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Traffic Regulation Orders (TRO)

Converting polygon-based restrictions to line-based restrictions for Traffic Regulation Orders (TROs)

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Overview

Highway authorities have traditionally used polygons to capture static traffic regulation orders.

Although it was up to individual preferences which type of geometry to use for digitally capturing restriction shapes, polygon-based restrictions were considered to have several advantages over line-based restrictions:

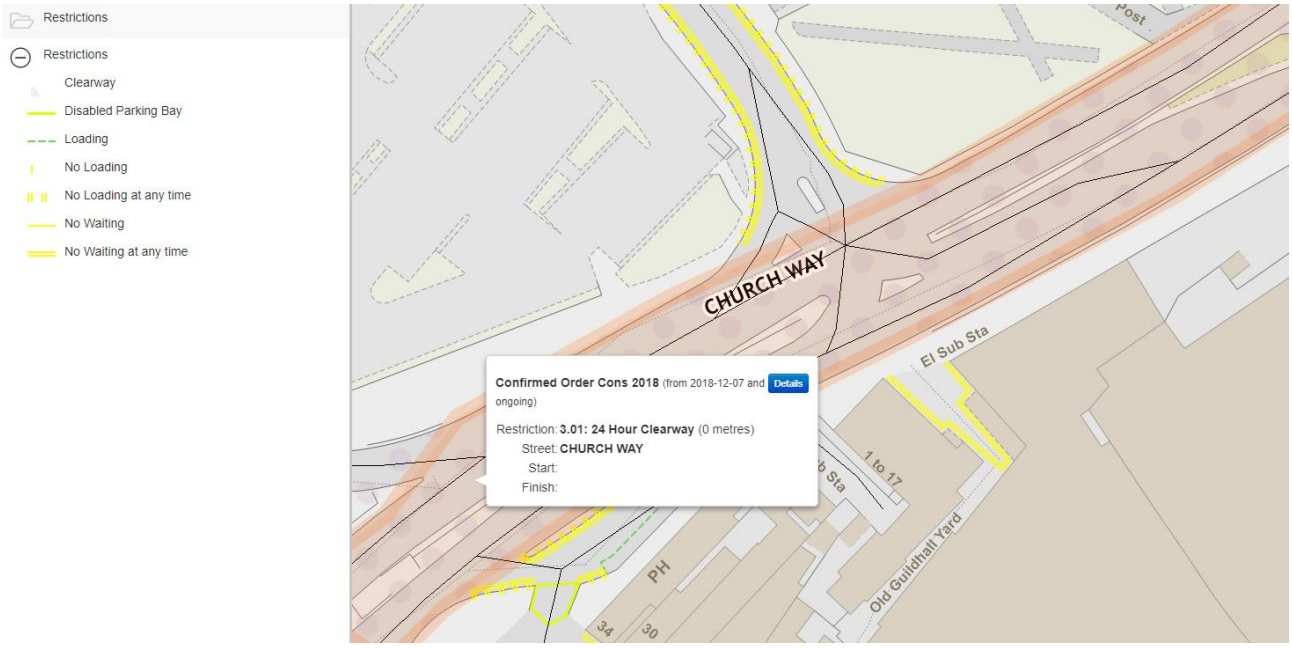
a. Creating polygon-based restrictions was easier, especially for non-professional users. By simply drawing an area of interest, the TRO software could calculate the cross-section of the user-defined area with the road polygon from the underlying basemap (specifically, Ordnance Survey MasterMap).

b. Using a polygon-based approach was very straightforward in the case of moving restrictions. Moving restrictions control car movements, such as mandatory turns or no U-turn signs. One of the most important moving restrictions from the TRO's point of view is speed limits. Speed limits usually span large areas, covering multiple streets or even whole neighborhoods. Therefore, using one large area as a polygon can immensely speed up the process of digitizing restrictions.

Overall, the use of polygons for capturing moving traffic regulation orders had provided a simpler and more efficient approach than using a line-based approach to moving restrictions.

This allowed (and allows) for easier creation and maintenance of TROs, especially in cases where there are multiple moving restrictions that need to be captured over large areas.

An example of a polygon-based restriction depicting Clearway in the centre of Doncaster:



While polygon-based restrictions for capturing traffic regulation orders have their advantages, they also pose several problems when used for capturing static traffic regulation orders (and even for moving traffic regulation orders) that need to be considered, including:

a) Polygon-based restrictions are less readable on the map, particularly when multiple restrictions are applied. The whole surface of the road is highlighted using a specific pattern, making it difficult to see road-specific elements like street names. They clutter the map and obscure other TRO and highway related information.

b) Grants are awarded to highway authorities for fixing and rectifying TRO capturing, but these grants are based on the length of the restriction. It is not easy to automatically calculate the length of a restriction from polygon geometry. Line-based restrictions provide a natural way to calculate the length, as the length of a line is its natural property. A geometry in the shape of the road with a width dimension is much more complicated to calculate. The length is not a default characteristic of a two-dimensional polygon (as opposed to area and perimeter).

c) Polygon-based restrictions are more difficult to edit and require an up-to-date basemap. It is not possible to quickly adjust a polygon that needs to be constantly aligned to a road shape. Moreover, the shape of the road changes relatively often, for instance, due to precision improvements introduced by Ordnance Survey. The position or length of a road centerline or borders is not susceptible to these changes.

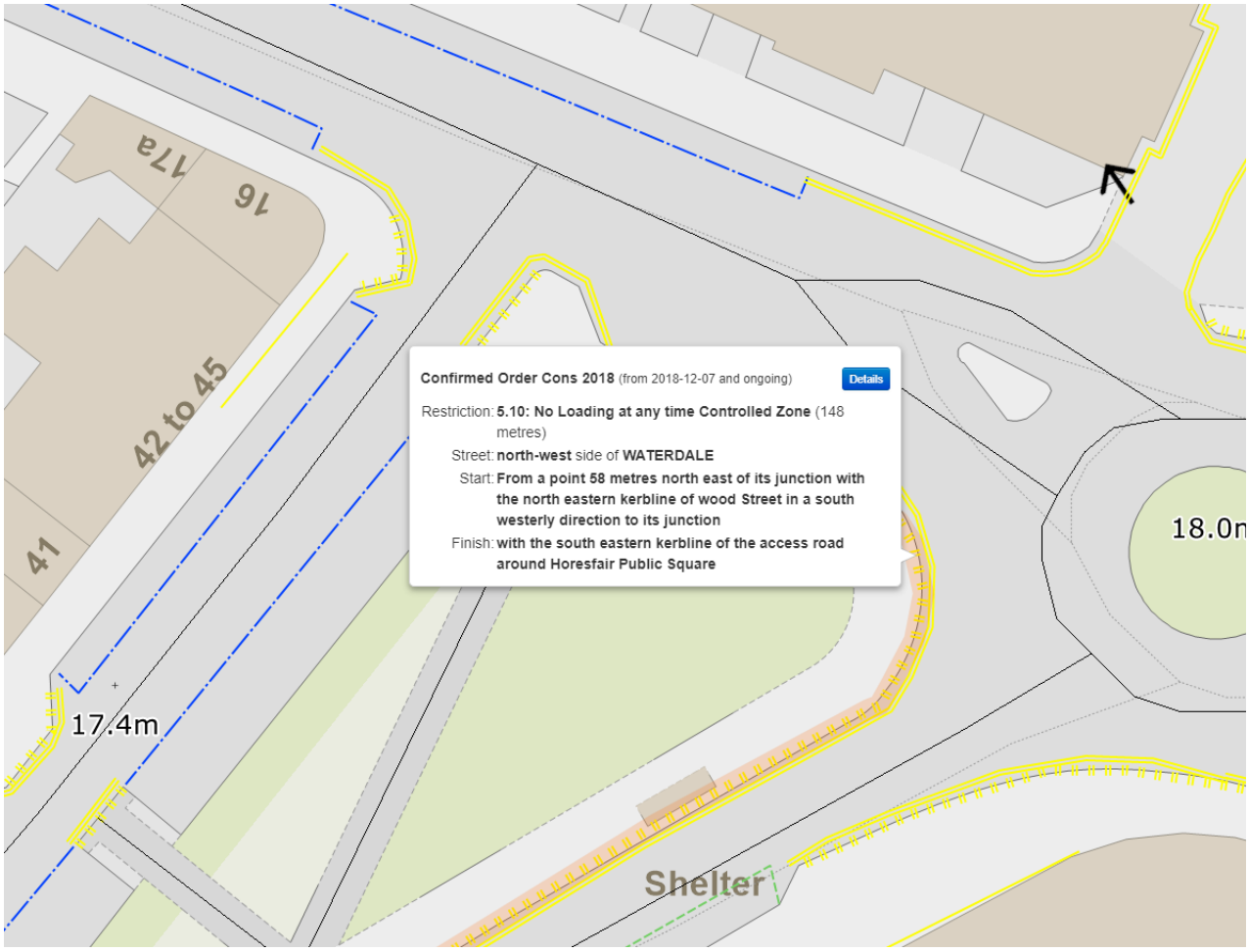
d) Readability can be an issue with polygon-based restrictions. If a double yellow or a double red line is drawn on the map, there is no need to explain to the public what it means. The connection is made automatically as the map represents physical markings made on the surface of the road. The use of polygons to represent existing restrictions expressed in the real world as painted lines can introduce confusion and a disconnect reality from its data and legal model.

In summary, while polygon-based restrictions have their advantages, it is important to consider the potential problems that can arise, including: readability issues, difficulties in calculating lengths of highway affected by restrictions (e.g. speed limits) for grant applications, editing complexities, and increasing greatly the potential for confusing the public.

Aside from parking bays, which can lend themselves to a polygon-based approach, for the limitations mentioned above (points 'a' to 'd') kerb-side restrictions are better captured as line-based restrictions.

Ultimately, the choice between polygon-based and line-based restrictions will depend on the specific needs and requirements of the highway authorities and their respective jurisdictions.

An example of such kerb-side line-based restrictions can be seen in the following image: please note its clarity and natural representation of real-world markings (including parking bays and double-yellow lines):



The Challenge and Solution

By way of a real-life case study, StatMap has been working with one of our new highway authority clients who had captured all of their restrictions as polygons. The quality of the data was high, and everything was meticulously maintained and up-to-date. However, because all of the restrictions were captured as polygons, it was impossible to fully utilise the benefits of the data. Ultimately, we were presented with a substantial number of polygon-based restrictions (approximately 20,000) that needed to be converted to lines.

In spite of the complex data challenge, our objective was to design and implement a process enabling the introduction of automation. During the project, we triailled the following approaches:

(1) Projecting existing polygon data on the centerlines of the roads and reprojecting them on the curves,

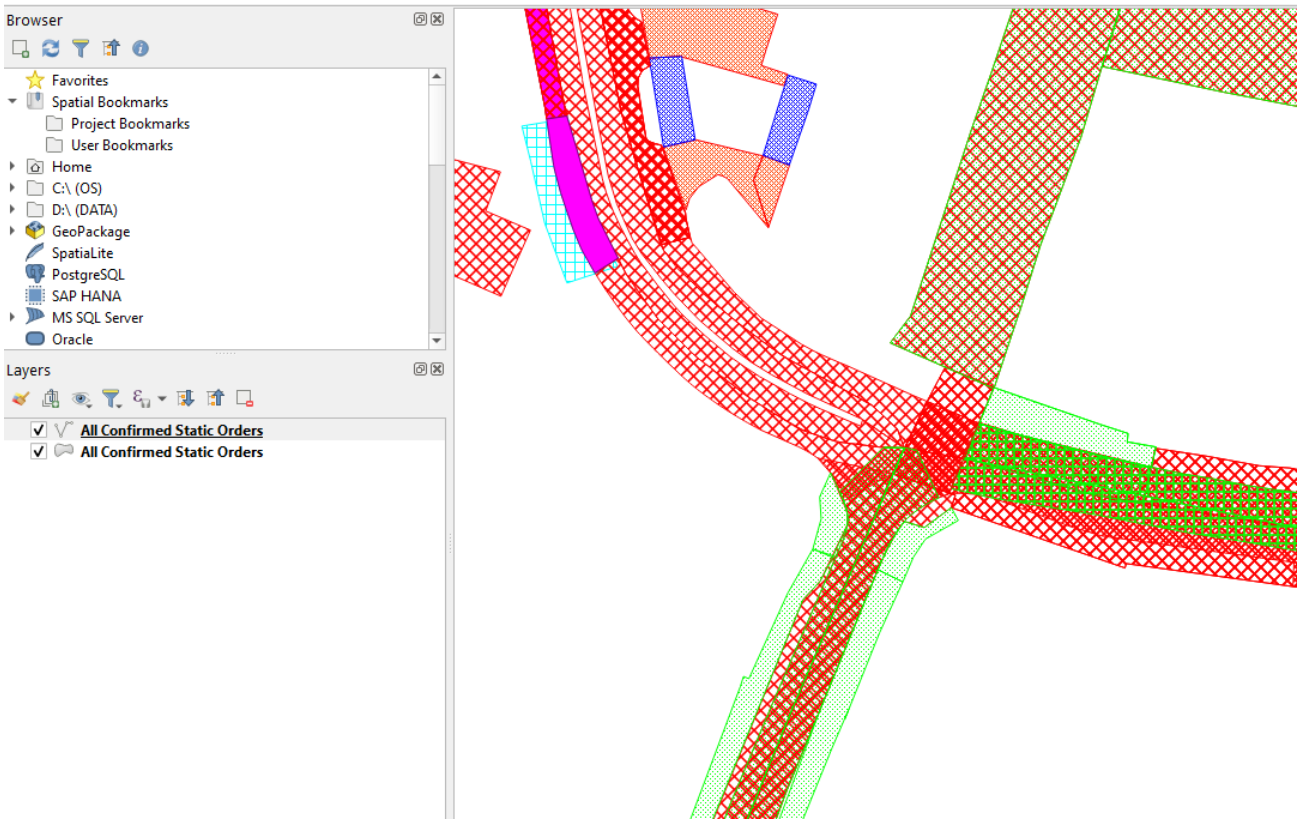
(2) Intersecting polygon-based restrictions on the lines

(3) Aligning existing polygons to a linework structure in order to extract line-based information.

This challenge presented an opportunity for us to explore new ways of managing geospatial data while enhancing its usability and accessibility. Converting such a large volume of polygon-based restrictions into line-based representations required a meticulous and efficient approach to ensure that the integrity of the data was preserved throughout the process.

Our team embarked on a thorough investigation of the existing data, examining the intricacies of the polygons and the restrictions they represented. By gaining a deep understanding of the customer's requirements and the specific nature of the data, we were able to devise a comprehensive plan for converting the polygon-based restrictions into line-based representations.

The following image shows a visual depiction of a sample of original polygon-based restrictions, as provided by the highway authority:



In order to accomplish this task, we employed various spatial algorithms and geospatial data processing techniques to handle the large volume of data accurately and efficiently. Our dedicated team worked to develop a custom solution tailored to the specific needs of our customer, ensuring that the conversion process was both smooth and accurate.

Throughout the conversion process, we maintained close communication with the client authority, keeping them informed of our progress and addressing any concerns that arose. This collaborative approach enabled us to fine-tune our methodology and deliver a final product that exceeded the client's expectations.

Upon completion of the conversion process, the client was presented with a dataset that was not only accurate and up-to-date but also far more accessible and useful. The line-based representations of the restrictions allowed for greater flexibility and adaptability in the utilisation of the data, unlocking its full potential and enabling the customer to make more informed decisions based on the information provided.

In addition, the successful conversion of the polygon-based restrictions into line-based representations has opened the door for further innovations and improvements in the field of geospatial data management. By demonstrating that it is possible to efficiently convert large volumes of polygon-based data into more versatile line-based representations, we have set the stage for the development of new tools and techniques that can streamline data processing and enhance the overall quality of geospatial information.

This innovative project has not only provided immediate benefits for the client authority but also laid the foundation for future advancements in the industry. As we continue to push the boundaries of what is possible in geospatial data management, we are committed to working closely with our customers and partners to develop innovative solutions that meet their unique needs and challenges. With a focus on collaboration, expertise, and a relentless pursuit of excellence, we aim to drive the industry forward and create new opportunities for growth and success in the realm of geospatial data management.

The Model Approach

After many refinements, we finally adopted the following model:

1. The abandonment of the use of line-based base mapping products, such as Ordnance Survey Topographic Line, in favor of polygon layers, specifically OS MasterMap Topographic

Area. The initial polygon-based restriction is then enlarged by 30 centimeters to account for any data capture discrepancies.

2. The enlarged polygon is then used to query all road polygons that intersect with it. The road polygons extracted from the Topographic Area layer are spatially merged, resulting in a single surface of the road(s) instead of multiple instances of polygons.

3. The boundary of the polygon, which is a line referred to as the outer ring or shell of the polygon, is then intersected with a buffered geometry of the original polygon-based restriction. This creates the final line work, which is then trimmed by 30 centimeters to compensate for the 30 centimetre buffering applied initially (in 1.)

By using this process, we can ensure that the resulting line work accurately reflects the intended restriction while accommodating for any potential data capture discrepancies. The use of polygon layers also provides a more efficient and streamlined approach to capturing and processing traffic regulation orders.

The Outcome

The automatic algorithm demonstrated remarkable success, converting over 90% of the polygon-based restrictions. Its clarity allowed for easy interpretation of its output, and the final results were highly encouraging. In fact, the end results were so promising that we could consider using polygon-based capturing as the first stage of an automated line-based restriction creation process.

The adopted approach would ultimately present the end result as a set of lines, even though polygons were originally used to mark the restriction zone. However, more research is needed to determine the feasibility of this approach, but the initial results are undoubtedly promising.

Currently, the officers of the client authority are evaluating the initial results of the automatic conversion of polygon-based restrictions into line-based representations. The visual and layman checks conducted so far have been very successful, with the outcome of the conversion appearing to match the manual process of redrawing lines from the original polygons.

While we await a more detailed response from the client authority, we have confidence that this new and unique methodology will help numerous highway authorities align their standards with the needs of the Department for Transport (DfT) and the clear requirements of the public.

The raw result of the algorithm, black lines were automatically extracted from polygons:

And final version with post-processing applied (lines have been styled and spatially offset from the kerb):

By automating the conversion process and using a more streamlined approach, highway authorities can more efficiently and effectively manage traffic regulation orders. The additional benefits of this follow on thereafter: helping to improve highway safety, accessibility, and sustainability of our road networks, ultimately benefiting the public as a whole.

This innovative solution has the potential to revolutionise the way in which highway authorities manage and maintain their land charge data. By streamlining the process of converting polygon-based restrictions into line-based representations, councils can more effectively meet the demands of both the Department for Transport (DfT) and the general public. Additionally, the automated nature of the algorithm reduces the risk of human error and ensures a higher degree of accuracy in the data.

As we continue to refine and expand upon this approach, we anticipate that it will become an invaluable tool for local authorities across the country. With the potential to improve data quality, reduce administrative burdens, and enhance the overall efficiency of land charge management, the automatic algorithm represents a significant step forward in the world of geospatial data management.

In conclusion, the initial success of the automatic algorithm has laid the groundwork for further research and development in this area. By building upon these promising results, we hope to create a comprehensive solution that not only meets the needs of the Department for Transport (DfT) and the public but also sets a new standard for land charge management and data accuracy. Through continued collaboration with partnering highway authorities and industry experts, we aim to shape the future of geospatial data management for the betterment of local authorities and the communities they serve.

Taking the Line-Based Approach further

Even for moving restrictions, using appropriately styled and rendered line geometries for speed limit signs is much clearer than the use of polygons.

Point restrictions (single road signs) are also better captured as a two-point line as this enables the direction of the sign to be encoded, so displaying the direction in which the sign is facing.

In effect, a line-based approach could replace all other geometry types for capturing TROs.