a much simply task as you don't need to worry about how the polygons are drawn, if they correctly capture the Address Points.



Tips –

- Don't make the Round/District polygons **too precise**! The more **angular** the better, as ultimately they will be easier to reshape if needed later.
- Try to use the **road network** and **OS mapping** to ensure that you don't cut across roads or through properties!
- When digitising adjacent Round/District polygons, fewer **vertices are better!...** this is because the adjacent polygons will have shared vertices, so you want to limit the impact of moving a vertex in one polygon to ensure you don't create **gaps and overlaps** between the Rounds.

6 – Redistricting Tips –

Here are some extra tips I discovered as I played with the settings available within the tool!

A – Select using a Column

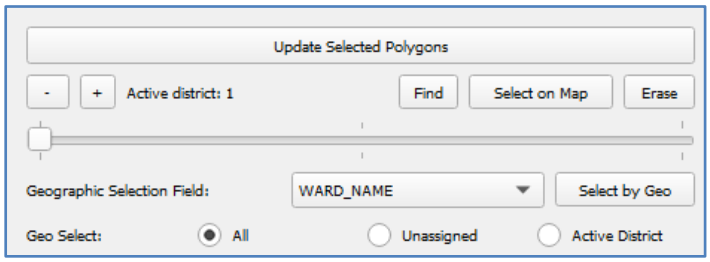
Instead of manually/geographically selecting points in the map to assign to a Round/District, you can also use a **COLUMN** in the underlying data table to assign like points into the same Round/District first… then manually adjust them later.

For example, LLPG Address records may well have a field called **WARD_NAME** that can be used to assign Address to the same Round/District.

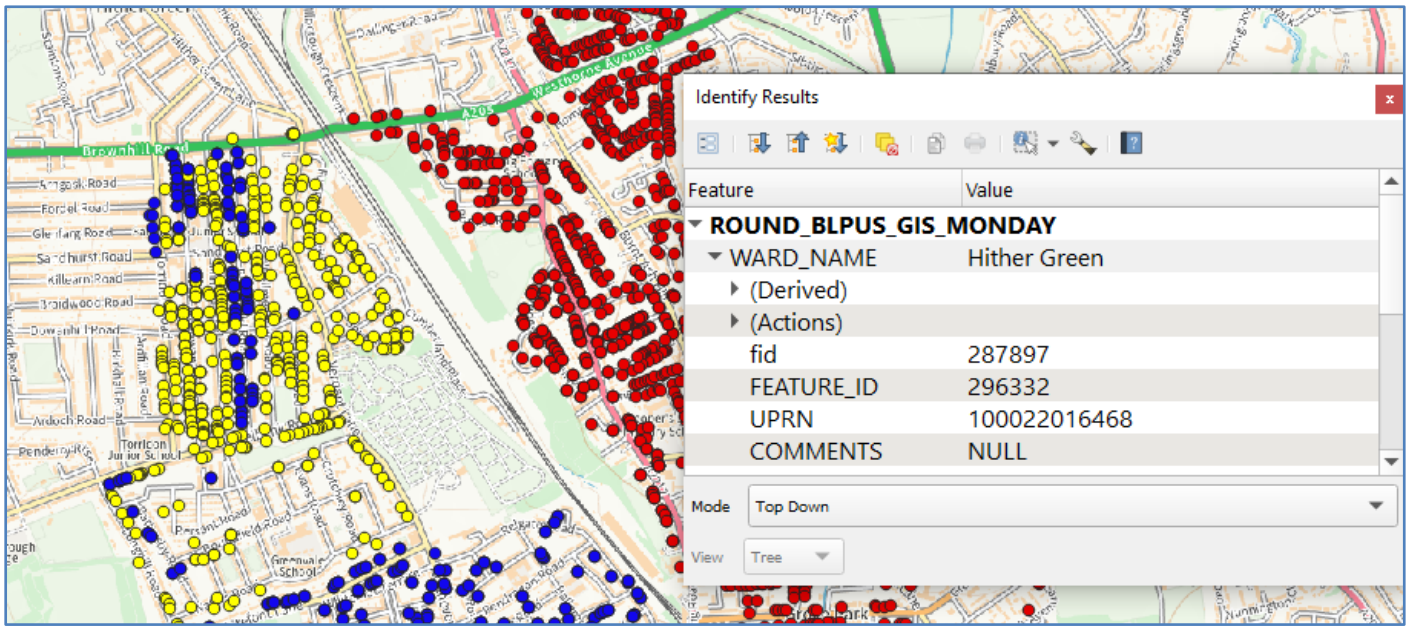
ROUND_BLPUS_GIS_MONDAY — Features Total: 5055, Filtered: 5055, Selected: 0

	fid	FEATURE_ID	UPRN	COMMENTS	FULL_ADDRESS	WARD_NAME
1	295042	296341	100021996422	NULL	2 PITFOLD CLOSE ...	Lee Green
2	295043	296341	100021996423	NULL	3 PITFOLD CLOSE ...	Lee Green
3	295044	296341	100021996424	NULL	4 PITFOLD CLOSE ...	Lee Green
4	295048	296341	100021996432	NULL	12 PITFOLD CLOSE...	Lee Green
5	295049	296341	100021996437	NULL	17 PITFOLD CLOSE...	Lee Green
6	295050	296341	100021996438	NULL	18 PITFOLD CLOSE...	Lee Green
7	295051	296341	100021996439	NULL	19 PITFOLD CLOSE...	Lee Green

In the Redistricting Tool choose the **Geographic Selection Field** and from the drop-down list, choose the **WARD_NAME** field. Then click the **Select by Geo Button** and **click in the map** and select one of the Address Points.



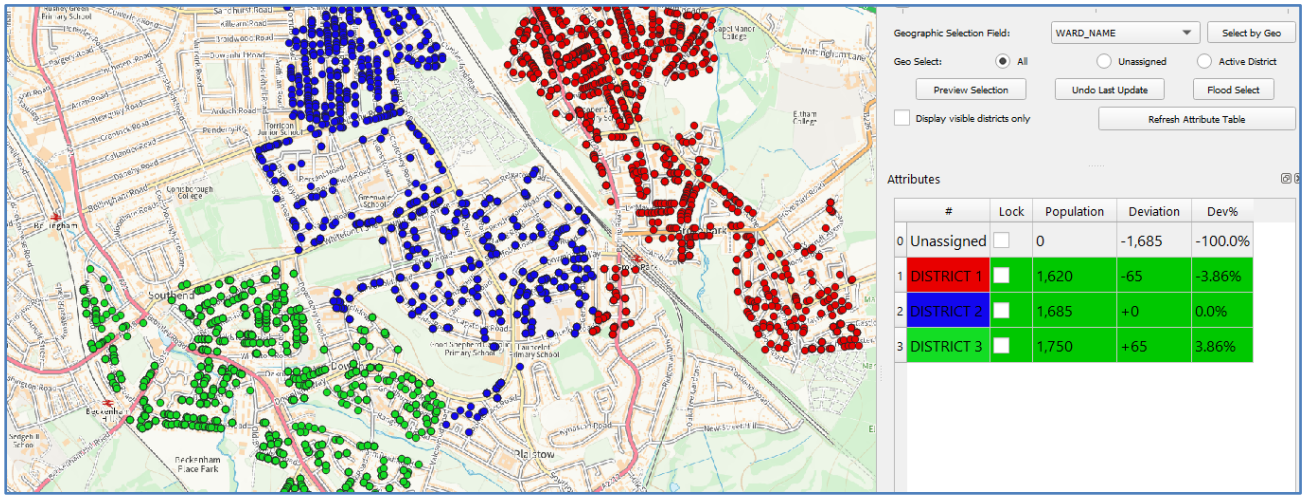
The system, will then **auto select all Address Points** that have the same **Ward_Name** value as the Address that you clicked on.



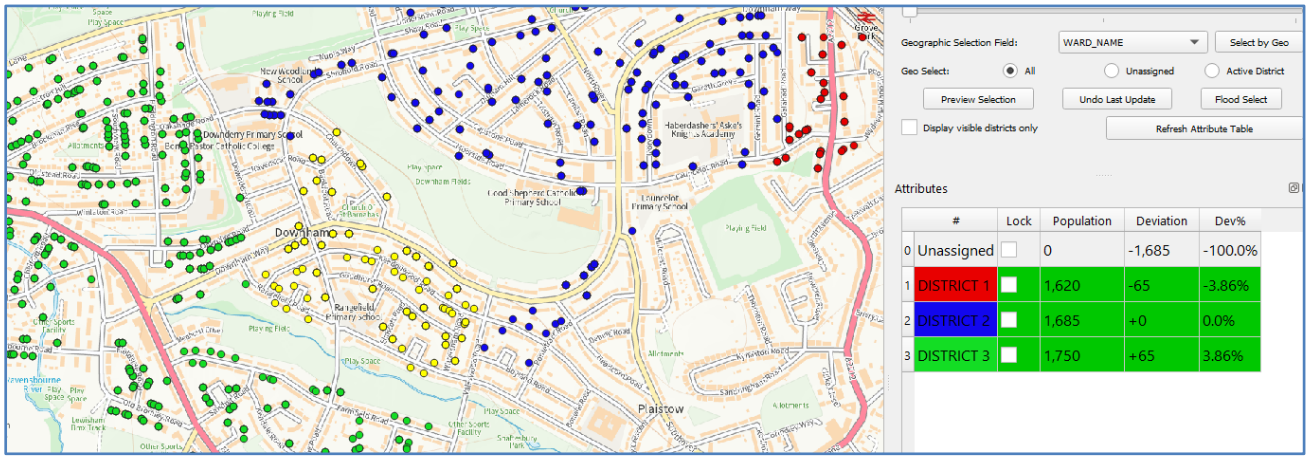
You can then quickly assign all the Points from the same WARD into the designated Round/District.

B – Preview before Assigning

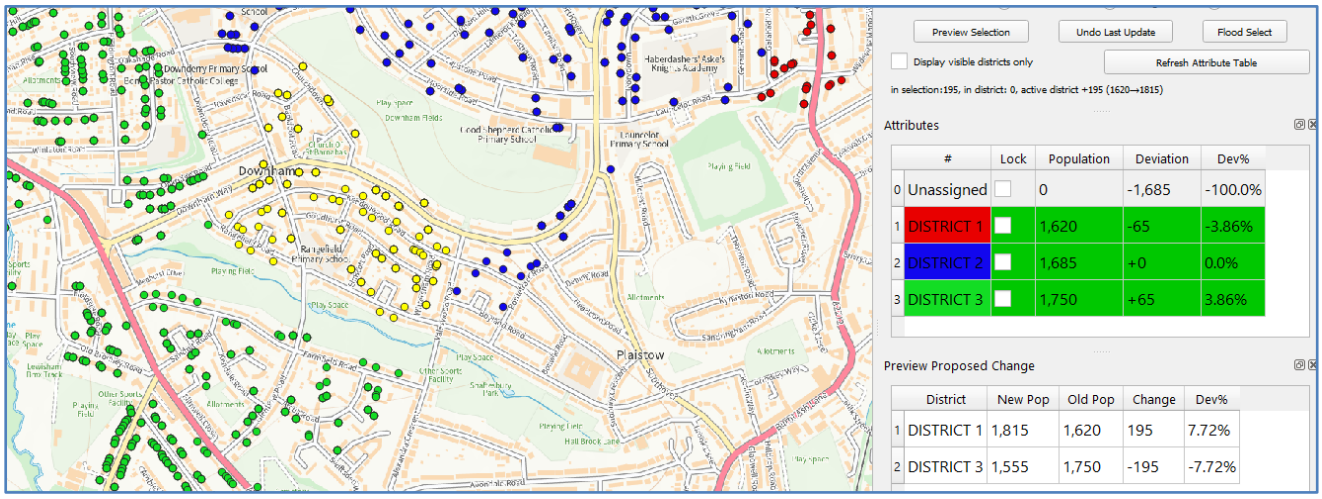
Use the **Preview Proposed Change** window to see what the changes would be before you assign them. For example, currently we have **-3.8% deviation for Round/District 1 (red)** and **plus 3.8%** for **Round/District 3 (green).** This equates to **65 properties** too many in one Round/District and 65 too few in the other. So, it will be worthwhile re-assigning some Address points from District 3 to District 1 to balance out the inequality.



Select some of the currently **Green (Round/District 3**) points so that they are then shown as **YELLOW** in the map.

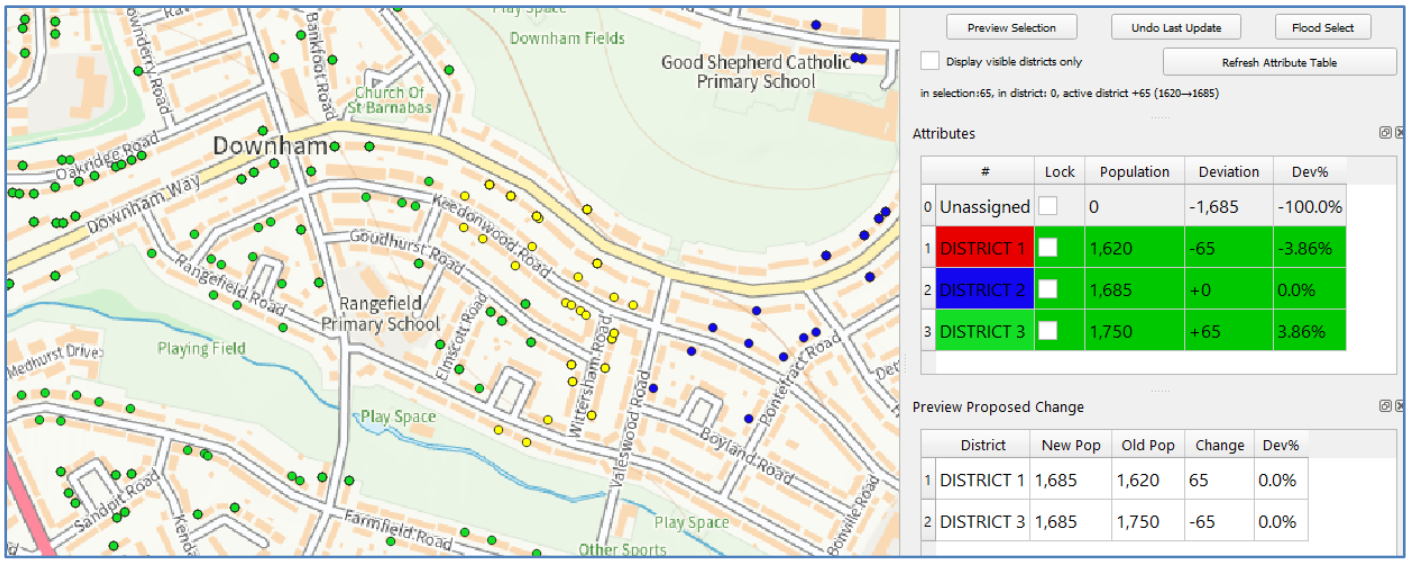


Then choose **Preview Selection** this opens the **Preview window** and adds the Districts in.

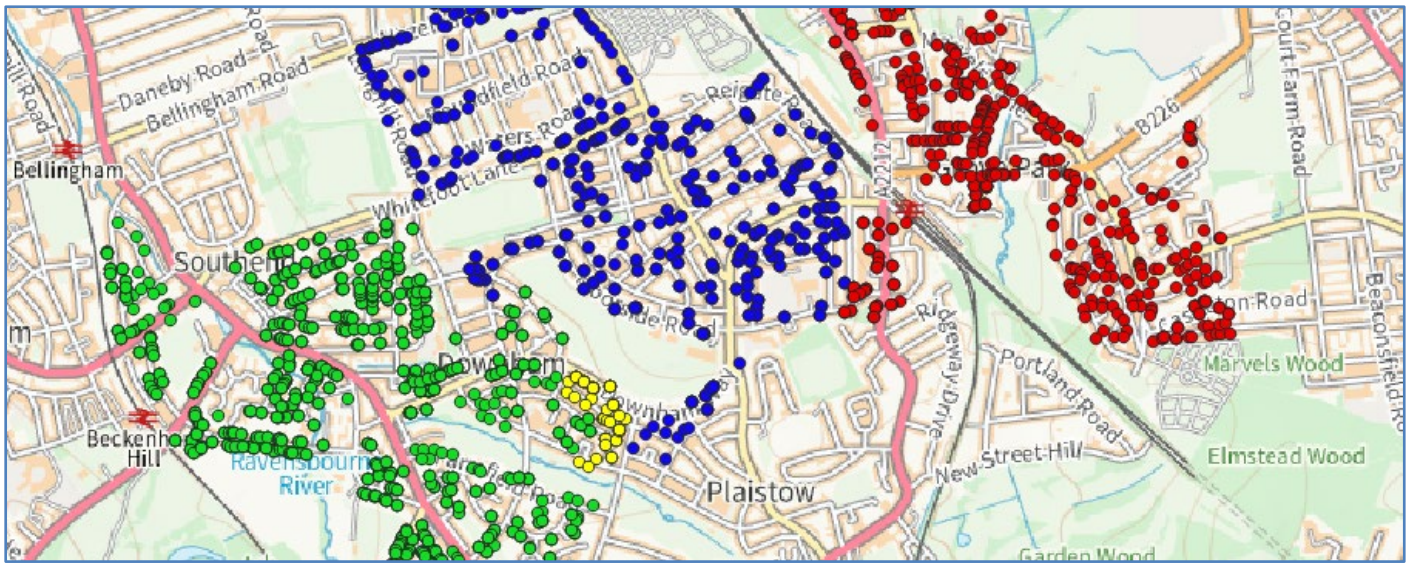


This will tell you what the change would do to these 2 Round/Districts. In this example, by re-assigning the selected properties from District 3 to District 1, it will change each District by 195 properties, and the **% deviation (7.72%)** from target will swap so District 1 now has too many properties…

…so, try to select a few **less properties** in the map… and choose **Preview again**, this time the change is smaller (only 65 Addresses) and so both Rounds/Districts have a **0% deviation.**



HOWEVER – remember **geography** should be considered before making redistricting…. simply re-assigning some properties from Round/District 3 (green) to Round/District 1 (red) makes little logical sense for Bin Collection as these properties are not close to the other District 1 properties.



In this case, we should have re-assigned some properties from **Round/District 2 (blue)** into the bordering **Round/District 1 (red)** and then subsequently moved some **Round/District 3 (green)** properties into **Round/District 2 (blue).**