Surrey Fire & Rescue Service

STUDY OF EMERGENCY COVER

FINAL REPORT

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1 INTRODUCTION

1.1 ORH Limited was commissioned by Surrey Fire and Rescue Service (SFRS) to undertake modelling to support the Service in planning the future deployment of stations, appliances and personnel in support of the IRMP for 2011-2020.

1.2 ORH completed a study of emergency fire cover (ORH reference SuF/4) in November 2010. The purpose of this report is to identify and assess alternative options using an analytical and modelling approach.

1.3 As part of this work, it was agreed with SFRS that the simulation and optimisation models would be updated in order to take account of more recent incident workload and appliance availability data.

1.4 SFRS supplied up-to-date incident data for 2010/11 and some summaries of the analysis undertaken are provided in this report. A new system for recording RDS availability was implemented by SFRS since the commencement of the previous project and these data were included in the model revalidation. An overview of the current service profile is given in Section 2.

1.5 The model revalidation itself involved a number of key assumptions which were required in order to ensure that the model is fit for purpose. The processes involved in revalidating the model are described in Section 3.

1.6 To provide a robust basis for comparing options, an appropriate base position had to be established, and this process is detailed in Section 4.

1.7 An iterative modelling methodology was subsequently undertaken to consider different options for the future deployment of pumping appliances in Surrey and this work is described in Sections 5 to 7.

1.8 All of the analysis and modelling work presented in this report is in relation to pumping appliances only, and does not include special appliances.

1.9 This report presents detailed modelling results concerning the proposed deployment of pumping appliances as specified by SFRS.

2 CURRENT SERVICE PROFILE

2.1 SFRS supplied incident data from the IRS database for the period from 1st April 2010 to 31st March 2011, and this was processed alongside data from the previous 12 months to give a two-year database for analysing demand and performance levels.

2.2 The purpose of the data analysis undertaken on this database was to develop an appropriate set of model input parameters. It was previously agreed with SFRS that using a two-year database of demand and performance would provide a more robust position for the modelling.

2.3 In order to develop a model which can be used to assess the impact of changes to the appliance configuration to different incident types, the analysis and modelling was based on three types of incidents:

a. One-Pump Incidents ('1Pump') = all incidents to which only one pumping appliance arrived at the scene of the incident;

b. Two-Pump False Alarm Incidents ('2PumpFA') = incidents for which the stop code was recorded as a false alarm and two or more pumping appliances arrived at the scene of the incident;

c. Two-Pump Non-False Alarm Incidents ('2PumpXFA') = all other incidents at which two or more pumping appliances arrived at the scene of the incident. This category includes the majority of primary fires and critical RTCs and can therefore be thought of as 'serious incidents'.

2.4 The data analysis included in Appendix **A** is based only on incidents which occurred within Surrey and generated a response from a Surrey pumping appliance. There are some data accuracy issues associated with the information for Over-The-Border (OTB) appliance response times.

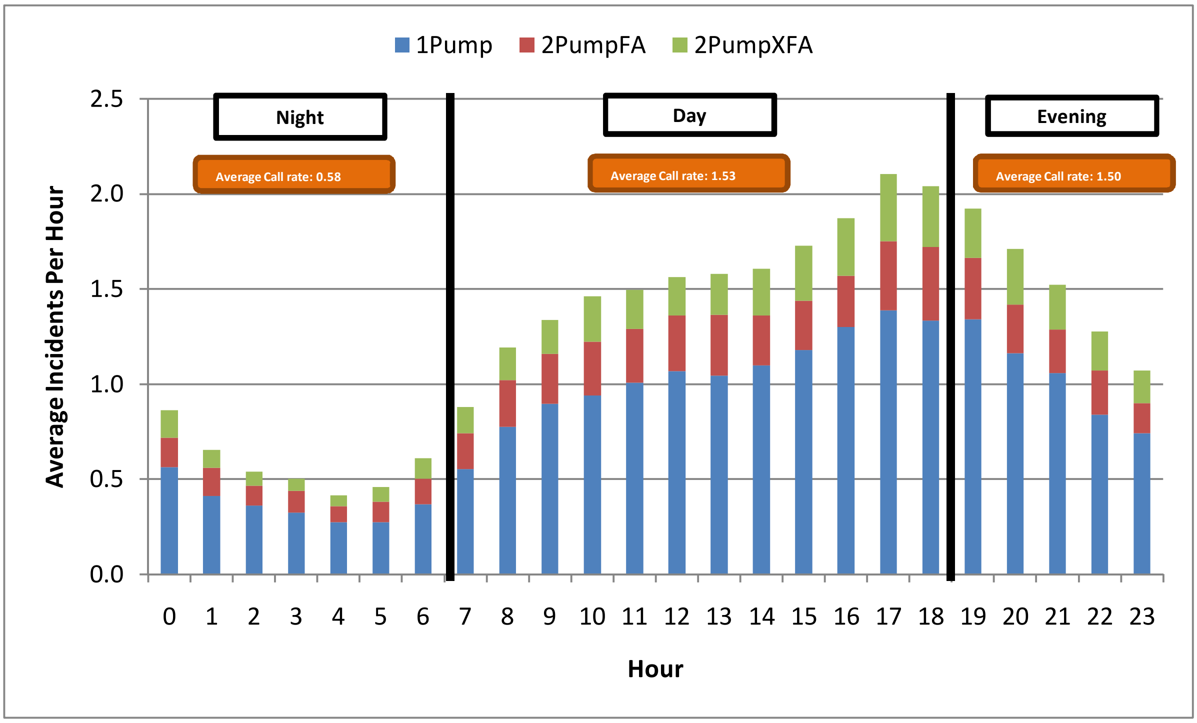
2.5 For producing geographical incident distributions, a five-year incident sample was selected – 1st April 2006 to 31st March 2011. This sample period was selected based on analysis undertaken around geographical incident correlations. Maps showing the geographical pattern of each incident type are shown in Appendix **A1**.

2.6 The monthly profile of incident demand is shown in Appendix **A2**. There is evidence that the overall demand rate across the two-year sample is decreasing, although the proportion across the different incident types remains similar. The overall breakdown of demand across the incident types is as follows:

- 1Pump = 67%
- 2PumpFA = 18%
- 2PumpXFA = 15%

FIGURE 1 INCIDENT DEMAND

Average Hourly Profile



Total Incident Volumes

Incident Type	Modelling Period			
	Night	Day	Evening	Total
1 Appliance	1,878	9,185	3,753	14,816
2+ Pump False Alarms	622	2,493	876	3,991
2+ Pump Non False Alarms	450	2,091	848	3,389
Total	2,950	13,769	5,477	22,196

Note:
Demand based on two-year sample (April 2009 to March 2011)

2.7 Appendix **A3a** and Figure **1** opposite present the average hourly demand levels. Crew turnout by hour is shown in Appendix **A3b**. The hourly analysis of demand and crew turnout support the use of the following modelling periods:

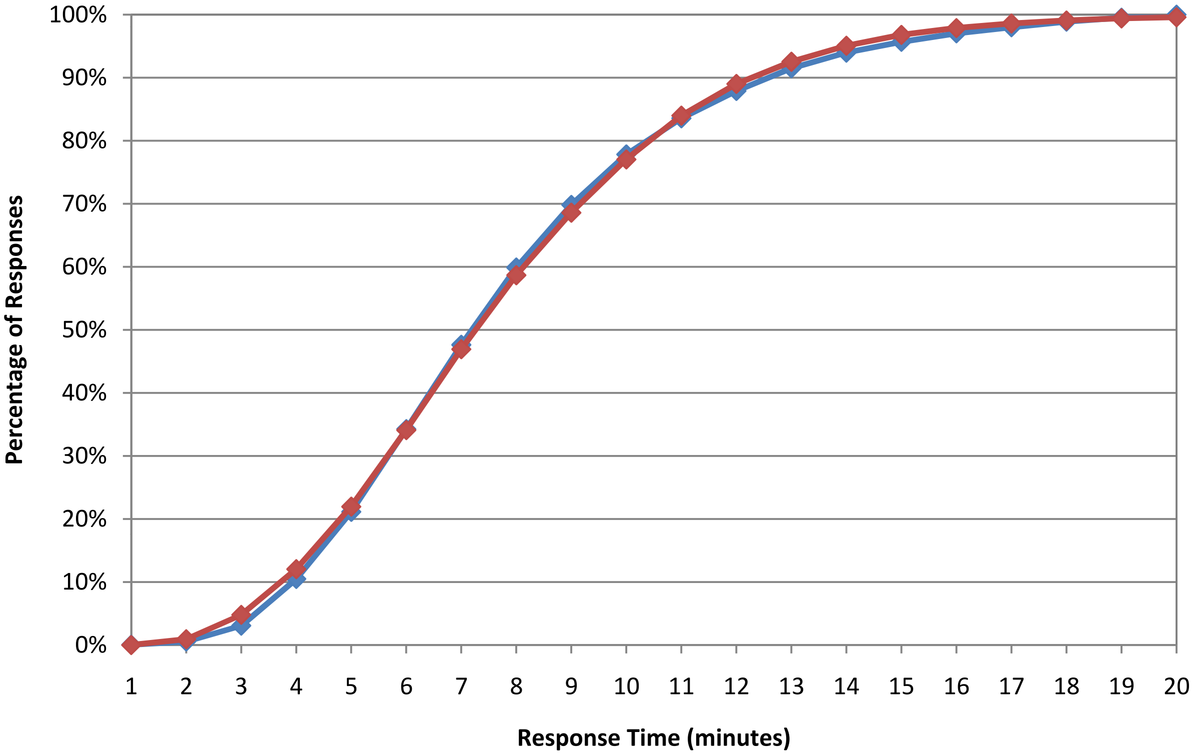
- Day = 0700-1900
- Evening = 1900-2400
- Night = 0000-0700

2.8 Analyses around the average number of responses and crew turnout times by individual callsigns were undertaken and are summarised in Appendices **A4a** and **A4b** respectively. The variations between periods of the day in terms of both turnout and demand levels were taken into account in the model revalidation.

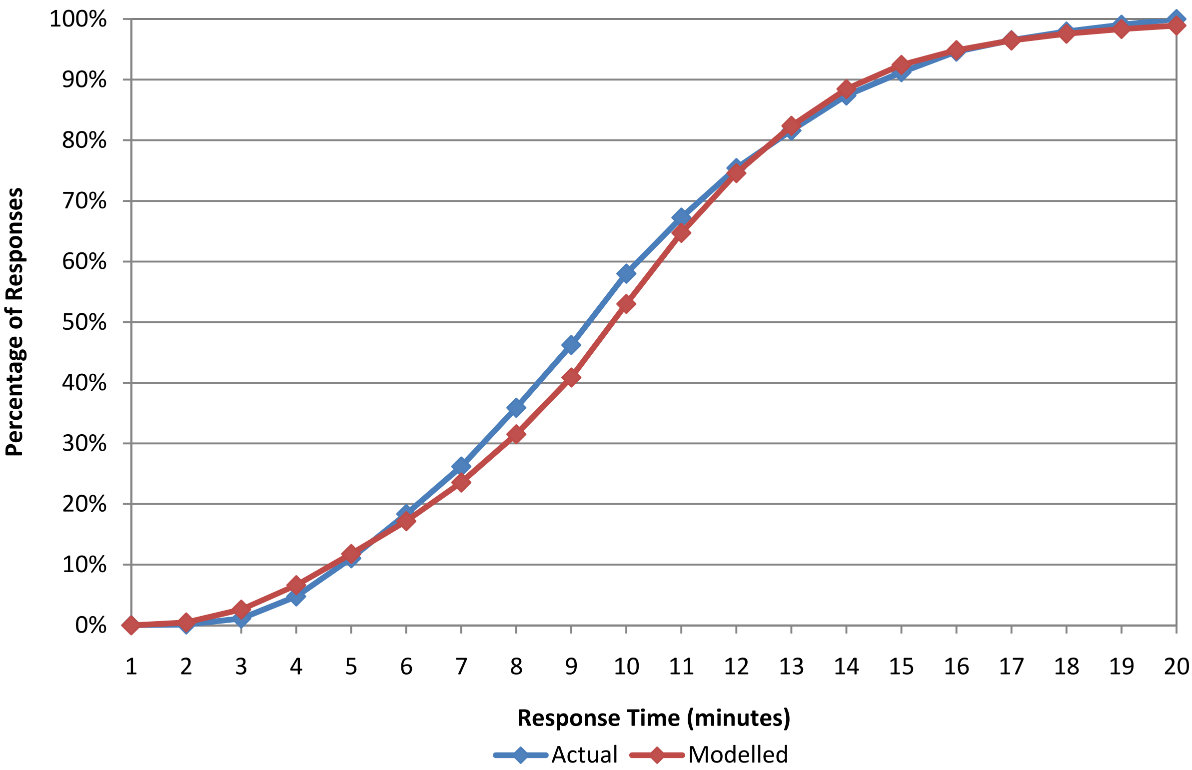
2.9 In addition to the incident workload data, SFRS supplied a one-year database (1st April 2010 to 31st March 2011) detailing the level of RDS unavailability by callsign and period of the day. This information is summarised in Appendix **A5**. The RDS appliance at Walton (there is also a variable crewed pumping appliance deployed from Walton) was unavailable 93.5% of the time and the only pumping appliance at Gomshall station was unavailable for 79.0% of the time. The RDS appliance with the lowest level of unavailability was Cranleigh's first appliance (4.74% unavailable). The unavailability level shown for each appliance was fed into the model for each period of the day.

FIGURE 2 CRW RESPONSE PERFORMANCE VALIDATION

1st Response to All Incidents



2nd Response to All Incidents



3 MODEL VALIDATION

3.1 Model validation is the process whereby the model is calibrated against known performance. For this study, the model validation process aimed to match the modelled response performance with the crew response distributions as calculated from the two-year IRS data sample.

3.2 Model validation involves taking inputs and outputs from the current service profile and ensuring that the model replicates the same outputs (eg, for response performance and utilisation) for the same inputs.

3.3 ORH's Fire Simulation Model (FireSim) uses highly sophisticated Navteq travel time data. These data, when combined with RouteFinder software for producing and analysing travel time networks, provide a detailed and robust source of information, which can then be calibrated against travel times actually achieved.

3.4 The turnout times and modelled call rates were based on the average hourly number of incidents by period for 2009-2011 (as described above). The model runs for several years (of simulated time) and the distribution of response times by period, area and type can be obtained.

3.5 For the model validation it is necessary to calibrate the model based on journeys for which there is confidence in the data collected. It was therefore appropriate to only consider incidents which occurred within Surrey and generated a response from a Surrey pumping appliance as the time fields within the IRS database have been checked by SFRS for these incidents.

3.6 The distributions of the modelled response times and actual response times observed from the IRS database were then compared. The model validation process was undertaken for each modelling period separately, and considered all of the appropriate incident and response types.

3.7 The response distributions for the first and second appliance responses to all incidents are shown by modelling period in Appendices **B1** to **B3**.

3.8 An amalgamated 24/7 modelled position has also been developed for use in this study and the validated position for all incidents is presented in Figure **2** opposite and Appendix **B4a**. The 24/7 validated position for 'serious incidents' (ie, 2PumpXFA incidents) is given in Appendix **B4b**.

3.9 The modelled curves showing performance by minute match very closely to the actual position for all response types, particularly for the first response.

3.10 Given the complexity and inherent variability of the responses modelled, the close correspondence between modelled and actual travel times is very good, and the model was therefore considered as appropriate for use.

FIGURE 3 MODELLED BASE DEPLOYMENTS

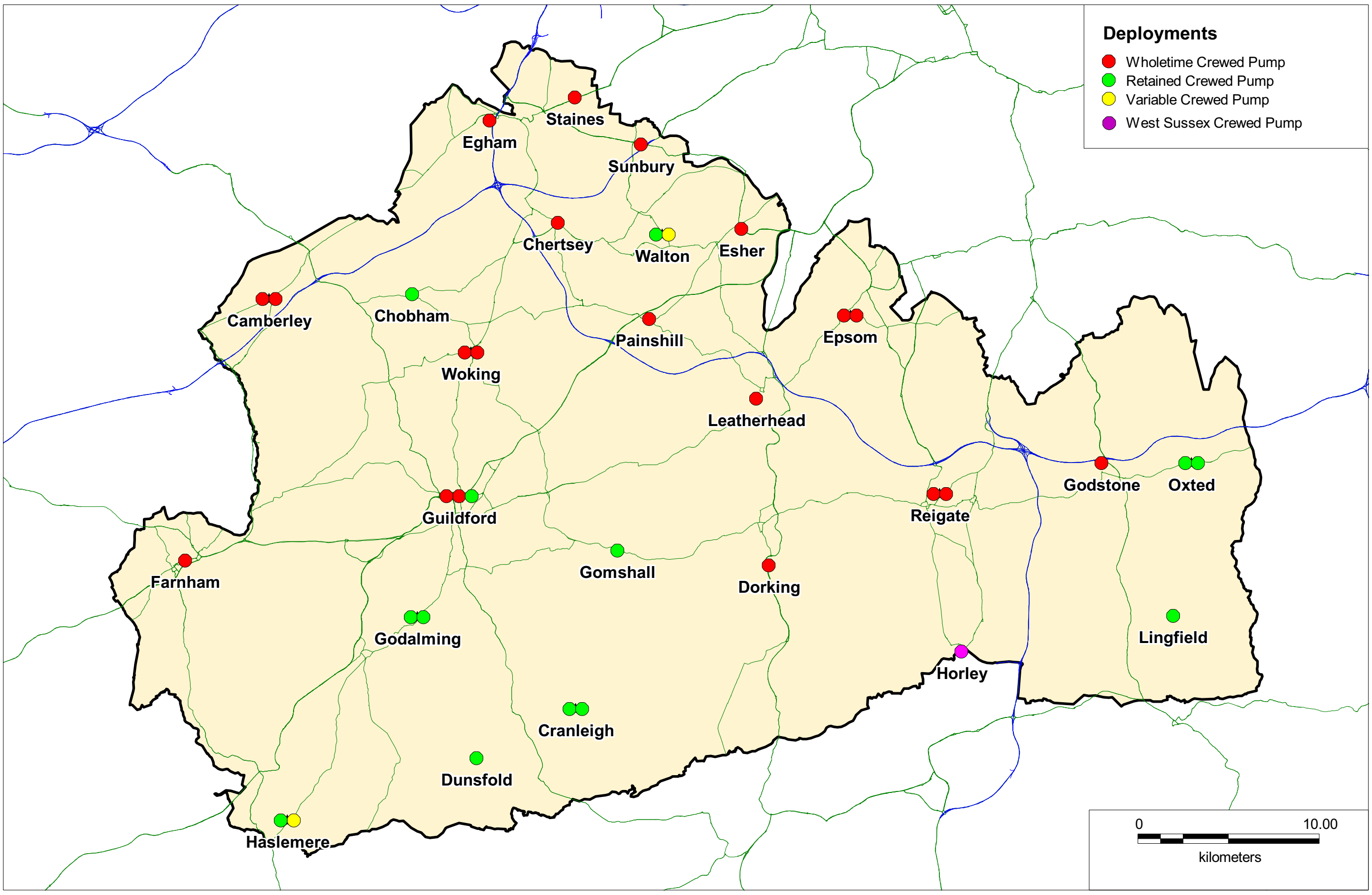


FIGURE 4 MODELLED BASE POSITION

Time given in mm:ss

District	1st Response to All 2+ Pump Incidents		2nd Response to All 2+ Pump Incidents		1st Response to All Incidents
	Average	% in 10 mins	Average	% in 15 mins	% in 16 mins
Overall	07:25	80.7%	10:03	90.3%	98.1%
Elmbridge	07:09	88.7%	10:48	95.5%	99.4%
Epsom and Ewell	05:16	94.0%	06:12	96.2%	98.5%
Guildford	07:35	75.3%	08:48	94.7%	98.7%
Mole Valley	08:01	77.7%	12:00	87.8%	98.7%
Reigate and Banstead	08:36	69.2%	10:21	90.1%	97.5%
Runnymede	06:26	91.8%	10:30	96.0%	99.0%
Spelthorne	06:20	95.2%	10:00	98.7%	99.7%
Surrey Heath	07:24	88.4%	08:50	95.8%	98.5%
Tandridge	09:28	57.0%	13:43	66.3%	95.0%
Waverley	09:09	60.4%	14:19	57.4%	94.7%
Woking	06:08	92.2%	07:11	98.6%	99.5%

4 ESTABLISHING A MODELLED BASE POSITION

4.1 As described above, it was necessary to base the model validation around responses for which all aspects of the data can be verified, and therefore only incidents within Surrey that received a response from a Surrey pumping appliance were included. However, a significant number of incidents within the Surrey boundary were attended by OTB appliances and these needed to be taken into account in establishing an appropriate base position.

4.2 As Surrey plans on the assumption of responding to all incidents within its boundary, all incidents within Surrey, whether responded to by a Surrey or an OTB pumping appliance were included in the demand for the modelled base position.

4.3 In terms of planning for the future, SFRS has a formal arrangement to cede part of its operational response to Horley station. Continued support and provision of responses to the area around Horley can be expected and therefore, a pumping appliance at Horley was included in the modelled base position. The current deployments are presented in Appendix **C1** and in Figure **3** opposite.

4.4 It was necessary to apply a level of unavailability in the modelling to restrict how available Horley's pumping appliance is to respond to incidents within Surrey. The utilisation levels associated with responding to incidents for SFRS pumping appliances are given in Appendix **C1a**. The average wholetime appliance is utilised 4.6% of the time and the most utilised is 7.0% (Guildford's second appliance).

4.5 To take account of demand within West Sussex and additional duties (eg, training and prevention activities) placed on Horley's pumping appliance, an unavailability level of 25% was applied. Evidence taken from the utilisation levels of SFRS pumping appliances and work carried out by ORH for other FRSs suggest this was a conservative assumption but therefore prevented over reliance on the West Sussex pumping appliance.

4.6 Additionally, to capture the potential delay in mobilising an OTB appliance to an incident within Surrey, the mobilisation time for the wholetime pumping appliance was increased by two minutes in comparison to SFRS pumping appliances. This was again expected to be greater than observed but provided a safe position to be planning from.

4.7 A summary of the modelled base position by modelling period is given in Appendices **C2** to **C4**. The amalgamated 24/7 modelled base position is shown in Figure **4** opposite and in Appendix **C5**. Range coverage maps for the current position are presented in Appendix **C6**; these assume that only the RDS pumping appliances with availability levels over 90% by period are modelled as available.

4.8 It was appropriate to take this new level and pattern of demand forwards as a 'base' result for modelling options as it represents an appropriate but

conservative position. Future planning for SFRS was therefore tailored to meeting demand across the whole Service.

4.9 In addition to Horley, some areas within Surrey are likely to continue receiving responses from other OTB pumping appliances. The potential impact of these pumping appliances to the level of fire cover associated with different deployment positions were considered under sensitivity analysis (see Section 7).

5 PLANNING FOR THE FUTURE

5.1 The current deployment of pumping appliances across Surrey are made up of the following crew types:

- Wholetime (WT) – Crewed 24/7
- Retained Duty System (RDS) – Crewed 24/7
- Variable Crewed (VC) – Wholetime during Weekday Day; RDS during Evenings, Nights and Weekends.

5.2 RDS unavailability is a specific concern in Surrey as highlighted in Appendix **A5**, especially during the daytime period. For this reason, SFRS sought to consider potential deployments which include 'on-call' pumping appliances as an alternative to established RDS appliances.

5.3 These 'on-call' pumping appliances would operate with the same mobilisation times currently associated with RDS crews, however modelled availability was assumed to be 100%, as new contractual arrangements would be introduced. The 'on-call' pumping appliances would only operate out of existing RDS stations as setting up an arrangement of this type would be difficult in non-RDS stations.

5.4 In addition, a '5-day day-crewed' and a '7-day day-crewed' pumping appliances were considered. The different crew types in potential options presented in this report are therefore as follows:

- Wholetime – Crewed 24/7
- 7-day Day-Crewed – Wholetime 07:00 to 19:00, 7 days a week
- 5-day Day Crewed – Wholetime 07:00 to 19:00, weekdays only
- On-Call Night – 19:00 to 07:00, also available at weekends daytime
- On-Call Day – 07:00 to 19:00

5.5 The new set of proposed performance measures that potential configurations were reported against in the modelling are as follows:

- 1st Response to 2+ Pump Incidents – average response time and percentage of incidents responded to within 10 minutes (80% target).
- 2nd Response to 2+ Pump Incidents – average response time and percentage of incidents responded to within 15 minutes (80% target).
- 1st Response to All Incidents – percentage of incidents responded to within 16 minutes as a 'back stop' measure (95% target).

5.6 The above incident types reported in the modelling were defined by how many appliances attended the scene of the incident. There is a subtle difference to how SFRS will report performance, with incident types defined by how many appliances are mobilised to an incident.

5.7 Following on from the previous work ORH carried out for SFRS in SuF/4, ORH continued to generate a number of deployment options in an iterative process alongside options put forward by SFRS. This process allowed SFRS to refine its plans for future deployments into a two phased approach.

5.8 The two phases, as defined by SFRS were as follows:

- Phase 1: Using only existing station locations.

- Phase 2: Additional station locations were considered.

5.9 The modelling presented in this report concentrates on the deployment concerning 'Phase 1'.

5.10 Further exploratory modelling, with alternative deployments were examined for 'Phase 2' and the results provided to SFRS. Potential areas for new station locations were identified but actual sites were yet to be determined. The potential areas were as follows:

- Spelthorne – between Staines and Sunbury stations,

- Burgh Heath – south east of Epsom station,

- Milford – South west of Godalming station.

FIGURE 5 PHASE 1 DEPLOYMENTS

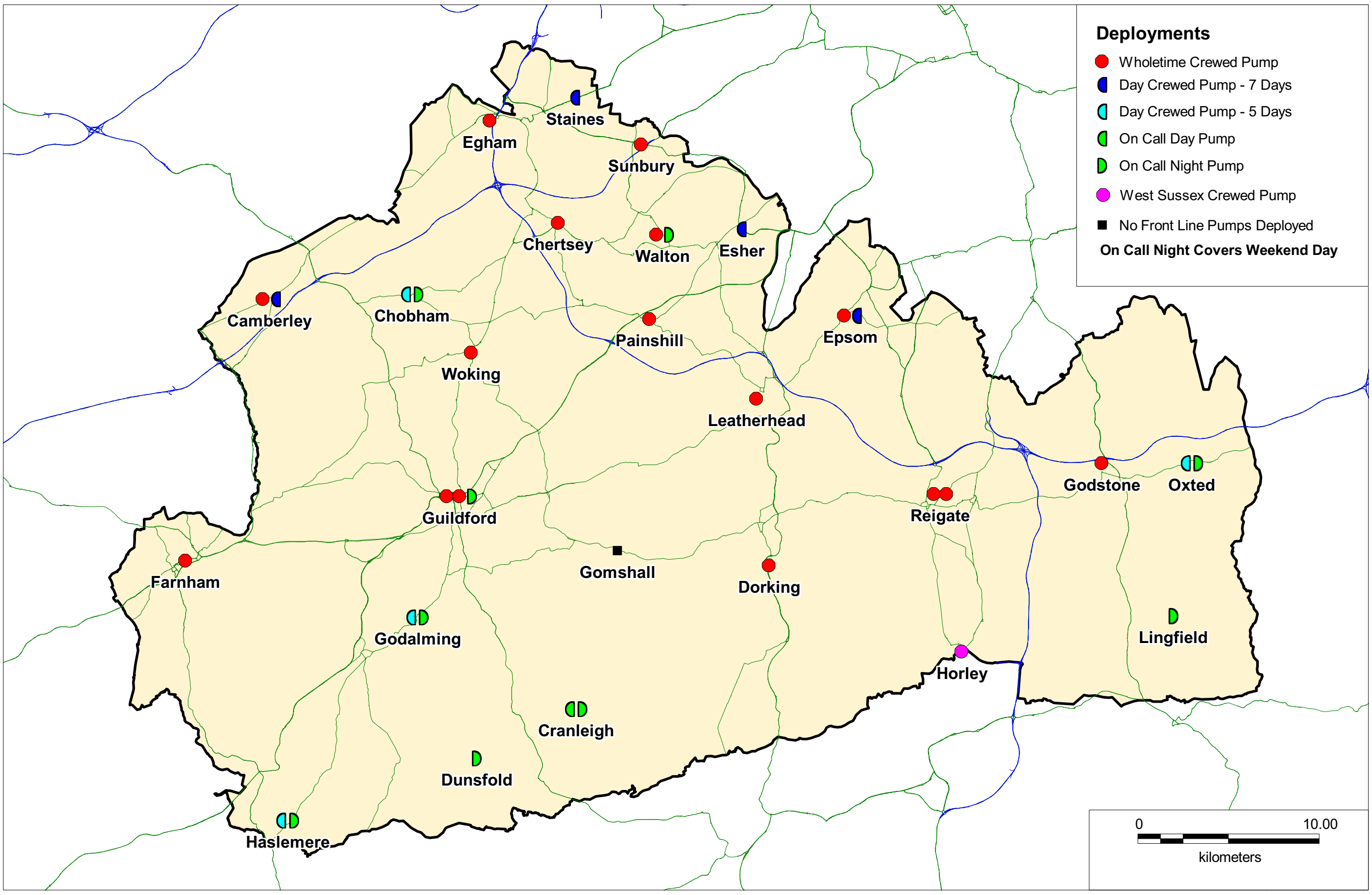


FIGURE 6 PHASE 1 MODELLING RESULTS

Surrey Wide Response Performance ***Time given in mm:ss***

Modelling Position	1st Response to All 2+ Pump Incidents		2nd Response to All 2+ Pump Incidents		1st Response to All Incidents
	Average	% in 10 mins	Average	% in 15 mins	% in 16 mins
Modelled Base	07:25	80.7%	10:03	90.3%	98.1%
Phase 1	07:32	78.5%	10:45	88.0%	98.1%
Impact	00:07	-2.2%	00:43	-2.3%	0.0%

Number of Districts within Target (out of11)

Modelling Position	1st Response to All 2+ Pump Incidents	2nd Response to All 2+ Pump Incidents	1st Response to All Incidents
	80% in 10 mins	80% in 15 mins	95% in 16 mins
Modelled Base	6	9	9
Phase 1	6	9	11
Difference	0	0	2

6 PHASE 1 MODELLING

6.1 The 'Phase 1' deployments are given in Appendix **D1** and also in Figure **5** opposite. A number of changes to the current deployments due to the alternative crew types were considered (see Appendix **D1a**). Under this proposed deployment, Gomshall station would no longer deploy any front line pumping appliances.

6.2 The impacts on attendance performance by district for individual modelling periods are shown in Appendix **D2**. The 24/7 impact on Surrey-wide performance is shown in Figure **6** opposite.

6.3 There is a negligible impact Surrey-wide during the day period on weekdays and weekends (see Appendices **D2a** and **D2b**) however, there are some significant impacts to individual districts. The second appliance response performance in Woking is adversely impacted due to the reduced deployment at Woking station, but still remains comfortably within target. Significant improvements to response performance in Tandridge and Waverley in the day periods lead to both districts meeting a target which they previously did not.

6.4 Appendices **D2c** and **D2d** show a noticeable Surrey-wide fall in performance in the evening and night periods, especially for second appliance performance. Surrey Heath, Epsom and Ewell and Spelthorne districts are all shown to no longer achieve one of the targets previously met in the base position for the evening and night periods.

6.5 Across the 24/7 period the overall percentage of first appliance responses within 10 minutes falls just below the 80% target (to 78.5%, previously 80.7%) and this result is presented in Appendix **D2e**. Second appliance performance in Surrey Heath falls from 95.8% to 76.2% within 15 minutes. Second appliance response performance in Tandridge district meets the target with 81.0% within 15 minutes (previously 66.3%) and also the first response to all incidents target with an improvement from 94.9% to 95.6% within 16 minutes. Response performance in Waverley district also achieves the first response to all incidents target with 96.8% within 16 minutes (previously 94.7%).

6.6 There are some significant impacts across the 24/7 period to individual districts not mentioned above, but none that result in a change to whether the percentage targets are met or not. Full response distributions by district for the 24/7 period are presented in Appendix **D3** for the three response types.

6.7 Appendix **D4** presents the range coverage maps for the 'Phase 1' position for first and second response for three different periods: weekday day, weekend day and evening and night combined.

7 SENSITIVITY MODELLING

7.1 During the validation process incidents receiving two or more appliances were divided into two categories; false alarm incidents and non false alarm incidents (serious incidents). The average response times to serious incidents tend to be longer than to false alarm incidents. This is due to a large proportion of false alarms occurring as a result of automatic false alarms which tend to be located in town centres and therefore within short journey times of fire stations.

7.2 Appendix **E1** presents the Surrey-wide response performance impacts to serious incidents by period for 'Phase 1'. The greatest impact on performance is during the evening and night periods. Second appliance performance is affected more than first.

7.3 When establishing a modelled base position, responses made within Surrey by OTB appliances were included in the demand. OTB appliances were not considered available to respond in the base position, with the exception of Horley. The responses made by wholetime and day-crewed OTB appliances within Surrey from April 2009 to March 2011 are shown in Appendix **E2**. After Horley, the biggest contribution came from Rushmoor, on the border with Hampshire.

7.4 There are reduced deployments at some stations in the 'Phase 1' deployments and it is likely that some OTB appliances will continue to contribute to some incidents within Surrey. Sensitivity modelling was therefore carried out to assess the impact on response performance.

7.5 Wholetime and day-crewed appliances from the stations shown in Appendix **E2** were added into the modelled base position and the 'Phase 1' deployments. The same assumptions that were placed upon Horley's appliance in the modelled base position were applied to the additional OTB appliances (ie, 25% unavailability and additional two minutes turnout time). OTB RDS appliances were not included as there are very few actual responses made over the last two years and it would be difficult to estimate the unavailability levels.

7.6 Appendix **E3** shows the 'Phase 1' modelling with OTB appliances included in the modelled base and new deployment positions. The reduced performance in Surrey Heath is still significant, but the inclusion of a wholetime appliance at Rushmoor negates some of the impact associated with reducing the deployment at Camberley in the evening and night.

FIGURE 7 DEPLOYMENTS BY PERIOD AND PERFORMANCE

Weekday Day

Crewing Type	Modelled Base	Phase 1 Crewing
Wholetime/Variable Crewed/Day Crewed	22	24
Retained/On Call	13	1

Weekend Day

Crewing Type	Modelled Base	Phase 1 Crewing
Wholetime/Day Crewed	20	20
Retained/Variable Crewed/On Call	15	9

Evening

Crewing Type	Modelled Base	Phase 1 Crewing
Wholetime/Day Crewed	20	16
Retained/Variable Crewed/On Call	15	9

Night

Crewing Type	Modelled Base	Phase 1 Crewing
Wholetime/Day Crewed	20	16
Retained/Variable Crewed/On Call	15	9

24/7 Performance

Performance Target	Modelled Base	Phase 1 Crewing
1st Response to 2+ Incidents Within 10 Minutes	80.7%	78.5%
2nd Response to 2+ Incidents Within 15 Minutes	90.3%	88.0%
1st Response to All Incidents Within 16 Minutes	98.1%	98.1%

Notes

Horley wholetime appliance not included in crewing numbers

On-Call appliances 100% available while retained have varying unavailability levels

8 CONCLUSIONS

8.1 This report has presented analysis and modelling to support SFRS in planning the future deployment of stations, appliances and personnel in support of the IRMP for 2011-2020.

8.2 Data analysis was undertaken to give a comprehensive description of service delivery and provide inputs for the simulation and optimisation models. Response performance and demand levels were taken from the most recent two financial years and the incident locations used the most recent five financial years' data. This gave a robust position to validate performance against.

8.3 The evidence supporting the model preparation and validation process presented in the report shows that there is a close correspondence between actual and modelled crew response times. This demonstrates that the model accurately emulates the speed and behaviour of pumping appliance responses across Surrey, allowing the model to be used with confidence to identify and evaluate options for change.

8.4 A modelled base position was created taking into account all demand within Surrey's borders and recognising the formal arrangement in place with West Sussex FRS in terms of continued support and provision of responses to the area around Horley.

8.5 One of the major operational issues currently facing SFRS is the low availability of RDS appliances. Although RDS unavailability is a national problem, the unique geographical and demographic make-up of Surrey, with a high commuter population, leads to this issue being particularly accentuated. SFRS has determined that developing a new 'on-call' resource of firefighters can improve pumping appliance availability to close to 100% with new contractual arrangements.

8.6 A number of potential deployment options were generated by ORH and SFRS. A two-phased approach has been favoured by SFRS and this report has presented detailed modelling results for 'Phase 1'. The Surrey-wide deployments by period and associated performance are presented in Figure **7** opposite.

8.7 'Phase 1' deployments result in first appliance performance across Surrey being broadly maintained at the same level. Second appliance performance is adversely affected, mainly during the evening and night periods.

8.8 Sensitivity modelling was carried out to assess the impact on serious incidents for each phased deployment. The potential contribution of OTB wholetime appliances to each deployment was also considered.

8.9 The modelling results provided in this report can aid senior officers at SFRS in terms of the decision making around future deployments of pumping appliances.