Report into Estates Strategy Optimisation and Modelling for East Midlands Ambulance Service

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6th November 2012

Document control

Document Title	Report into Estates Strategy Optimisation and Modelling for East Midlands Ambulance Service
Version	1.0
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Distribution	Andrew Spice
Document Status	For publication

Executive Summary

This report contains the findings from analysis conducted to optimise the location of East Midlands Ambulance Service (EMAS) Tactical Deployment Points (TDP). Optimisation was undertaken based upon three key variables defined by EMAS, namely: time to arrive at incidents, concentration of staff into hubs and travel times from hubs to tactical deployment points.

The solutions were developed initially using geographical optimisation software and then refined taking into account practical considerations. The impact on response standards of introducing the solution has been quantified using a proven simulation model of ambulance response processes that has been validated against historical performance achieved by the Trust.

Proposed solution

The proposed solution has the following characteristics:

- 110 tactical deployment points (131 if an option for increased geographical resilience is selected) compared to 153 currently
- 13 hubs compared to 66 stations currently
- A predicted rise in Red8 performance of 3.7% based upon 2011/12 performance and incident volumes
- By adopting the new service model in conjunction with the estates changes, Red 8 performance is predicted to rise further
- An increase in the average travel time to work for operational staff, from 17.4 minutes to 21.5 minutes
- It includes a number of practical changes to the theoretical optimum incorporated as a result of consultation with operational managers and other stakeholders

Key dependencies on realising the above benefits are:

- Removal of historical divisional boundaries in order that hubs can serve their designated TDPs
    - In turn requiring changes to operating practices and processes within the EOC
- It is practical to base vehicles at or very close to the TDPs locations stated in this report

Implementation

Clearly further practical estate constraints, feedback during the consultation period and external drivers are likely to mean that the solution will evolve over time.

The configured simulation models can be used to support the evolution of the estates strategy by quantifying the effect of such changes, not just on overall performance but also on other measures such as geographical equality of performance and staff journey times.

We recommend that continued access to the toolset is acquired in order that the benefits from the proposed solution are not diluted during the next phases.

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1. Introduction

This report contains the findings from a study commissioned from Process Evolution to develop an 'optimised estates strategy' as part of East Midlands Ambulance Service's (EMAS) '*Being the Best*' programme.

Being the Best is designed to ensure that the EMAS provides the right patient services, within the funds available, for the long term. It will involve improving the way in which the Trust works, including changes to the estate, service model and management structures.

Process Evolution specialises in helping the emergency services to optimise *where*, *when* and *how* they deploy their resources in order to respond to demand effectively and efficiently. We have developed an evidence based approach that is underpinned by a suite of advanced analytical tools. These tools propose optimal solutions and can accurately predict the effect on performance if these solutions are implemented in real life. Our evidence based approach is proven across the emergency services including other UK ambulance services.

1.1. Desired outcomes

In developing the solution contained in this report, we recognised the following desirable outcomes from the new estates strategy:

- Improving timeliness of response by siting deployment locations near to where demand occurs with broad geographical coverage
- A smaller number of 'hubs' to replace existing stations in order to facilitate:
    - Increased availability of clinicians to treat patients through 'make ready' vehicle services being undertaken by other staff
    - More modern facilities for staff
    - Increased access to crew support when required
- Hub locations that take into account staff travel time to work and from hub to deployment locations
- Potential sales value of current stations and reduction in required maintenance spend
- Appropriate given operational considerations

We therefore spent time working with EMAS stakeholders to understand the practical implications in achieving these outcomes and these were fed into the optimisation process. Refinements were made to the initial 'theoretical solutions' in order to take into account operational issues, the suitability of existing estate and the feasibility of finding new estate.

1.2. New service model

The estates strategy cannot be considered in isolation from the Trust's plans to change its service model and management structures. In particular:

- The location and size of estate needs to take into account any planned changes in resource mix and number to ensure that the resource can be suitable accommodated
- New management principles such as staff regularly seeing Team Leaders at shift start and end requires hubs of a critical size
- The larger resource pools at hubs provide greater opportunity to design rosters that align staff availability more closely to *when* demand occurs

Indeed, it is only by combining the estates strategy and operating model that the response process can be truly optimised. In particular, the new service model can be used to mitigate areas of risk in the estates strategy.

1.3. Report structure

The report structured as follows:

- Section 2 contains an overview of software used to conduct the analysis, alongside the data used and any assumptions made in the analysis
- Section 3 details the analysis to optimise the locations of tactical deployment points across EMAS and then to group them into sensible hub locations
- Section 4 describes the process by which other considerations were incorporated to convert a theoretical solution into a practical one
- Section 5 quantifies the effects upon response performance if the practical estates solution were to be implemented
- Section 6 assesses the impact on operational staff of adopting the practical estates solution
- Section 7 draws together the key findings and our conclusions from the optimisation and modelling work

2. Software Used for the Analysis

To conduct the optimisation analysis and to assess the impact changes made would have on EMAS performance two pieces of software developed by Process Evolution were used:

- Facility Location Planner: This software was used to find the optimal locations for tactical deployment points across all five divisions of EMAS and to allocate these points into an optimised number of despatch groups with associated hub locations (see section 2.1 for further detail)
- Ambulance Response Profiler: This software was used to assess the impact upon EMAS performance of any changes made to the Estates Strategy (see section 2.2 for further detail)

2.1. Facility Location Planner

2.1.1. Overview

When conducting location optimisation the number of potential combinations those locations may take increases exponentially as the number of locations required increases.

For example, to decide where to put one location out of 100 possible options requires 100 tests to find the 'optimal' solution. To find the optimal solution of two locations requires 100*99/2 = 4950 tests and there are 79,776,075,565,900,400,000,000 ways of selecting 24 locations out of 100 possible options – clearly to test every combination would not be practical.

Facility Location Planner (FLP) is a tool that uses heuristic algorithms to intelligently refine and improve solutions, removing the need to test every single potential combination of locations in an optimisation analysis. Its role within the work was two-fold:

- Obtain the optimal number of and locations for tactical deployment points across the EMAS Trust area
- Allocate these tactical deployment points into an optimised number of despatch groups with associated hub locations, so that each group contains tactical deployment points within a desired travel time of their associated hub

2.1.2. Key data inputs and data sources

This section details the sources for the input data used and provides summaries of the key data points used in the optimisation analysis.

Incident Data

Raw incident and deployment data has been provided by EMAS for the period 1st April 2011-31st March 2012. This was used to generate the following key inputs:

- Overall annual volumes for the 2011/12 financial year
- How these incidents split into difference incident categories
- How these incidents split across the geography (see below)

When optimising locations the geography covered must be split into *areas* that show the location and concentration of incidents across the trust. However when deciding what size of area to split the geography into there is a trade-off to be made; if the area chosen is too large there will not be the required granularity in the data to allow sufficiently accurate optimisation, whereas if the area chosen is too small it impacts the processing time required to conduct the optimisation.

Consequently the locations of each incident within the year were allocated, based upon its postcode, into its relevant Lower Super Output Area (LSOA). A LSOA is a subset of a Super Output Area, which is defined as "a geographical area designed for the collection and publication of small area statistics". It is used on the Neighbourhood Statistics website, and has a wider application throughout national statistics. "SOAs give an improved basis for comparison throughout the country because the units are more similar in size of population than, for example, electoral wards"[1].

Process Data

Travel Times: The time taken to travel from each LSOA to all of the other LSOAs within the EMAS Trust boundary was generated using Microsoft MapPoint 2011. An allowance was made for the fact that emergency response vehicles will typically be able to travel at faster speeds than normal vehicles.

2.2. Ambulance Response Profiler

2.2.1. Overview

Ambulance Response Profiler (ARP) is a computer simulation model used to accurately predict the effect on performance against response standards of various 'what-if' scenarios. Its role within this work was also two-fold:

- Predict the impact on performance of the optimised tactical deployment points and hub locations
- Predict the impact on performance of the changes made to the optimised solution to account for practical considerations proposed by EMAS operational staff

2.2.2. Key data inputs, data sources and assumptions

Clearly any model such as ARP is reliant on good quality input data to ensure that the outputs of the model are an accurate reflection of reality. This section details the sources for the input data used in ARP, provides summaries of the key data points and lists any assumptions used in the modelling.

Data sources for the model fall into one of three main categories:

Incident and Deployment Data

As previously mentioned, raw incident and deployment data has been provided by EMAS for the period 1st April 2011-31st March 2012. This has been used to generate the following key inputs:

- Incident profiles
    - Overall annual volumes for the 2011/12 financial year
    - How these incidents split across incident categories, geography (post code sectors), weeks of the year (seasonality) and hours of the week (weekly demand profile)
- Allocation times, Mobilisation times and At Scene times
    - These are split by both incident category and vehicle type to provide the most accurate profile possible
    - Distributions of data are used (as opposed to just averages) to ensure that the impact of both shorter than average and longer than average times is modelled

[1] Source: Local Government, Improvement and Developent, Website; Local Government Glossary, Super Output Areas, http://www.idea.gov.uk/idk/core/page.do?pageId=7175806

- Conveyance rates to hospital
    - Split by incident category and whether the first arriving vehicle was an ambulance or car
- Hospitals attended and Handover times

Resource Data

Each division provided a list of 'core shifts' – those shifts which they are planning to put out on a weekly basis. Break windows and lengths within these shifts were included according to each division's policy.

Process Data

The final strand of data is process data – an understanding of how the operation works which is not covered by the incident and deployment data:

Vehicle Dispatch Logic and Status Plans: The locations from which vehicles can be deployed, their priority order and the approach taken in each division when dispatching vehicles to incidents of different categories was obtained through meetings held with Ben Holdaway and Simon Tomlinson.

Travel Times: The time taken to travel from the deployment locations to incident locations (at a postcode sector level) and from the incidents to hospitals is generated using Microsoft MapPoint 2011. An allowance for faster than expected travel times for emergency incidents is calculated to ensure the total amount of time spent travelling to incidents matches the actual amount of time which can be calculated from the raw data.

2.2.3. Model Validation

The first stage of any simulation project is to validate the model against known existing performance. A separate model for each division was built in ARP and used for the validation, modelling the 'as-is' process and incident data from 2011/12 and assessing the model 'predictions' against actual performance of financial year 2011/12.

In each case the model was found to accurately predict performance and to be well within normal tolerances. Overall Trust performance was to within 0.2% of that actually achieved for the Red8.

2.2.4. ARP Data Limitations and Assumptions

There were a small number of assumptions that had to be made regarding the data used in the Ambulance Response Profiler models, which resulted in a slightly higher tolerance of 'validated' model performance to account for these; however these higher tolerances are still acceptable for the high level estates strategy modelling that is being undertaken in this project.

- Resource Availability - Shifts: There was little data available regarding how often the core vehicle shifts provided for each division were actually fulfilled. Therefore the models assume that the vehicle shifts in the data are always fulfilled exactly as specified; it is noted that the limited data available to check this indicates that this is a fair assumption
- Resource Availability – Lost Hours: There was no data available to indicate what proportion of on-shift vehicle time is lost, i.e. time when a vehicle should be on shift but is neither allocated to an incident nor available for allocation. It has been assumed that 2% of on-shift time is lost time based upon work conducted by Process Evolution for other ambulance trusts

3. Optimisation of Tactical Deployment Points and Hubs

As detailed in section 2.1.2, the incidents that occurred in the financial year 2011-12 were grouped into Lower Super Output Areas as a suitable granularity of geography to enable the optimisation conducted to be of sufficient granularity. This section details the approach taken to optimising the tactical deployment points (TDPs) based upon this information and the results of that analysis.

3.1. Comparing Different Estates Solutions

In order to compare the current locations of TDPs with those generated from any optimisation an 'Optimisation Score' is used; this score, expressed as a percentage, is a static assessment of the proportion of incidents that are within a required *drive time* of the locations included. So a score of 100% would mean that all incidents were within the required drive time from at least one of the locations

It is important to note that an ***optimisation score is not an assessment of the level of performance that may be achieved using those locations***, it is merely an indication of how well positioned the locations are compared with the locations of the incidents. Whilst a score of 80% would mean that 80% of incidents are within the required drive time of a TDP, there would have to be available resource at all TDPs 24/7 in order for this to be the achieved performance. In reality of course, resources get called away from TDPs to attend incidents as events evolve each day and the Trust dynamically allocates resources to the busiest areas as they then become available again.

Our simulation modelling software is however able to accurately quantify the impact of these real events and has therefore been used to determine the impact on performance – the findings are contained in section 5 of this report.

3.2. General Optimisation Methodology

The optimisation of the TDPs has been split into two stages:

1. Use the incident data in Facility Location Planner to optimise the tactical deployment points
    a. This assessment was broken down from trust level and conducted within each of the five current divisions; this was due to the large quantity of Lower Super Output Areas contained within the entire trust
2. Arrange the optimised TDPs into despatch groups and associated hubs (see section 3.5 for further detail)
    a. This assessment was done without adhering to existing divisional boundaries

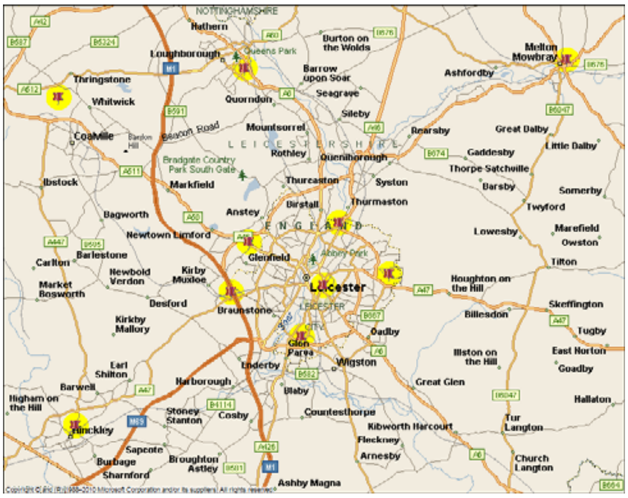
When conducting the optimisation of the TDPs and the hubs there was no reference made to the existing estate of the trust; it was decided that the theoretical best solution was to be found and the predicted performance of this solution (found using Ambulance Response Profiler) would then be compared with the historical performance of the trust.

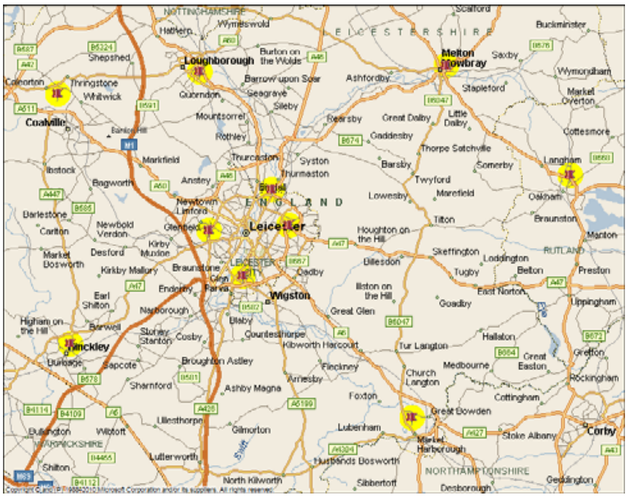
3.2.1. Relative Importance of Different Incident Targets

Facility Location Planer can optimise against several different targets at the same time; in this analysis the incidents (and hence the targets) were broken down into Red 8, Red 19, Green 1 (20 minute target), Green 2 (30 minute target) and 'all other' incidents (Green 3, Green 4 and Urgent – given a nominal target of 60 minutes). A one minute mobilisation time was assumed to create the 'drive time targets' used by the optimiser – e.g. for the Red 8 target it is looking to optimise the number of incidents that are within 7 minutes' drive of a TDP.

Each of these different targets is given a weighting in the software to define their relative importance. How these weightings are set can make a difference to the locations chosen by the optimisation algorithm.

For example, the two maps below show the best ten locations in Leicestershire, with the map on the left being when Red 8 is the only target that we're interested in and the map on the right being if we are equally interested in all performance measures.





As can be seen, when Red 8 is the only performance target of interest there are six deployment points in the city of Leicester with no deployment points to the south east. When all targets are given equal importance two deployment points are moved from Leicester to be near Market Harborough and Oakham; i.e. there is a better geographical spread.

Although EMAS is judged nationally against the Red 8 and Red 19 targets, it was felt that solely focusing on these targets would not be desirable to achieve a good optimisation; EMAS has a duty of care to all patients and this needs to be factored into the analysis.

Consequently, the relative importance of the targets was analysed and set to a level where there was a focus on the Red 8 target but other targets were also given weightings that ensured a good geographical spread around each of the divisions.

3.3. *Optimisation of TDPs in Leicestershire*

This section describes the approach taken to determining what the desired number of TDPs in a division should be, using Leicestershire as an example. Once this section has been used to explain the rationale behind the analysis, the outcomes in the other divisions (but not the detailed approach) are reported in section 3.4.

3.3.1. Comparing Optimisation with Current Estate

When the locations of the current stations and tactical deployment points are entered into Facility Location Planner it gives it an overall optimisation score of 88.7%. Within that 79.6% of all Red incidents are within 8 minutes mobilisation and travel of either a deployment point or station.

The current estates strategy within Leicestershire contains 21 locations, however it is noted that some of these locations are very similar due to some stations having local deployment points.

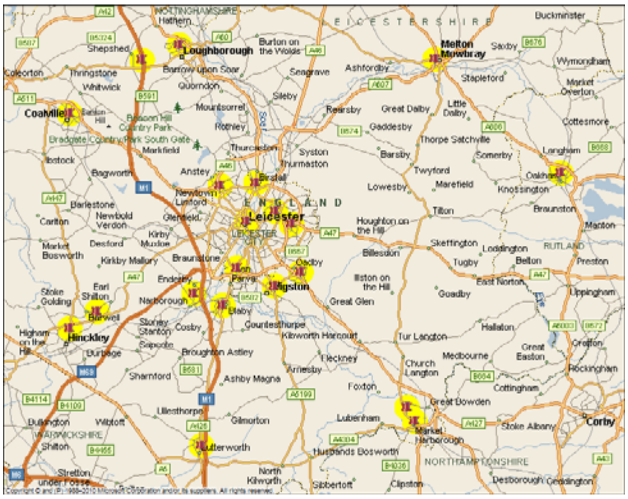
To analyse the effects of moving to an optimised solution the optimisation algorithm within Facility Location Planner was asked to provide the best 16 deployment locations within the division; this number of locations was chosen because it is comparable with the number of TDPs within the current Leicestershire daytime status plan.

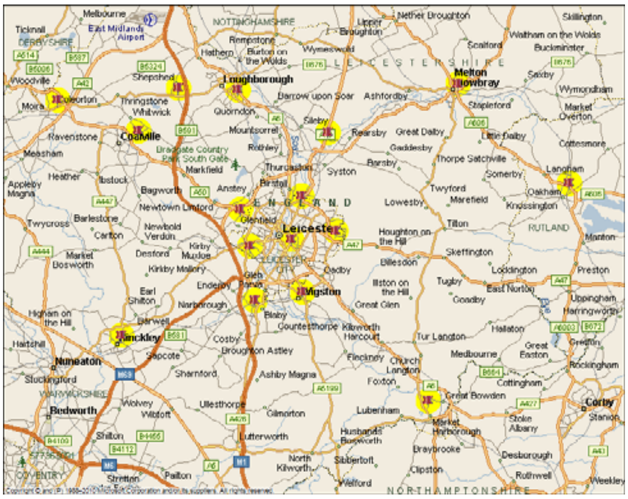
The table below compares the optimisation score of the 16 optimised locations with the current estate:

	# of Locations	Optimisation Score	Red Incidents within 8 Mins.
Current Estate	21	88.7%	79.6%
Optimised Locations	16	92.4%	86.4%

As can be seen, an improved optimisation score is achieved using a smaller number of locations than the current estate.

The two maps below show a comparison of where the current locations (stations and deployment points) are positioned in the current estate (left hand map) with where the optimal 16 locations are positioned (right hand map).





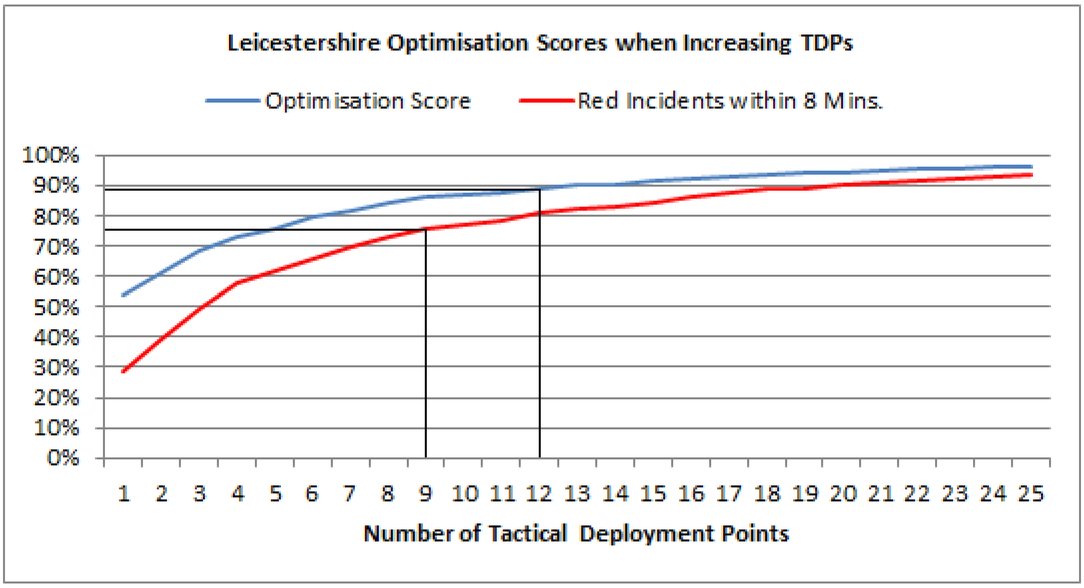
The TDPs in the optimal solution are in broadly similar places as the current estate but positioned at different places within them. The main differences in the optimised solution are:

- Fewer TDPs in Leicester, the Hinckley area and Market Harborough
- A TDP located near to Ashby (west of Coalville, in the upper left corner of the right hand map)

3.3.2. Setting the Required Number of TDPs

As the number of TDPs within each division increases the optimisation score achieved will also increase; however there is a diminishing return as each one is added to the solution.

The chart below shows the optimisation score and the proportion of Red incidents within 8 minutes mobilisation and travel of a deployment point as the number of deployment points in Leicestershire increases.



When choosing the 'required' number of TDPs within a division there are three approaches that could be used based upon comparing the above chart with a level of desired performance:

1. Set the number of TDPs such that the optimisation score achieved is comparable with the Red 8 performance required; in this instance that equates to 9 TDPs. However to achieve a performance of 75% using that number of TDPs would be virtually impossible, since it assumes that all TDPs would always have a resource free and waiting when an incident occurs.
2. Set the number of TDPs such that the optimisation score achieved is comparable with the optimisation score of the current estate; in this instance that equates to 12 TDPs. This is perhaps the most cost effective solution but it has a risk that there may be some geographical gaps within the division.
3. Set the number of TDPs such that the vast majority of Red incidents are within 19 minutes of a TDP and a good geographical coverage is achieved

Although option 3 is slightly more subjective that the other two, it was chosen as the approach to maximise the performance benefits whilst still reducing the number of overall despatch locations.

For Leicestershire the number of TDPs chosen was actually 16 and the relevant map in section 3.3.1 previously shows the chosen locations of those TDPs.

3.4. Optimisation of TDPs in Remaining Four Divisions

This section details the results of the tactical deployment point optimisation in each of the remaining four divisions using the same methodology as detailed for Leicestershire in section 3.3. For each division there is a table that shows the number of TDPs, the overall optimisation score and the number of Red incidents within 8 minutes mobilisation and travel of a TDP for 6 scenarios:

- The number of daytime deployment locations in the current status plan
- The number of all current deployment and station locations
- Optimised locations of the same number of TDPs as are in the current daytime status plan
- Optimised locations of TDPs required to achieve 75% of Red incidents within 8 minutes mobilisation and travel of a TDP

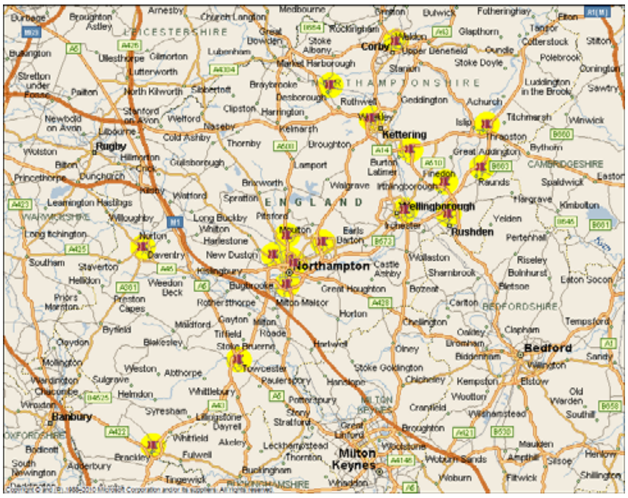
- Optimised locations of TDPs required to achieve an optimisation score at least as good as the current estate strategy
- The chosen number of TDPs (see section 3.3.2 for on what the approach to choosing this number is based)

In addition there are maps showing a comparison of the current estates strategy and the chosen number of optimised TDPs.

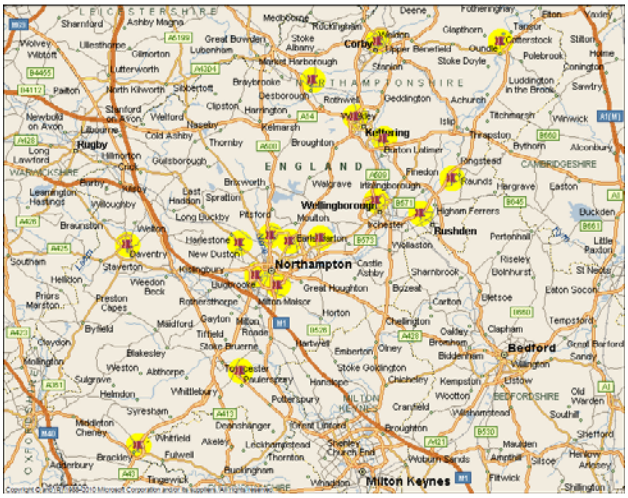
3.4.1. Northamptonshire

	Current Status Plan	All TDPs & Stations	Optimised - Same # TDPs as Status Plan	Optimised - Meet 75% Red Incidents in 8 Mins.	Optimised - Score at Least Same as Current	Optimised - Chosen Number of TDPs
# Points	18	18	18	8	12	17
Optimisation Score	91.5%	91.5%	95.1%	87.7%	91.6%	94.6%
Red Incidents within 8 Minutes	81.2%	81.2%	90.9%	78.2%	84.7%	90.0%

Current Estate



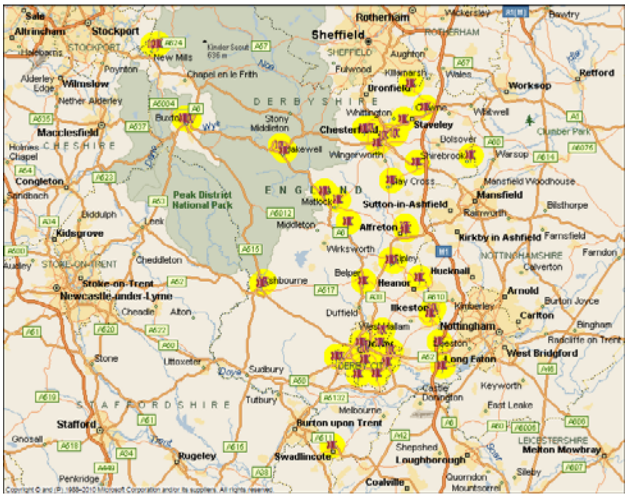
Optimised TDPs



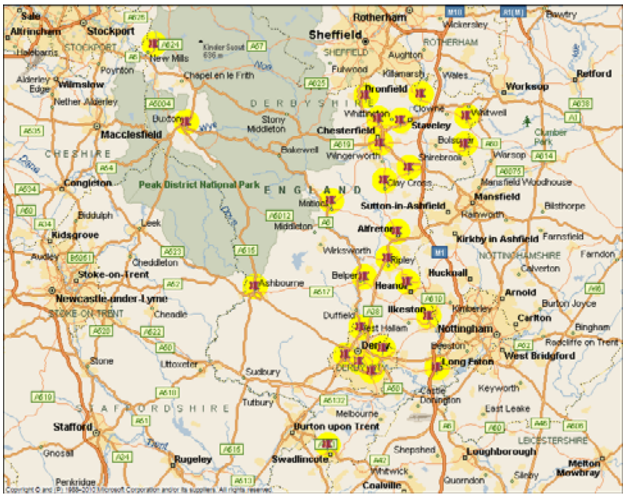
3.4.2. Derbyshire

	Current Status Plan	All TDPs & Stations	Optimised - Same # TDPs as Status Plan	Optimised - Meet 75% Red Incidents in 8 Mins.	Optimised - Score at Least Same as Current	Optimised - Chosen Number of TDPs
# Points	32	47	32	14	21	25
Optimisation Score	90.4%	91.9%	96.6%	86.6%	91.9%	94.0%
Red Incidents within 8 Minutes	82.5%	85.3%	94.0%	76.6%	85.4%	89.2%

Current Estate



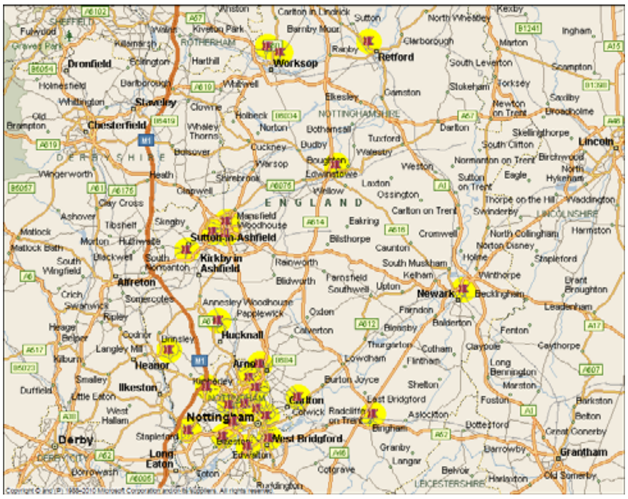
Optimised TDPs



3.4.3. Nottinghamshire

	Current Status Plan	All TDPs & Stations	Optimised - Same # TDPs as Status Plan	Optimised - Meet 75% Red Incidents in 8 Mins.	Optimised - Score at Least Same as Current	Optimised - Chosen Number of TDPs
# Points	16	26	16	10	14	19
Optimisation Score	85.5%	90.9%	92.9%	86.3%	91.0%	94.5%
Red Incidents within 8 Minutes	73.3%	83.2%	86.9%	75.1%	83.4%	89.9%

Current Estate

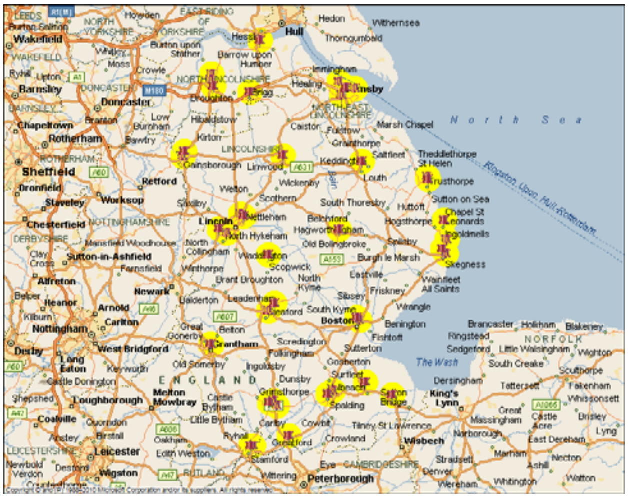


Optimised TDPs

3.4.4. Lincolnshire

	Current Status Plan	All TDPs & Stations	Optimised - Same # TDPs as Status Plan	Optimised - Meet 75% Red Incidents in 8 Mins.	Optimised - Score at Least Same as Current	Optimised - Chosen Number of TDPs
# Points	33	41	33	21	21	26
Optimisation Score	85.0%	86.2%	91.9%	86.7%	86.7%	89.1%
Red Incidents within 8 Minutes	72.7%	74.8%	85.2%	75.9%	75.9%	80.3%

Current Estate Optimised TDPs



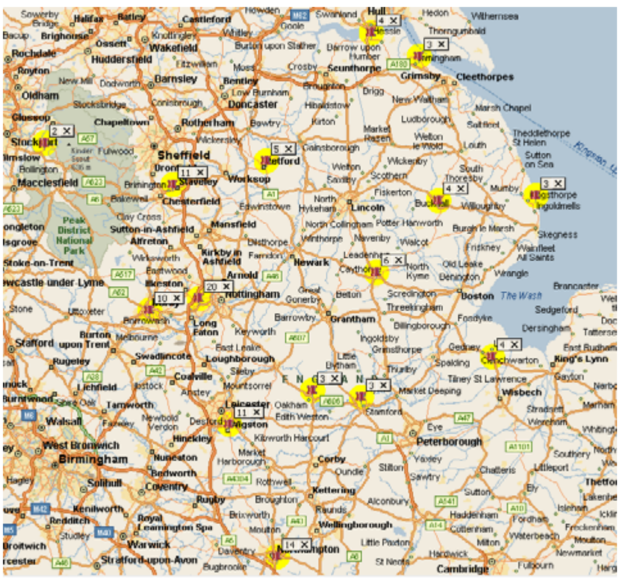
3.5. *Hub Optimisation Methodology*

Once the optimised number and positions of the TDPs had been ascertained, the next stage was to select the locations of the hubs that would serve those TDPs. As noted in section 3.2, this process was done without it being influenced by existing divisional boundaries.

In this document the term *hub* is a generic one that simply refers to a location that members of operational staff will report to at the beginning and end of their shift, which could be anything from a station with no other associated TDPs (stand-alone hubs) through to very large inner-city station with a number of associated TDPs.

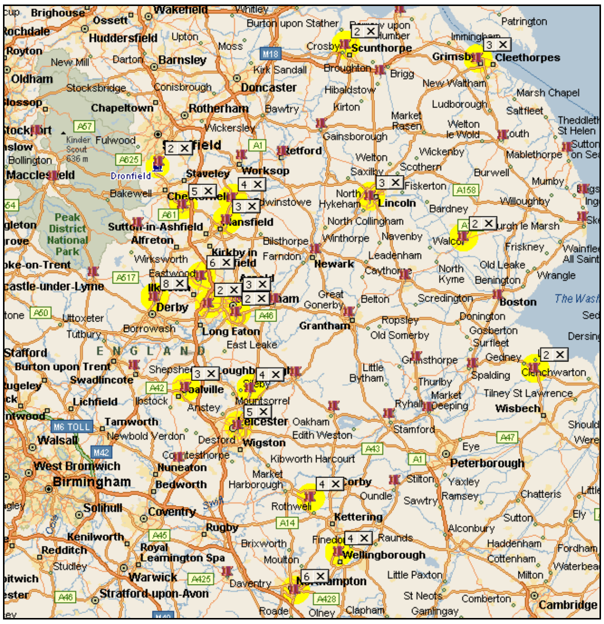
The approach taken to this was to optimise the number of TDPs that are within *x* minutes of their hub, where x was tested for a range of values. Note that any TDPs that were not within the required travel time of any other TDP had to be defined as a hub. It is assumed that hubs are also TDPs in their own right, thus we are selecting our hub locations from the list of TDPs already identified.

The two maps below show the optimised TDPs (left hand map) alongside the locations of hubs (right hand map). The numbers adjacent to the hubs are the number of TDPs associated with each hub if all TDPs had to be within 30 minutes' drive of their hub.



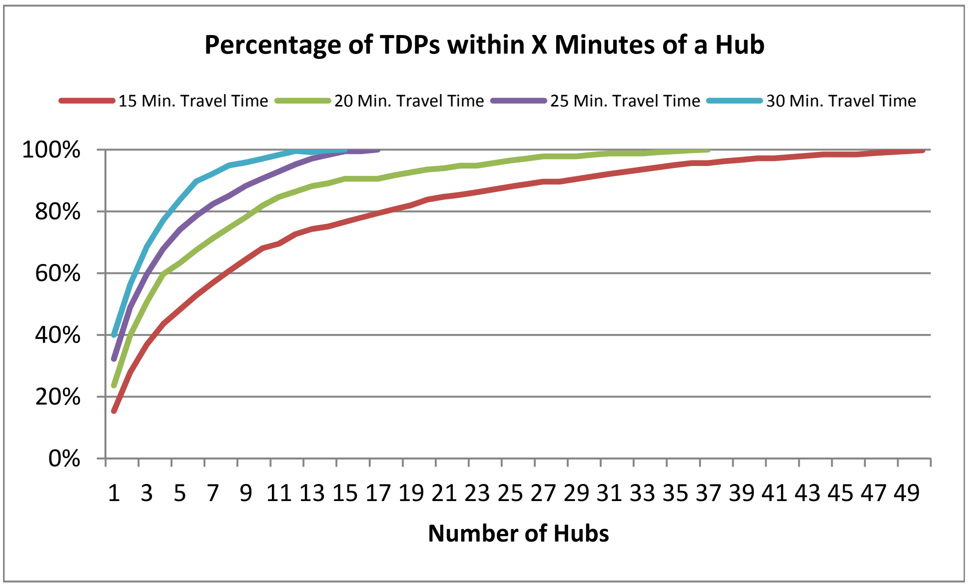
This would require there to be 15 hubs across the entirety of the trust, with none of them being stand-alone hubs.

The two maps below show the comparable solution using 15 minute drive times.



This would require there to be 50 hubs across the trust, with 30 of them being stand-alone hubs.

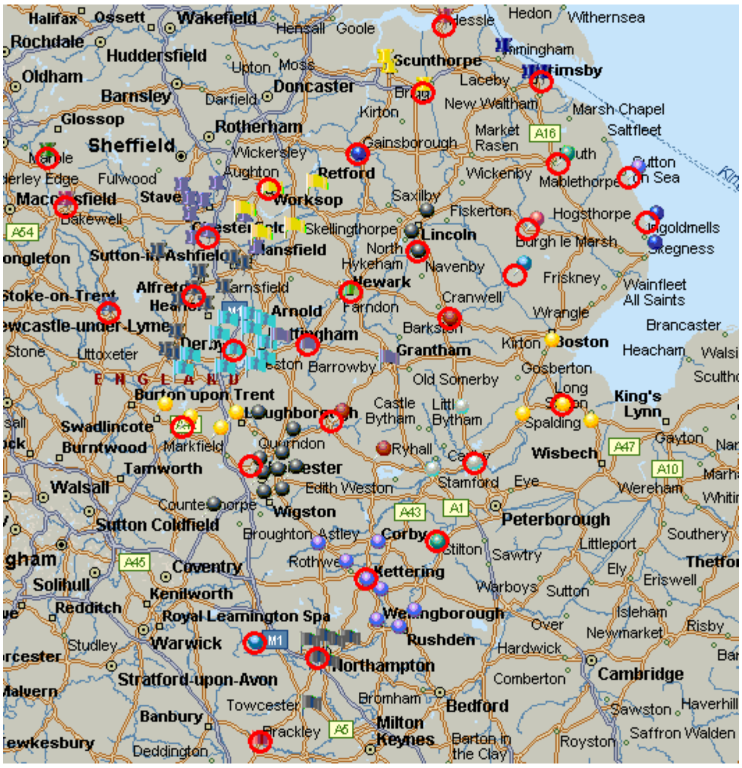
There is clearly a range of times between examples of 15 and 30 minutes shown above; alongside that, as the number of hubs increases for each time value the proportion of the TDPs that are within the required travel time will increase. This is shown in the chart below.



In order to balance drive times between hubs and TDPs an initial optimisation was carried out based upon a maximum 20 minute drive time from hub to TDP. This theoretical solution was then refined (section 4) in the light of practical considerations.

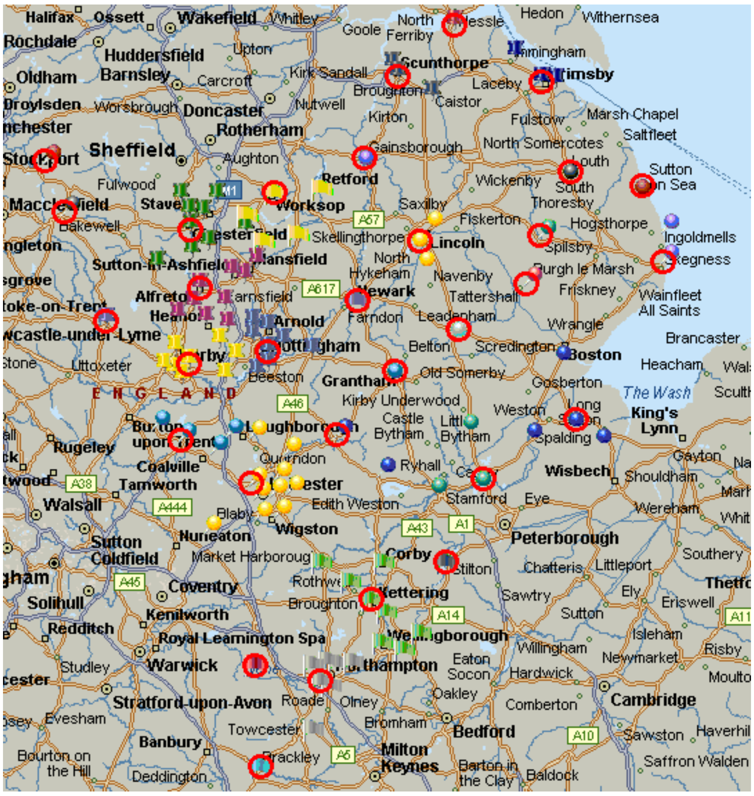
3.6. Theoretically Optimised Hub Locations

The map below shows how Facility Location Planner grouped the optimised TDPs into hubs based upon the points being within 20 minutes' drive of their hub. Each of the hubs is highlighted by a red circle, with its associated TDPs being shown with the same symbol as the hub itself.



When assessing the output from Facility Location Planner it was noted that there were a small number of areas where although the output satisfied the requirement for TDPs to be within 20 minutes' drive of their hub it was felt that some manual adjustment was required to improve the quality of the proposed solution:

By applying these manual changes the solution shown in the map below was reached.



The approach used to optimise the hub locations without accounting for existing divisional boundaries has resulted in TDP allocations that cross those boundaries in several places:

- Large crossover on the boundary of Derbyshire and Nottinghamshire
- Swadlincote is allocated to a hub in Leicestershire
- Market Harborough is allocated to a hub in Northamptonshire

The next stages of the analysis were to assess the potential impact of adopting the chosen theoretically optimised solution and to assess whether there were any changes required to account for practical considerations proposed by EMAS operational staff.

4. Converting theory into a practical solution

The analysis detailed in section 3 showed that moving from the current estates strategy to the theoretically optimised strategy would significantly increase the proportion of incidents that were within target response times of a TDP. Initial runs of our simulation model confirmed that this could be translated into significant performance improvements.

However the optimisation up to this point had been conducted very much as a theoretical solution; no consideration has been made regarding the practical implementation of the proposed strategy. This section describes the process by which we consulted with stakeholders and the key findings obtained. There were four key areas examined:

- Workshops with managers from operations and estates
- Realising the benefits from hubs
- Testing the proposed estates strategy in conjunction with the proposed new service model
- Understanding the impact on geographical resilience from increasing the number of TDPs

These four areas are considered in the sub-sections below.

4.1. Workshops with operations and estates

As discussed in section 3, the clustering of TDPs into hubs resulted in hub catchments that crossed geographical boundaries. We received a steer from senior management that if evidenced as beneficial, merging historical divisions would be permitted, recognising that implementation of such new structures would require examination of EOC dispatch processes and operating practices.

We therefore held workshops which reflected the suggested merger of Derbyshire with Nottinghamshire and Leicestershire with Northamptonshire with Lincolnshire remaining stand alone. The workshops involved discussion of the proposed locations from an operational perspective, such as taking into account patient flows, and from an estates perspective in terms of feasibility of selling / retaining current buildings.

We then tested the proposed changes in order to quantify their effect, with staff allocated from existing stations to their nearest hub.

4.1.1. Derbyshire and Nottinghamshire

- A third hub should be added between Derby and Nottinghamshire (near the QMC), with the Derby hub being moved nearer to the Royal Derby Hospital
- A hub should be included in Mansfield (Kings Mill)
- A number of minor adjustments to TDPs in order to increase accessibility to the wider road network

This would result in a hub structure with corresponding staff numbers as follows:

Hub	Staff
Derby West	201
Chesterfield	115
Nottingham	111
QMC	103
Kings Mill	89
Worksop	61
Ripley	58
Newark	30
Buxton	29
Ashbourne	12
New Mills	12

4.1.2. Leicestershire and Northamptonshire

- The Ashby hub should be located at Loughborough (and the consequential movement of increased levels of resource to that area), giving improved performance in that area
- Oundle hub should be removed from the solution, giving a small incremental performance from locating its staff at the neighbouring hub
- A hub should be located at Wellingborough whilst moving the Kettering hub further north to Corby. This leads to improved performance in that area, with 'knock-on' improvements in Leicestershire

This would result in a hub structure with corresponding staff numbers as follows:

Hub	Staff
Leicester	253
Loughborough	101
Northampton	94
Corby	85
Wellingborough	48
Melton Mowbray	32
Daventry	23
Brackley	12

4.1.3. Lincolnshire

- Moving Holbeach hub to Algarkirk brings improved performance in that area and should be adopted

This would result in a hub structure with corresponding staff numbers as follows:

Hub	Staff
Lincoln	76
Algarkirk (Boston)	75
Grimsby	69
Scunthorpe	65
Louth	41
Skegness	38
Grantham	32
Market Deeping	27
Sleaford	25
Gainsborough	25
Barton-Upon-Humber	12
Coningsby	12
Horncastle	12
Trusthorpe	12

4.2. *Realising the benefits from hubs*

A key driver for replacing the current ambulance station estate with a smaller number of hubs is to provide a greater number of facilities and support for staff when required. In particular, the Trust is keen to ensure that PTLs are able to provide a more 'hands on' management and support role to staff that are often operating in a stressful and pressurised environment.

In order to co-locate PTLs with the staff for whom they are responsible, provide 24/7 coverage and maintain appropriate ratios of PTLs to staff, it is desirable to create hubs with a minimum of 120 staff. The allocations in section 4.1 above give only two hubs of that size. We therefore examined ways to merge hubs in order to achieve this goal, recognising that in Lincolnshire, the nature of the geography may render it impractical.

This resulted in the following allocations, forming the basis of results reported in section 5:

4.2.1. Derbyshire and Nottinghamshire

Hub	Baseline Hub(s) Staff Moved From	Staff
Derby	Derby West, Ashbourne	213
Chesterfield	Chesterfield, Buxton, New Mills, Worksop	217
Nottingham	Nottingham, QMC, Newark	245
Kings Mills	Kings Mill, Ripley	147

4.2.2. Leicestershire and Northamptonshire

Hub	Baseline Hub(s) Staff Moved From	Staff
Leicester	Leicester	253
Loughborough	Loughborough, Melton Mowbray	133
Northampton	Northampton, Daventry, Brackley	129
Kettering	Corby, Wellingborough	132

4.2.3. Lincolnshire

Hub	Baseline Hub(s) Staff Moved From	Staff
Lincoln	Lincoln, Gainsborough	101
Algarkirk	Algarkirk, Market Deeping	102
Elsham	Scunthorpe, Grimsby, Barton	146
Skegness	Skegness, Louth, Trusthorpe, Horncastle	103
Sleaford	Sleaford, Grantham, Coningsby	69

4.3. *New service model*

In parallel to developing its estates strategy, EMAS had been designing a new service delivery model that provides a three-tier response to incidents. Process Evolution has been evaluating the proposed design and optimising the deployment of resources within it.

This work, which is the subject of a separate report, has identified significant opportunities to further improve performance against response standards. We therefore combined the optimised resource profiles derived from this work with the proposed estates solution in order to understand the overall impact from the *'Being the Best'* changes. These results are provided in section 5.

4.4. *Impact of additional TDPs on geographical resilience*

Whilst our analysis shows that it is the location of TDPs that most impacts performance (as opposed to the number and location of hubs), we felt that there was a potential risk to geographical coverage from reducing the number of hubs. In order to mitigate this we considered adding further TDPs. These results are provided in section 5.

A full list of the hub and TDP locations after this process is given in Appendix B.

5. Performance impact from implementation

As detailed in section 2.2 the Ambulance Response Profiler (ARP) simulation model enables the impact upon performance of adopting different estates strategies to be quantified by running a 'year in the life' of the process, alongside the testing of various 'what-if' scenarios.

In the light of the practical considerations detailed in section 4, a 13-hub solution with 110 TDPs was selected for the detailed evaluation, along with the option to increase the number of TDPs to 131 for resilience purposes.

This section presents the predicted impact on performance if these solutions were to be implemented.

5.1. Changes in Model Structure from Validation

As stated in section 2.2.3, a separate ARP model for every division was built and validated. However it became clear that having a separate model for each division was not going to be suitable when assessing the impact of moving to the optimised estates strategy.

Due to the large crossover in the Derbyshire/Nottinghamshire border it became clear that these two divisions would need to be combined into a single model.

It was also felt that it would be helpful to combine Leicestershire and Northamptonshire into a single model, especially since vehicles being despatched in the Market Harborough area are based at a hub in Northamptonshire in the optimised strategy.

Therefore the optimised estates strategy was analysed using three models:

1. Derbyshire and Nottinghamshire
2. Leicestershire and Northamptonshire
3. Lincolnshire

The hub optimisation process was conducted without having to stick to traditional divisional boundaries and whilst these three new models keep the names of the current divisions for simplicity the actual areas covered are similar to but not directly equivalent to the existing divisional boundaries (as described in section 3.6).

5.1.1. Allocating Resources to New Hubs

When moving resources from existing stations in the validated ARP models to the new optimised hub locations they were moved based upon being moved to the hub that would cover the area covered by their previous station.

This keeps the overall level and profile of resource availability the same, allowing the assessment to be focused, as far as possible, upon the impact of changing deployment locations and the position of staff.

5.2. Derbyshire and Nottinghamshire

The table below compares the baseline validation performance (once Derbyshire and Nottinghamshire have been combined into a single model) with the predicted performance of moving to the 13 hub estates strategy, along with the change in performance between the two scenarios.

Derbyshire / Notts.	Red 8	Red 19	Green 1	Green 2
Baseline	75.3%	95.4%	85.3%	83.7%
13 Hub Solution	80.6%	96.7%	89.5%	88.7%
Change	5.3%	1.3%	4.2%	5.0%

Using the 13 hub estates strategy has brought about in improvement across all performance metrics, with Red 8 performance increasing by 5.3%; which has been achieved by using 46 locations compared to 73 currently and using 4 hubs compared with 30 stations currently.

5.3. *Leicestershire and Northamptonshire*

The table below compares the baseline validation performance (once Leicestershire and Northamptonshire have been combined into a single model) with the predicted performance of moving to the 13 hub estates strategy, along with the change in performance between the two scenarios.

Leics./Northants	Red 8	Red 19	Green 1	Green 2
Baseline	75.0%	94.4%	82.0%	80.7%
13 Hub Solution	78.5%	95.3%	86.9%	86.1%
Change	3.5%	0.9%	4.9%	5.4%

Using the 13 hub estates strategy has again brought about an improvement across all performance metrics, with Red 8 performance increasing by 3.5% whilst there has also been significant improvement in both Green 1 and Green 2 performance; which has been achieved by using 36 locations compared to 39 currently and using 4 hubs compared with 19 stations currently.

5.4. *Lincolnshire*

The table below compares the baseline validation performance with the predicted performance of moving to the 13 hub estates strategy, along with the change in performance between the two scenarios.

Lincolnshire	Red 8	Red 19	Green 1	Green 2
Baseline	74.0%	88.5%	73.8%	81.7%
13 Hub Solution	75.1%	89.8%	75.2%	82.7%
Change	1.1%	1.3%	1.4%	1.0%

Using the 13 hub estates strategy has again brought about in improvement across the majority of performance metrics, however the improvements in predicted performance are smaller than they are for the other two models; this has been achieved by using 28 locations compared to 41 currently and using 5 hubs compared with 18 stations currently.

5.5. *Incorporating the new service model*

The findings shown so far in this section detail the predicted performance impact of optimising TDPs under the 13-hub solution, but keeping resource shifts and deployment processes as they are currently. As described in sections 1.2 and 4.3, parallel work has been undertaken for the trust investigating the performance impact of moving to a 3-tier service delivery model and optimising the resource mix and profile (via the changing of shift patterns to better match demand). This section details the performance impact of incorporating our recommendations from this work on top of the estates scenarios shown above:

Derbyshire / Notts.	Red 8	Red 19	Green 1	Green 2
Baseline	75.3%	95.4%	85.3%	83.7%
13 Hub Solution, with new model	82.5%	97.6%	90.3%	91.9%
Change	7.2%	2.2%	5.0%	8.2%

Leics./Northants	Red 8	Red 19	Green 1	Green 2
Baseline	75.0%	94.4%	82.0%	80.7%
13 Hub Solution, with new model	78.8%	96.1%	89.3%	87.0%
Change	3.8%	1.7%	7.3%	6.3%

Lincolnshire	Red 8	Red 19	Green 1	Green 2
Baseline	74.0%	88.5%	73.8%	81.7%
13 Hub Solution, with new model	76.4%	91.1%	80.5%	83.7%
Change	2.4%	2.6%	6.7%	2.0%

5.6. *Improving geographical resilience*

Optimisation was used to identify further locations that could further improve performance. A scenario using 21 additional TDPs (detailed in Appendix B) resulted in the following performance changes compared to the results shown in section 5.2 – 5.4:

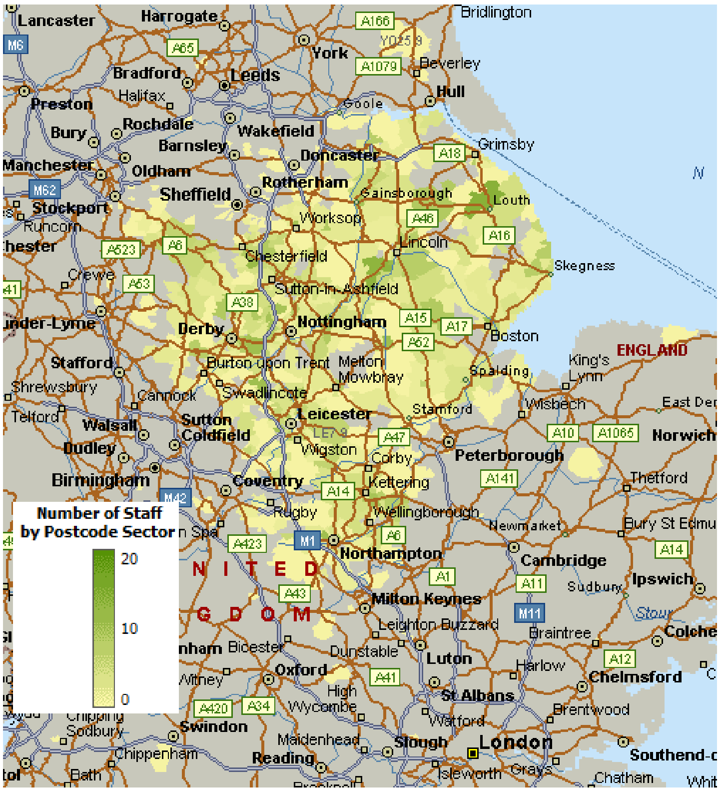
- 0.1% drop in performance in Derbyshire / Nottinghamshire to Red 8 performance
- 1.0% increase in Leicestershire / Northamptonshire to Red 8 performance
- 0.9% increase in Lincolnshire to Red 8 performance

6. Travel times to and from hubs

This section examines the impact of the hub locations on staff travel time from home to work and on the distance of hubs from the TDPs they support.

6.1. *Travel times from home to hub*

Data was provided by EMAS for the home postcodes (nb using only the first 5 characters for data protection reasons) of operational staff up to and including PTL level. The map below shows the concentration of those staff by postcode sector.



The vast majority of the staff concerned live within the EMAS trust boundary, with a small number living outside that area.

It is noted that some of the postcodes that were outside the EMAS boundary may be anomalies, such as someone that may have recently started working for EMAS but has yet to sell their home or someone that lives further away but stays closer to work at an alternative property when required; however it was the most accurate up to date information available.

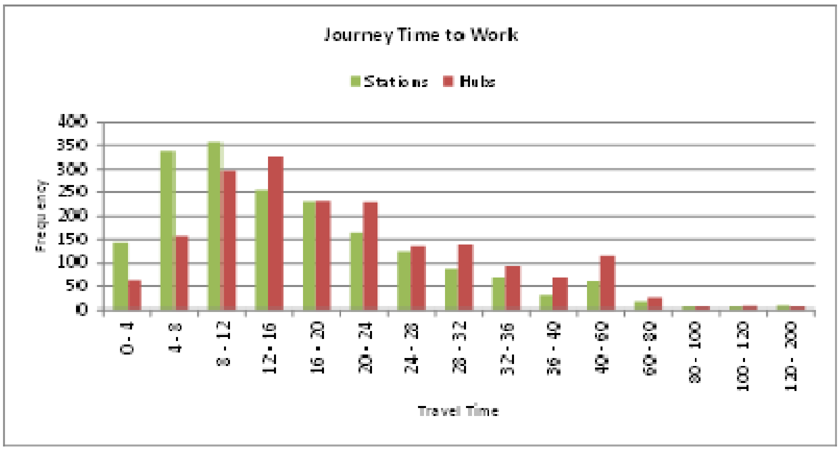
When conducting the hub and TDP optimisation process the effects upon travel times to work of moving operational staff was analysed. Based upon their existing station locations operational staff have, on average, a travel time to work of 17.4 minutes.

If PTLs and the staff they are responsible for are always co-located then operational staff would then have, on average, a travel time to work of 21.5 minutes (a 23.4% increase) with 57% of staff experiencing an increase in travel time.

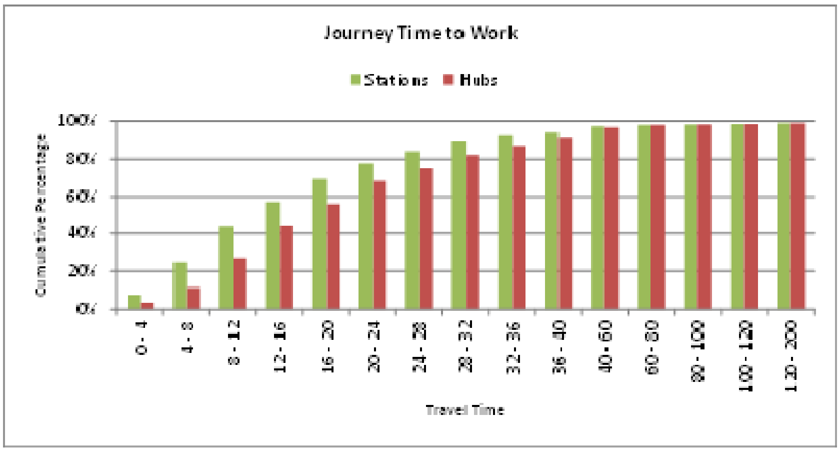
In addition, 20% of people have a journey time of greater than 30 minutes, which compares with 12% under the current estates strategy.

6.1.1. Distribution of travel time

The chart below compares the distributions of the travel times between the current estates strategy (current Ambulance Stations) and when 13 hubs are used.



There is a noticeable change in the proportion of journeys that are at least 16 minutes in length. This chart is shown as a cumulative percentage below:



44% of resources have a journey time of 16 minutes or greater, which is an increase from 31% with the current ambulance stations.

6.1.2. Amount of increase for staff with longer travel times

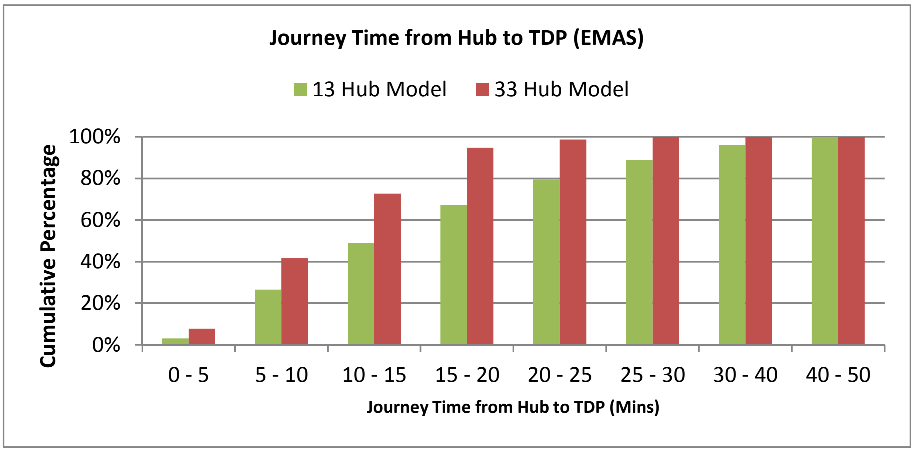
The chart below shows the distribution of increase in travel time for those staff whose travel to work time has increased:

Of the 57% of staff that have incurred an increase in journey time, 32% of them have had an increase in journey time of at least 10 minutes.

6.2. *Travel Times from Hubs to TDPs*

When creating the optimised estates strategy containing 33 hubs it was done with the assumption that it is undesirable to have TDPs being resourced from a hub that is more than 20 minutes' drive away.

The chart below shows the journey times from the hubs to their TDPs under the 13-hub model:



Under this model, 32.7% (32) of TDPs are greater than or equal to 20 minutes' drive from their hub, with 11.2% (11) being greater than 30 minutes' drive (7 in Derbyshire/Notts., 1 in Leics./Northants and 3 in Lincolnshire).

7. Summary of Findings and Conclusions

7.1. *Key Findings*

7.1.1. Theoretical Optimisation of TDPs and Hubs

- A weighting system was applied to the different response standards in optimising the locations of TDPs with the highest weight given to Red 8
  - Focusing solely on the Red 8 target resulted in solutions that did not provide enough geographical coverage
- The number of optimised TDPs in each division was set based upon ensuring that the vast majority of Red incidents are within 19 minutes of a TDP
  - Setting this number based upon the optimisation score achieved being either 75% for Red 8 only or comparable with the optimisation score of the current estate were both found to have disadvantages
- The optimisation of the TDPs resulted in a solution that used significantly fewer locations than the current estate, whilst at the same time achieving a greater proportion of incidents within various the response standards
  - The theoretically optimised solution contained 107 locations compared with the current 153 locations
- Optimising the hub locations based upon them being no more than 20 minutes from any TDPs that they are required to resource resulted in a theoretically optimum solution that contained 31 hubs compared with 66 current ambulance stations
- These hubs need to serve TDPs across historical divisional boundaries
  - Adhering to historical boundaries would increase the number of hubs required
  - Implications on EOC operations need to be considered

7.1.2. Practical Application of the Theoretical Solution

- The most significant impact resulted from a desire to base at least 120 staff in hubs where practical in order to enhance provision of support and improve facilities
  - In particular in order to enable PTLs to be co-located with staff
  - It resulted in a reduction in the number of hubs to 13 with all but 4 (all in Lincolnshire) having more than 120 staff
- Operational considerations led to a few changes to the theoretical solution suggested in order to create the practical baseline solution for each model
  - The most significant change was to introduce a hub in Mansfield (Kings Mill) where there wasn't one before
  - The hub proposed at Ashby was moved to Loughborough
  - These and other minor changes including a further 3 TDPs all led to minor improvements when quantified using our simulation tools
- A solution that provides additional geographical resilience was identified that would involve the use of a further 21 TDPs

7.1.3. Quantifying the benefits

- Simulation models created of the current five divisions accurately predicted the performance achieved historically when configured with historical incident data

- It was necessary to change the structure of the simulation models used following validation so that Derbyshire and Nottinghamshire were analysed together, as were Leicestershire and Northamptonshire
    - This was due to the hubs servicing TDPs across geographical boundaries
- In all three models the theoretical solution brought significant improvements to performance compared with the current estate
    - Improvements were found to be due to the re-positioning of the TDPs to the optimal areas rather than consolidating resources into fewer locations
- Additional TDPs in larger urban areas needed to be added to the solution to increase coverage due to the frequency of incidents in those areas
- Results from further geographical resilience option showed an incremental trust-wide improvement from adding a further 21 TDPs

7.1.4. Effects upon Staff Journey Times to Work

- Journey times to work are predicted to increase on average from 17.4 minutes to 21.5 minutes
- 57% of staff would experience some increase in travel time

7.2. Conclusions

Based upon the key findings detailed in section 7.1, the following conclusions may be drawn:

- A significant improvement to performance may be achieved by locating a much smaller number of TDPs at the optimised locations identified through this analysis
    - Red8 performance is predicted to rise 3.7%
- The current number of stations can be reduced to a much smaller number of ‘hubs’ without significantly compromising the performance gains achieved with the optimised TDPs
- Removing divisional boundaries is critical to implementing the proposed changes
- The optimised solution can be achieved with a manageable impact upon the amount of time operational staff spend travelling to and from work for the majority of staff
    - A small proportion of staff would have a significant increase in travel time which should be factored into any changes undertaken during the consultation period
- Although increasing TDPs can increase performance further, the return diminishes as each one is added and thus needs to be balanced against cost

8. Glossary

ARP – Ambulance Response Profiler

EMAS – East Midlands Ambulance Service

FLP – Facility Location Planner

PTL – Paramedic Team Leader

QMC – Queens Medical Centre

TDP – Tactical Deployment Point

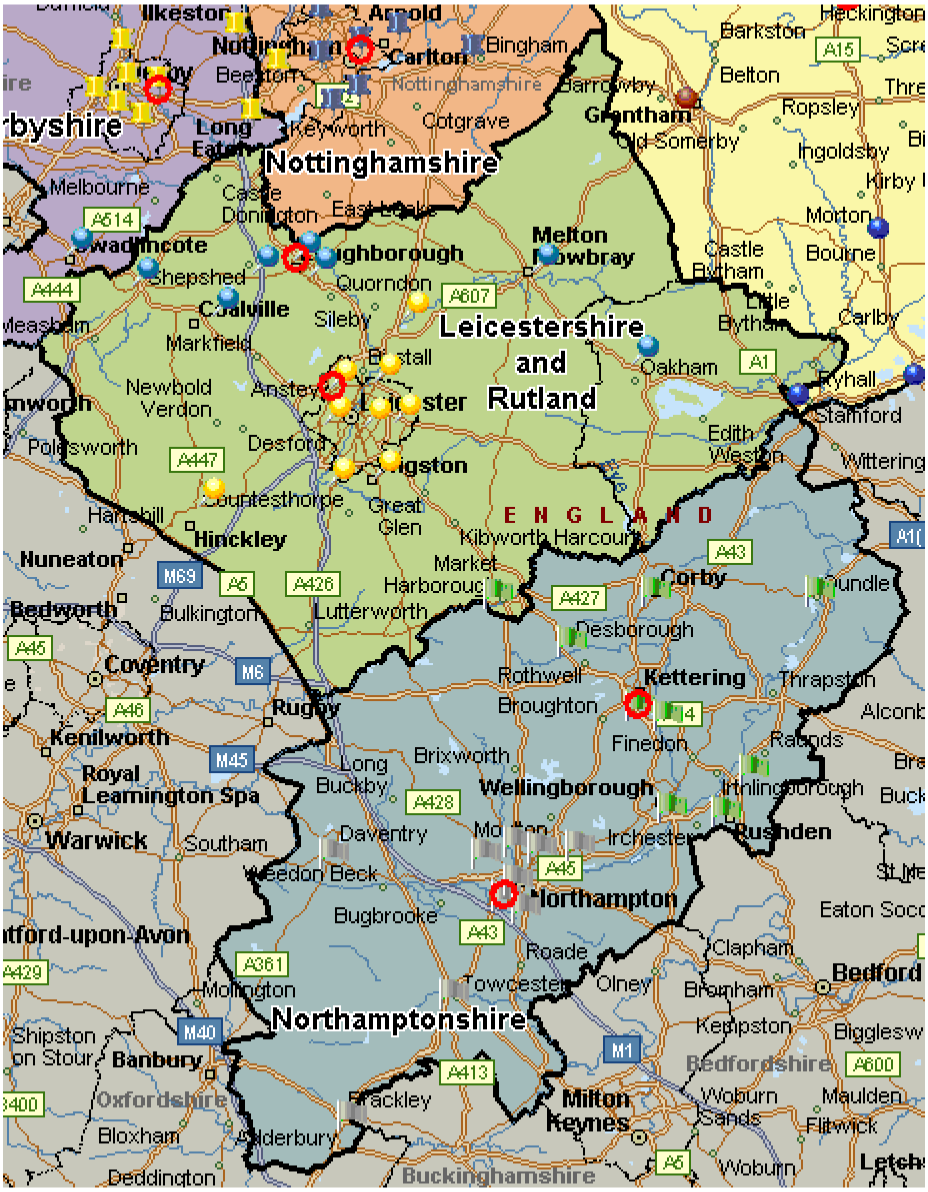
Appendix A: Maps of Finalised Practical Estates Solution

The maps below show final locations for the proposed hubs and TDPs based upon 13 hubs and 110 TDPs.

Each of the hubs is highlighted by a red circle, with its associated TDPs being shown with the same symbol as the hub itself.

Derbyshire/Nottinghamshire

Leicestershire/Northamptonshire



Lincolnshire

Appendix B: List of Finalised Practical Estates Solution Locations

This section provides precise locations for the proposed 13 hubs and 131 TDPs, which includes the additional 21 TDPs added to improve geographical resilience (highlighted in bold in lists below).

Derbyshire/Nottinghamshire - Hubs

Hub Name	Easting	Northing
Chesterfield	438155	369765
Derby	438669	335965
Kings Mill	452170	357733
Nottingham	458290	340175

Leicestershire/Northamptonshire – Hubs

Hub Name	Easting	Northing
Leicester	455926	307468
Loughborough	452157	319780
Northampton	473977	258723
Kettering	486688	277325

Lincolnshire – Hubs

Hub Name	Easting	Northing
Skegness	556094	364218
Lincoln	497910	370146
Algarkirk	529012	334177
Elsham	503691	412017
Sleaford	506038	346968

Derbyshire/Nottinghamshire – TDPs

TDP Name	Easting	Northing
Stapleford (E01028090)	450390	337914
Eastwood (E01028116)	448204	345795
Nottingham Central (E01013920)	458290	340175
Underwood (E01027993)	447430	350600
Arnold (E01028165)	458227	345327
Nottingham North (E01013879)	454539	346637
West Bridgford (E01028401)	458226	335579
Mansfield (E01028275)	455208	361561
Newark (E01028294)	480229	353718
Clifton (E01013906)	455695	334065
Warsop (E01028223)	456650	368010
Carlton (E01028171)	461988	341713
Bingham (E01028360)	469262	339610
Sutton-in-Ashfield (E01027968)	449060	358843
New Ollerton (E01028339)	465076	367547
Retford (E01028011)	470732	381312
Worksop (E01028042)	458854	380057
Kings Mill (E01027973)	452170	357733
Basford (E01013830)	454409	343155
Normanton (E01013570)	434830	333682
Allestree (E01013461)	435076	339561
Brimington (E01019552)	441380	373820
New Mills (E01019744)	400898	385778
Derby South (E01013497)	437090	332395
Matlock (E01019623)	429975	360195
Chaddesden (E01013511)	438669	335965
Ripley (E01019454)	439400	350825
Derby West (E01013543)	432565	335013
Creswell (E01019497)	452672	374401
Long Eaton (E01019708)	447820	333065
Heath (E01019800)	442866	365757
Alfreton (E01019404)	440607	354803
Renishaw (E01019815)	444836	377834
Ashbourne (E01019598)	417712	346208
Buxton (E01019716)	406405	372980
Belper (E01019408)	435645	347747
Heanor (E01019433)	442748	347174
Clay Cross (E01019775)	439070	363500
Dronfield (E01019785)	435789	378078
Chesterfield South (E01019575)	438155	369765
Ilkeston (E01019673)	446142	341363
Langwith (E01019506)	452128	369763
Whittington (E01019542)	437812	373806
Derby City Centre	435700	336400
Nottingham City Centre	454470	338850
Newark North	479325	358817
Rainworth (E01028254)	**458412**	**358662**
Langold (E01028029)	**458744**	**387229**
Calverton (E01028150)	**462040**	**349055**
Gamston (E01028376)	**461079**	**337686**
Rowsley (E01019630)	**426148**	**364844**
Bolsover (E01019490)	**447632**	**369979**
Kilburn (E01019449)	**437835**	**346235**
Swarkeston (E01019834)	**438798**	**328267**
Chapel-en-le-Frith (E01019713)	**404542**	**380220**

Leicestershire/Northamptonshire - TDPs

TDP Name	Easting	Northing
Swadlincote (E01019876)	429925	319805
Coalville (E01025936)	444378	314219
Leicester West (E01013632)	455515	304000
Loughborough (E01025715)	453767	318427
Ratcliffe (E01025769)	462822	314267
Hinkley (E01025858)	443220	295795
Ashby (E01025917)	436427	317094
Gorse Hill (E01025623)	455926	307468
Melton (E01025894)	475469	319125
Leicester Centre (E01013646)	459417	303882
Wigston (E01025992)	460493	298757
Blaby (E01025646)	455903	297900
Shepshed (E01025740)	448153	318429
Goodwood (E01013767)	462213	304210
Oakham (E01013798)	485450	310210
Market Harborough (E01025794)	472695	288060
Leicester NE (E01013734)	460351	308050
Wellingborough (E01027344)	490035	267519
Oundle (E01027047)	504265	288740
Great Billing (E01027174)	481170	263660
Hardingstone (E01027201)	475927	257447
Barton Seagrave (E01027086)	489601	276456
Rushden (E01027064)	495261	267166
Towcester (E01027297)	469130	248945
Stanwick (E01027074)	497966	271413
Daventry (E01026992)	457076	262384
Brackley (E01027264)	459230	236925
Kettering (E01027117)	486688	277325
Northampton SW (E01027252)	473977	258723
New Duston (E01027208)	471980	262675
Northampton North (E01027147)	475110	263996
Desborough (E01027093)	480115	283590
Northampton NW (E01027172)	477345	263320
Corby (E01026949)	488120	288540
Northampton City Centre	475137	260222
Loughborough Hub Location	452157	319780
Kirkby Mallory (E01025873)	**445291**	**300826**
Mountsorrel (E01025735)	**457489**	**315707**
Lutterworth (E01025808)	**456504**	**283572**
Great Doddington (E01027329)	**486946**	**264065**
Islip (E01027032)	**498430**	**279625**
Watford (E01027016)	**460603**	**268791**
Potterspury (E01027307)	**475065**	**243641**

Lincolnshire - TDPs

TDP Name	Easting	Northing
Waddington (E01026185)	497767	364207
Cleethorpes (E01013163)	528593	408038
Consingsby (E01026054)	522038	358016
Horncastle (E01026066)	525250	369795
Grimsby (E01013211)	525484	408337
Sutton Crosses (E01026254)	542633	321703
Immingham (E01013177)	518554	414801
Barton (E01013255)	503227	421817
Scawby (E01013325)	498062	404438
Chapel St Leonards (E01026048)	556035	371808
Crosby (E01013301)	487681	411182
Sleaford (E01026229)	506038	346968
Stamford (E01026289)	501720	307655
Lincoln SW (E01026172)	497910	370146
Morton (E01026341)	509280	323955
Gainsborough (E01026383)	481681	389152
Brumby (E01013318)	489196	408917
Grantham (E01026320)	490230	336302
Boston S (E01026040)	532377	341660
Spalding (E01026269)	525398	322678
Lincoln NE (E01026394)	499432	374469
Trusthorpe (E01026109)	551317	383314
Louth (E01026089)	532902	386843
Skegness (E01026084)	556094	364218
Holbeach (E01026252)	535565	325590
Market Deeping (E01026334)	512974	309858
Algarkirk Hub Location	529012	334177
Elsham Hub Location	503691	412017
Digby (E01026180)	**507627**	**356104**
Market Rasen	**510220**	**389613**
Spilsby (E01026100)	**540322**	**366074**
Boston N (E01026022)	**533676**	**345095**
Surfleet (E01026276)	**524970**	**329580**