Chief Ambulance Services Commissioners Report

Emergency Medical and Retrieval Service - Service Review

Supporting Document 7
Optima Modelling

POST PUBLIC ENGAGEMENT SCENARIOS

EMERGENCY MEDICAL RETRIEVAL AND TRANSFER SERVICE

Version 1.1

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EXECUTIVE SUMMARY

The Chief Ambulance Services Commissioner (**CASC**) has asked CSAM Optima to do modelling on possible changes in bases and shifts. The baseline and all scenarios use a combined dataset (historical + unmet need) for simulations. It ranges from 1 June 2022 hours up to 31 May 2023:

- **Scenario 1: Baseline**. The baseline includes the current 4 bases and shifts. The modelled daylight flying hours are the same for all bases and apply to all helicopters, except for the H67 in Cardiff. Outside daylight flying hours the crew of a location will always use a car. The modelled probabilities of not being able to use the helicopter are based on visibility data from the nearest weather station. If a crew cannot use the helicopter, then they will use the car to respond.

- **Scenario 2: Existing Bases, Existing Capacity (5 variations)**. This scenario tests potential performance improvements by changing the shift timings in Welshpool, Caernarfon, or both. The best-performing variation is 2B, where timings in Caernarfon are changed to 14:00 - 02:00 hours.

- **Scenario 3: Consolidated Base, Existing Capacity (4 variations)**. Welshpool (1 shift) and Caernarfon (1 shift) are merged into a single base (2 shifts). The best-performing variation is 3D. This is where the bases are merged in Rhuddlan, keeping one shift as 08:00 - 20:00 and changing the other to 14:00 - 02:00 hours.

- **Scenario 4: Additional Capacity to Scenario 3 (3 variations)**. This scenario investigates how the performance of scenario 3 can be improved further by adding a car-only shift to various potential locations. The best-performing variation is 4C, where a car-only shift of 20:00 - 08:00 is added.

- **Scenario 5: Additional Capacity to Baseline (4 variations)**. This scenario tests how the Baseline could be improved by adding an extra crew shift and no extra helicopters. The best-performing variation is 5C, where an extra crew shift is added to Caernarfon, working 20:00 - 08:00 hours.

- **Scenario 6: Additional Capacity to Scenario 2 (3 variations)**. Similar in approach to scenario 4, this scenario investigates how the performance of scenario 2B can be improved further by adding a car-only shift to various potential locations.

The high-level results of the best-performing variation of each scenario are shown in the table **below**.

Selection of scenarios	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
1) Baseline (BL)	3,650	2,696	858 (19%)	30%	56:21	26:20
2B) Caernarfon: change to 14-02	3,748	2,793	760 (17%)	31%	55:25	26:36
3D) Rhuddlan 08-20 + 14-02	3,791	2,835	717 (16%)	32%	53:23	25:22
4C) 3D + Extra car 20-08	3,859	2,904	649 (14%)	27%	52:33	24:12
5C) BL + add 20-08 to Caernarfon	3,755	2,801	753 (17%)	26%	55:19	25:30
6C) Extra car 20-08	3,857	2,901	651 (14%)	27%	51:47	24:50

This shows that merging Caernarfon and Welshpool into Rhuddlan on its own (3D) can lead to stronger performance improvements than adding an extra shift to existing locations (5C). The combination of merging into Rhuddlan and adding an extra car to a new location leads to the strongest performance improvements (4C). If best performance improvements are the goal, then it is recommended to implement scenario 4C. A good second-best option is scenario 6C. Optima also recommends that CASC reads this report in full as it contains more information about the methodology and more detailed results. Please contact Optima for questions or follow-up actions.

CONTENTS

GLOSSARY

The following abbreviations and terms are used in this report:

Abbreviation	Description
EMRTS	Emergency Medical Retrieval and Transfer Service
CASC	Chief Ambulance Services Commissioner
CSAM Optima Predict	Advanced simulation modelling software from CSAM Optima
H57, H59, H61, H67	Callsigns (car/helicopter names)
WAST	Welsh Ambulance Service Trust

1 INTRODUCTION

The Chief Ambulance Services Commissioner (**CASC**) has asked CSAM Optima to do modelling on certain possible changes in bases and shifts of EMRTS. The following sections cover the methodology, analysis, results, and conclusions based on this modelling.

2 METHODOLOGY

2.1 Data

The input data used for simulations is as follows:

- Historical incident and response data from the systems of the Welsh Ambulance Service Trust (**WAST**), which also holds historical data from EMRTS. It was agreed to use a dataset that covers all incidents that came in between 1 June 2022 00:00:00 hours up to 31 May 2023 23:59:59 hours. The data import and preparation has been done in the same way as before. This includes delaying the Vehicle Clear Timestamp for transported incidents by 45 minutes to explicitly factor in time for refuelling and restocking. This data import shows that there are 3485 incidents with a dispatch (of which 2583 have scene arrivals) that EMRTS has historically responded to.

- EMRTS has also provided a list of incidents they would have wanted to respond to, but were unable to (the 'unmet need'). The unmet need has also been taken out of the dataset from WAST and added to the incident & response data. This shows that the unmet need consists of 1023 incidents with a dispatch (of which 965 have scene arrivals) that were responded to by WAST instead of EMRTS.

- These two datasets have been combined (i.e. the incidents historically responded to by EMRTS + the unmet need) is 4508 incidents with a dispatch (of which 3548 have scene arrivals).

The image on the **right** gives an overview of the geography, bases, vehicles, hospitals, and incident dataset of the Baseline in the EMRTS Optima Predict simulation model.
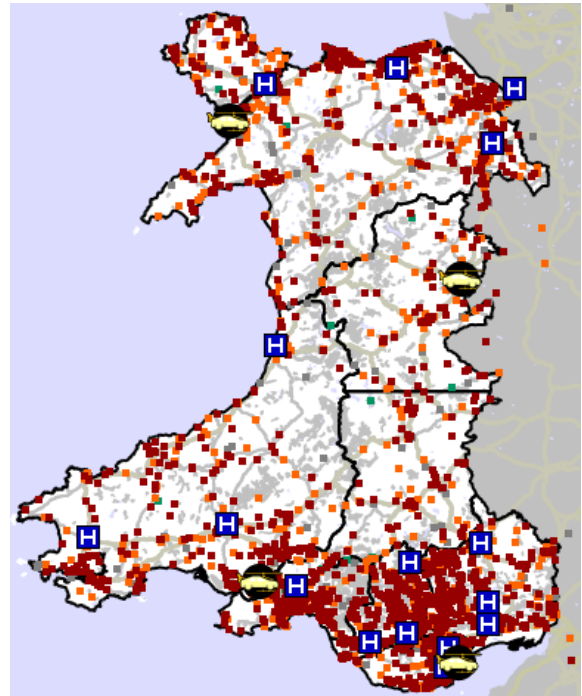
2.2 Baseline

The Baseline bases and shifts are as follows:

- There are 4 stations, in Cardiff, Dafen, Welshpool, and Caernarfon.
- Cardiff has two daily shifts (H67), working from 07:00 - 19:00 and 19:00 - 07:00. These crews have access to a car and a helicopter. The helicopter can fly at night but is limited by modelled bad weather probabilities.
- Dafen has one daily shift (H57), working from 07:00 - 19:00 hours. This crew has access to a car and helicopter. The helicopter is limited by daylight hours and by modelled bad weather probabilities.
- Welshpool has one daily shift (H59), working from 08:00 - 20:00 hours. This crew has access to a car and helicopter. The helicopter is limited by daylight hours and by modelled bad weather probabilities.
- Caernarfon (H61) has the same shifts setup as Welshpool.

The baseline and all scenarios use the combined dataset (historical + unmet need) for simulations. It ranges from 1 June 2022 00:00:00 hours up to 31 May 2023 23:59:59 hours.

2.3 Daylight flying hours

The daylight flying hours are the same for all bases and apply to all helicopters, except for the H67 in Cardiff. Outside daylight flying hours the crew of a location will always use a car.

Daylight flying hours	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Start	05:00	05:00	05:00	06:00	07:00	07:00	08:00	08:00	08:00	07:00	07:00	06:00
End	22:00	22:00	21:00	19:00	18:00	16:00	16:00	17:00	18:00	20:00	21:00	22:00

2.4 Bad weather probabilities per base

The probabilities of not being able to use a helicopter are shown **below** and are based on visibility data from the nearest weather station. They are the same in all scenarios. If a crew cannot use the helicopter, then they will use the car to respond. This data has been provided by an external agency that is specialised in the relationship between weather and the likelihood of being able to fly a helicopter.

Base	Weather station	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Cardiff	St Athan	5%	5%	5%	6%	5%	9%	15%	13%	6%	10%	5%	5%
Dafen	Pembrey Sands	9%	9%	11%	11%	11%	10%	18%	15%	17%	12%	7%	6%
Welshpool	Shawbury	3%	2%	2%	5%	3%	10%	11%	10%	4%	5%	3%	2%
Caernarfon	Caernarfon	8%	10%	9%	8%	7%	7%	11%	9%	8%	7%	4%	4%
Rhuddlan	Rhyl No 2	6%	4%	4%	4%	2%	2%	4%	3%	3%	3%	2%	1%

2.5 Scenarios

<u>Scenario 1: "Status quo":</u>
Baseline. This scenario is the Baseline as described above.

<u>Scenario 2: Existing Bases, Existing Capacity:</u>
2A) Welshpool 14-02. Change the Welshpool shift to 14:00 - 02:00 hours.
2B) Caernarfon 14-02. Change the Caernarfon shift to 14:00 - 02:00 hours.
2C) Welshpool & Caernarfon 14-02. Change the Welshpool and Caernarfon shifts to 14:00 - 02:00 hours.
2D) Welshpool 20-08. Change the Welshpool shift to 20:00 - 08:00 hours.
2E) Caernarfon 20-08. Change the Caernarfon shift to 20:00 - 08:00 hours.

<u>Scenario 3: "Consolidated Base, Existing Capacity":</u>
3A) Rhuddlan 2x 08-20. Merge Welshpool (1 shift) and Caernarfon (1 shift) into Rhuddlan (2 shifts).
3B) Best Alternative. Merge Welshpool and Caernarfon into the best alternative (2 shifts).
3C) Rhuddlan 08-20 + 20-08. Merge Welshpool (1 shift) and Caernarfon (1 shift) into Rhuddlan and change the shift timings to 08:00 - 20:00 and 20:00 - 08:00.
3D) Rhuddlan 08-20 + 14-02. Merge Welshpool (1 shift) and Caernarfon (1 shift) into Rhuddlan and change the shift timings to 08:00 - 20:00 and 14:00 - 02:00.

<u>Scenario 4: "Additional Capacity to Scenario 3":</u>
4A) Extra car 08-20. Uses the best-performing variation of scenario 3, then adds a car-only shift (08:00 - 20:00 hours) to a new, well-covering location in the north Wales.
4B) Extra car 14-02. Similar to the previous, but make the car-only shift 14:00 - 02:00 hours.
4C) Extra car 20-08. Similar to the previous, but make the car-only shift 20:00 - 08:00 hours.

<u>Scenario 5: "Additional Capacity to Baseline":</u>
5A) Welshpool add 20-08. Add a 20:00 - 08:00 crew to Welshpool.
5B) Welshpool add 14-02. Add a 14:00 - 02:00 crew to Welshpool. During the shift overlap (14:00 - 20:00), if the helicopter is already being used, then the second crew will use the car.
5C) Caernarfon add 20-08. Add a 20:00 - 08:00 crew to Caernarfon.
5D) Caernarfon add 14-02. Add a 14:00 - 02:00 crew to Caernarfon. During the shift overlap (14:00 - 20:00), if the helicopter is already being used, then the second crew will use the car.

<u>Scenario 6: "Additional Capacity to Scenario 2":</u>
6A) Extra car 08-20. Uses the best-performing variation of scenario 2, then adds a car-only shift (08:00 - 20:00 hours) to a new, well-covering location in the north Wales.
6B) Extra car 14-02. Similar to the previous, but make the car-only shift 14:00 - 02:00 hours.
6C) Extra car 20-08. Similar to the previous, but make the car-only shift 20:00 - 08:00 hours.

2.6 Performance indicators

This report uses the following performance indicators:

- Dispatches: how often a vehicle was dispatched (not necessarily arrived i.e. stood down). [count]
- Scene arrivals: how often a vehicle arrived arrived at scene. [count]
- Crew Utilisation: time assigned to incidents / planned shift time (e.g. 4h / 12h = 33%). [percentage]
  - In the results per best-performing scenario variation, these are also broken down by base.
- Response Duration: Clock Start Time --> First Vehicle Arrived Time. [mm:ss]
- Vehicle Reflex Duration: Vehicle Dispatch Time --> Vehicle Scene Arrival Time. [mm:ss]
- Residual unmet need: the count of all incidents in the input incident dataset, minus the count of incidents with a simulated dispatch.

3 SIMULATION RESULTS

3.1 Overall results

The table below **shows** the simulation results of the modelled scenarios:

Scenario	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
1) Baseline	3,650	2,696	858 (19%)	30%	56:21	26:20
Scenario 2: Existing Bases, Existing Capacity. The best-performing variation is marked as ★.						
2A) Welshpool 14-02	3,739	2,785	769 (17%)	31%	55:13	25:59
2B) Caernarfon 14-02 ★	3,748	2,793	760 (17%)	31%	55:25	26:36
2C) Welshpool & Caernarfon 14-02	3,684	2,730	824 (18%)	30%	55:50	25:12
2D) Welshpool 20-08	3,679	2,727	829 (18%)	30%	56:48	26:13
2E) Caernarfon 20-08	3,708	2,753	800 (18%)	31%	57:05	26:35
Scenario 3: Consolidated Base, Existing Capacity. The best-performing variation is marked as ★.						
3A) Rhuddlan 2x 08-20	3,661	2,707	847 (19%)	30%	56:36	26:09
3B) Best Alternative 2x 08-20	3,671	2,717	937 (21%)	31%	56:10	26:03
3C) Rhuddlan 08-20 + 20-08	3,767	2,812	741 (16%)	31%	53:58	24:43
3D) Rhuddlan 08-20 + 14-02 ★	3,791	2,835	717 (16%)	32%	53:23	25:22
Scenario 4: Additional Capacity to Scenario 3. The best-performing variation is marked as ★.						
4A) Extra car 08-20	3,817	2,861	691 (15%)	27%	54:29	25:08
4B) Extra car 14-02	3,843	2,888	665 (15%)	27%	53:02	24:34
4C) Extra car 20-08 ★	3,859	2,904	649 (14%)	27%	52:33	24:12
Scenario 5: Additional Capacity to Baseline. The best-performing variation is marked as ★.						
5A) Welshpool add 20-08	3,746	2,792	762 (17%)	26%	55:55	25:55
5B) Welshpool add 14-02	3,733	2,779	775 (17%)	26%	55:52	25:41
5C) Caernarfon add 20-08 ★	3,755	2,801	753 (17%)	26%	55:19	25:30
5D) Caernarfon add 14-02	3,738	2,785	770 (17%)	26%	56:06	25:50
Scenario 6: Additional Capacity to Scenario 2. The best-performing variation is marked as ★.						
6A) Extra car 08-20	3,777	2,823	731 (16%)	26%	54:06	25:55
6B) Extra car 14-02	3,834	2,878	674 (15%)	27%	52:44	25:08
6C) Extra car 20-08 ★	3,857	2,901	651 (14%)	27%	51:47	24:50

These results can be interpreted as below. More details per scenario are in the next sections.

- Scenario 2 tests potential performance improvements by changing the shift timings in Welshpool, Caernarfon, or both. The best-performing variation is 2B. In this scenario, the shift timings in Caernarfon are changed to 14:00 - 02:00 hours.

- In scenario 3, Welshpool (1 shift) and Caernarfon (1 shift) are merged into a single base (2 shifts). The best-performing variation is 3D. This is where the bases are merged in Rhuddlan, keeping one shift as 08:00 - 20:00 and changing the other to 14:00 - 02:00 hours.

- Scenario 4 investigates how the performance of scenario 3 can be improved upon further by adding a car-only shift to various potential locations. The best-performing variation is 4C, where a car-only shift of 20:00 - 08:00 is added.

- Scenario 5 evaluates how the Baseline could be improved upon by adding an extra crew shift, without adding extra helicopters. The best-performing variation is 5C, where an extra crew shift is added to Caernarfon, working 20:00 - 08:00 hours.

- Scenario 6 investigates how the performance of scenario 2 can be improved upon further by adding a car-only shift to various potential locations. The best-performing variation is 6C, where a car-only shift of 20:00 - 08:00 is added.

3.2 Scenario 2: Existing Bases, Existing Capacity

The table below repeats the simulated results of the best performing variation (scenario 2B):

Overall results	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
2B) Caernarfon: change to 14-02	3,748	2,793	760 (17%)	31%	55:25	26:36

The crew utilisation by base in scenario 2B is as follows:

Crew utilisation	Overall	Caernarfon	Cardiff	Dafen	Welshpool
2B) Caernarfon: change to 14-02	31%	21%	40%	35%	19%

The total count of scene arrivals of scenario 2B and the baseline by hour of day are as follows:
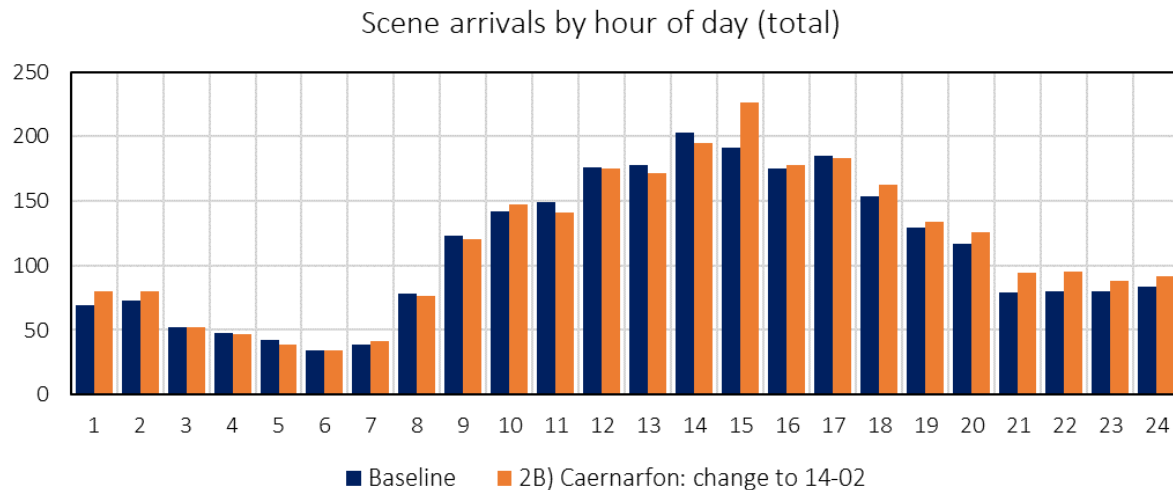
Scene arrivals by hour of day (total)

■ Baseline ■ 2B) Caernarfon: change to 14-02

The simulated response duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
2B) Caernarfon: change to 14-02	40:44	55:25	1:51:05
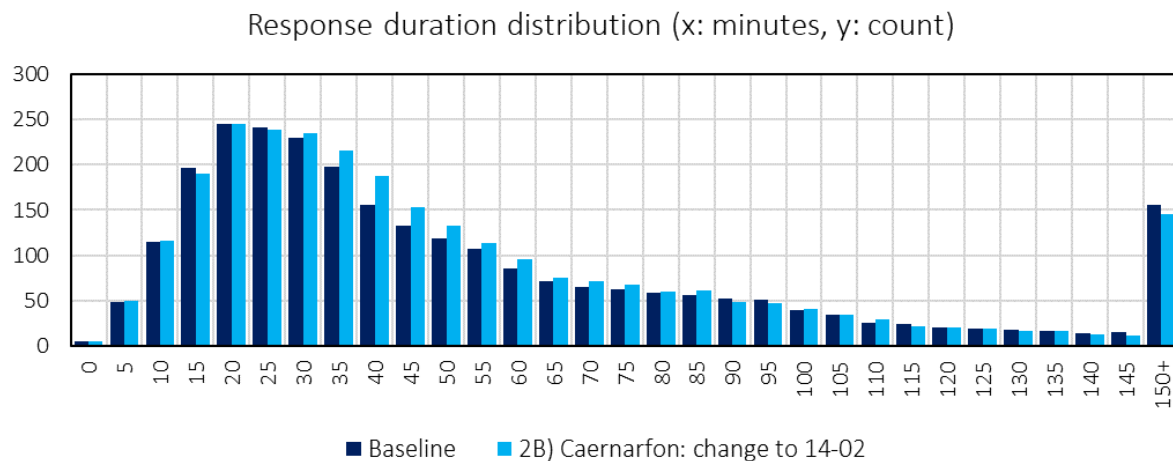
Response duration distribution (x: minutes, y: count)

■ Baseline ■ 2B) Caernarfon: change to 14-02

The simulated vehicle reflex duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
2B) Caernarfon: change to 14-02	22:42	26:36	48:48

### Vehicle reflex duration distribution (x: minutes, y: count)

■ Baseline ■ 2B) Caernarfon: change to 14-02
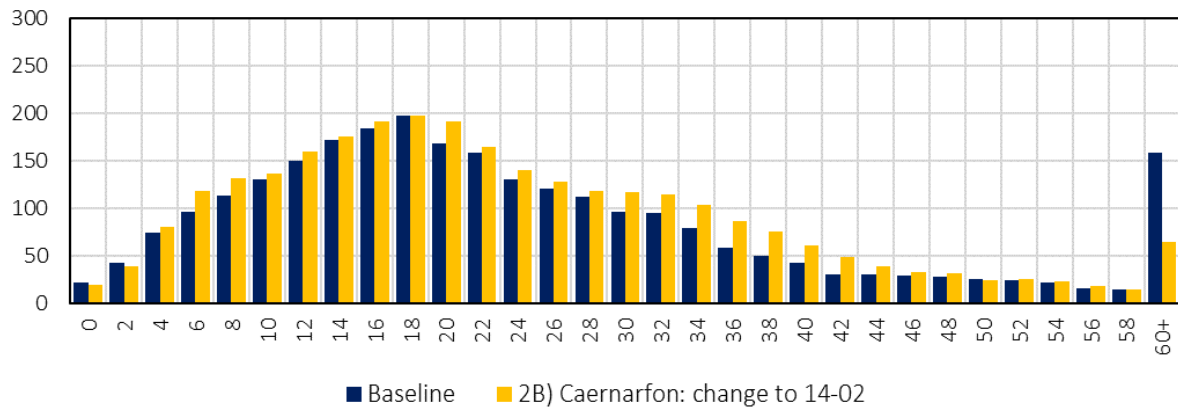
Left shows the difference in the simulated average response duration of scenario 2B compared to the baseline. **Right** shows the simulated residual unmet need in scenario 2B.
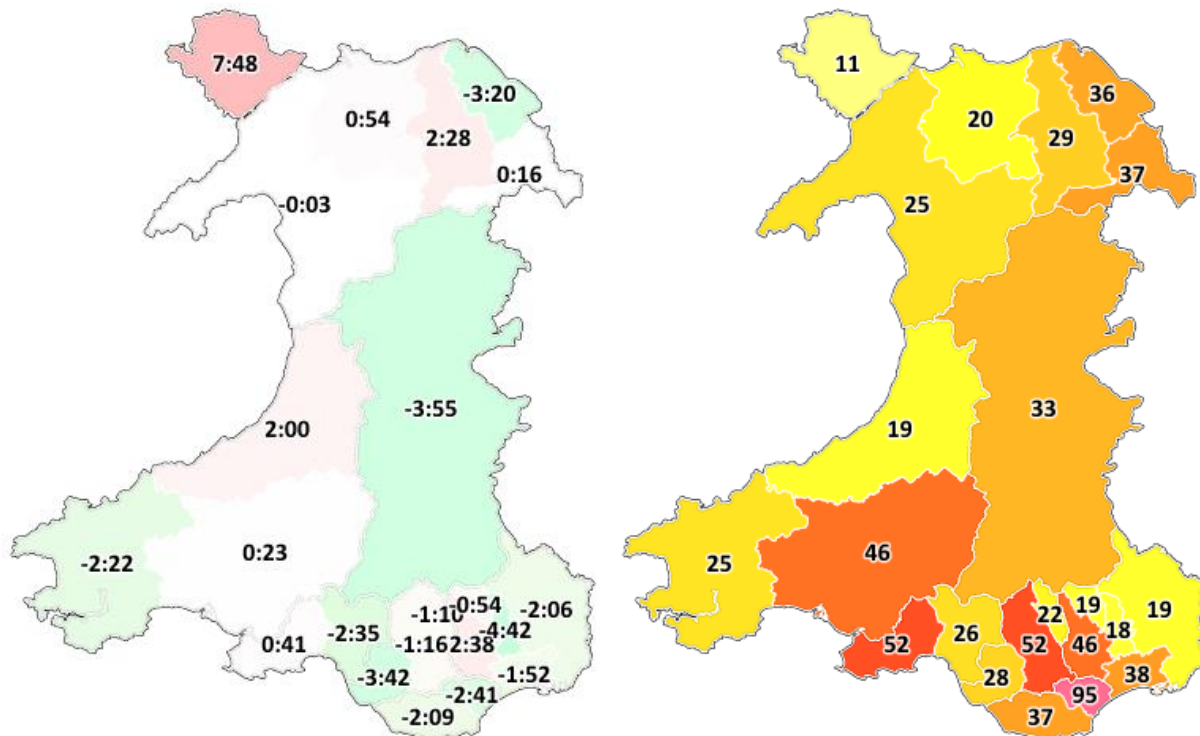
3.3 Scenario 3: Consolidated Base, Existing Capacity

For scenario 3B, coverage algorithms have been run in various settings across 1,718 generated potential locations, as shown **below**. This has led to a few different solutions, most of them in the middle in the far north in Wales. After testing these solutions in simulations, the location marked below with a red square was found to be the best-performing location. This is south of Rhyl / Rhuddlan, close to the A55. Green indicates what can be reached within 30 minutes, yellow within 60 minutes, and orange within 90 minutes.

Scenario 3B (best alternative with 2x an 08:00 - 20:00 shift) was created to test whether scenario 3A (Rhuddlan with 2x an 08:00 - 20:00 shift) could be improved upon. Scenarios 3B should not be directly compared to scenario 3C or 3D, because those two scenarios use different shift timings.
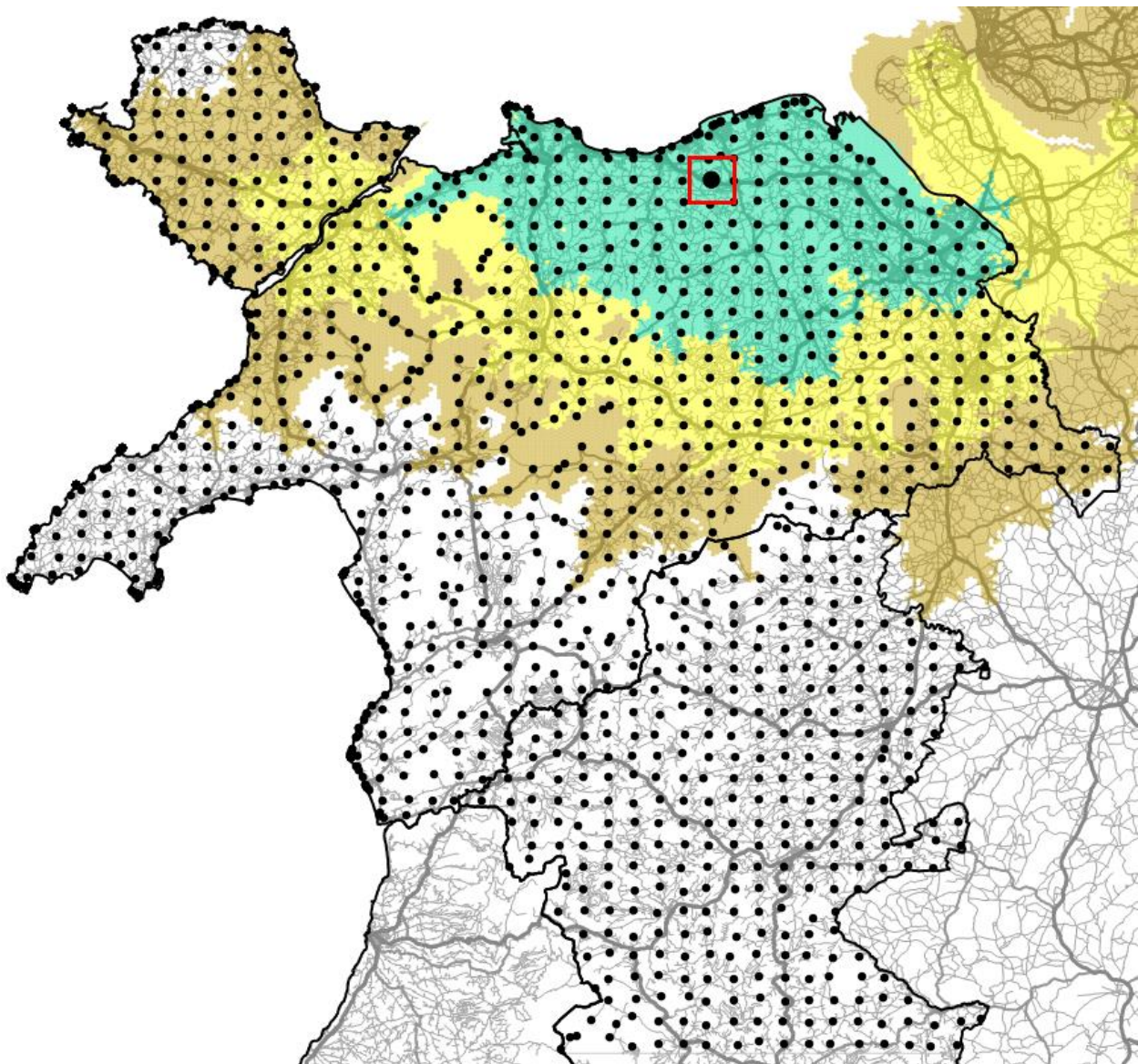
The table below repeats the simulated results of the best performing variation (scenario 3D):

| Overall results	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
3D) Rhuddlan 08-20 + 14-02	3,791	2,835	717 (16%)	32%	53:23	25:22

The crew utilisation by base in scenario 3D is as follows:

Crew utilisation	Overall	Cardiff	Dafen	Rhuddlan
3D) Rhuddlan 08-20 + 14-02	32%	39%	35%	22%

The total count of scene arrivals of scenario 3D and the baseline by hour of day are as follows:
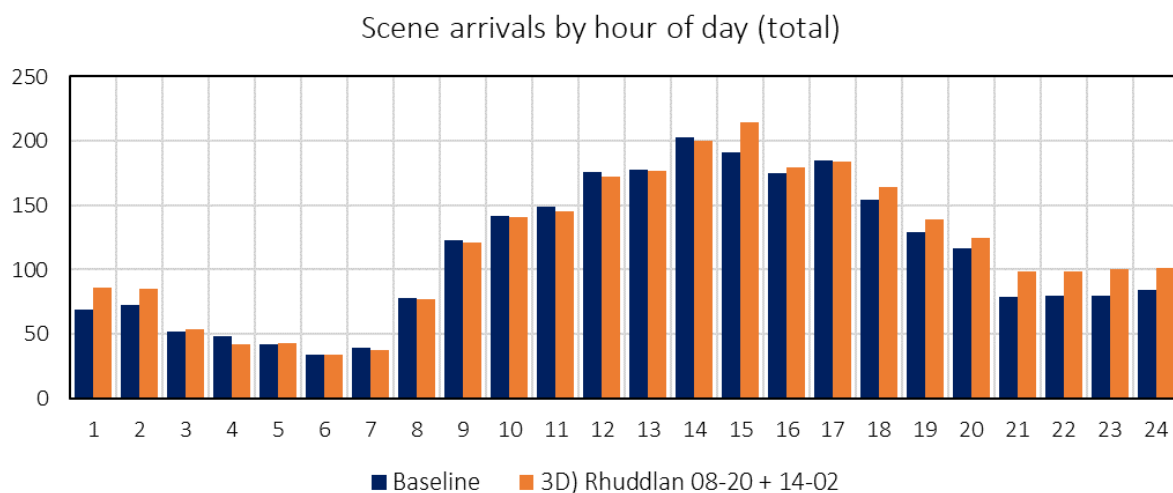
Scene arrivals by hour of day (total)

Baseline ■ 3D) Rhuddlan 08-20 + 14-02

The simulated response duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
3D) Rhuddlan 08-20 + 14-02	38:50	53:23	1:48:03
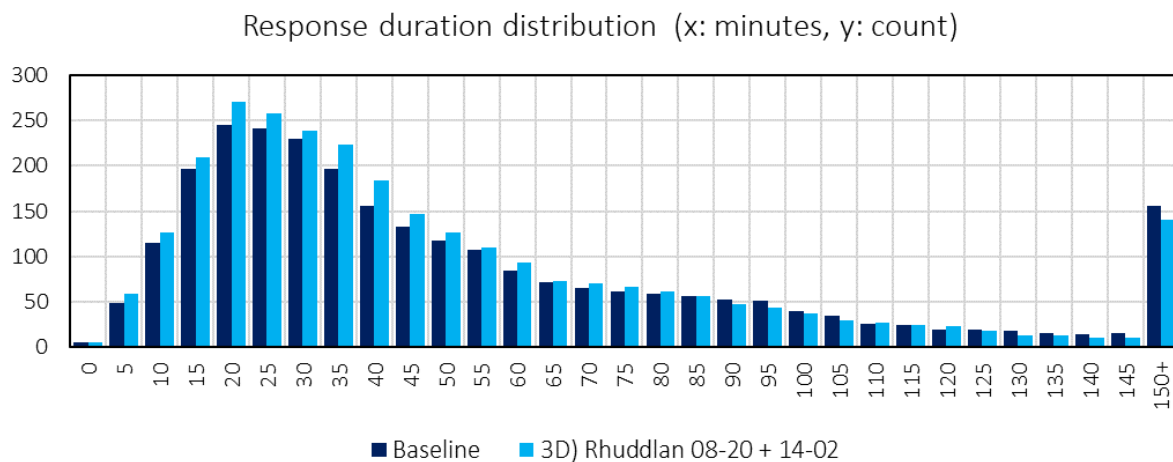
Response duration distribution (x: minutes, y: count)


Baseline ■ 3D) Rhuddlan 08-20 + 14-02

The simulated vehicle reflex duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
3D) Rhuddlan 08-20 + 14-02	21:43	25:22	45:10

Vehicle reflex duration distribution (x: minutes, y: count)


■ Baseline   ■ 3D) Rhuddlan 08-20 + 14-02
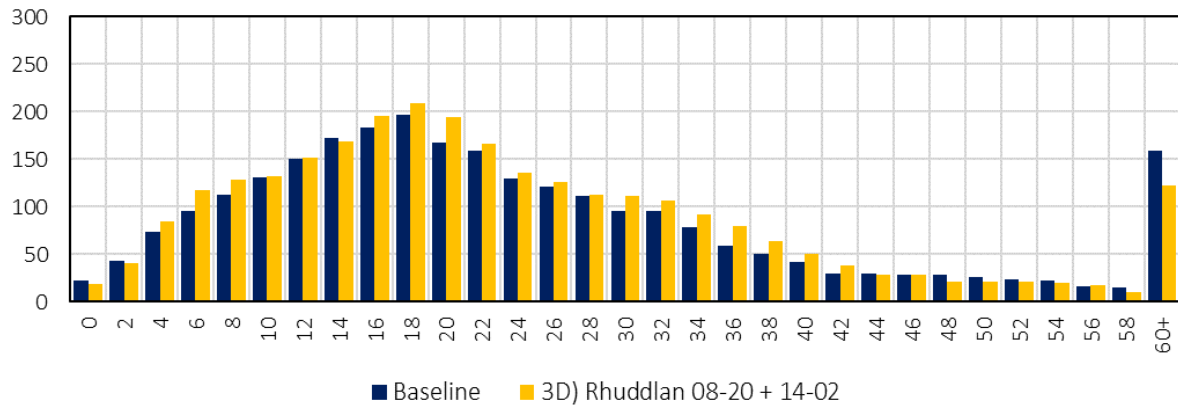
Left shows the difference in the simulated average response duration of scenario 3D compared to the baseline. **Right** shows the simulated residual unmet need in scenario 3D.
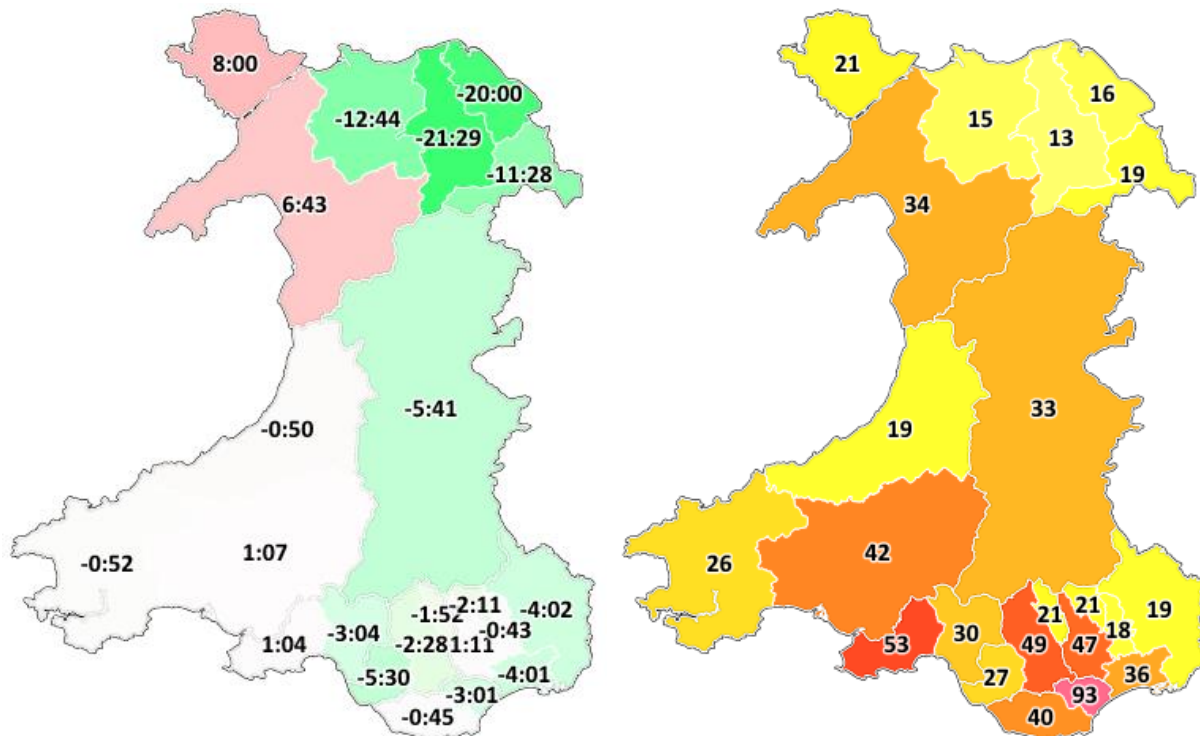
3.4 Scenario 4: Additional Capacity to Scenario 3

Scenario 4 investigates if the best-performing variation of scenario 3 can be improved upon further by adding a car-only shift. The best-performing variation of scenario 3 is variation 3D, Rhuddlan 08-20 + 14-02. Then, in variation 4A, the added car shift is 08:00 - 20:00 hours; in variation 4B this is 14:00 - 02:00 hours; in variation 4C this is 20:00 - 08:00 hours.

For scenario 4 it was decided to not use coverage algorithms to develop a limited set of options to test in simulations. Instead, all eight different potential locations as shown **below** have been tested.
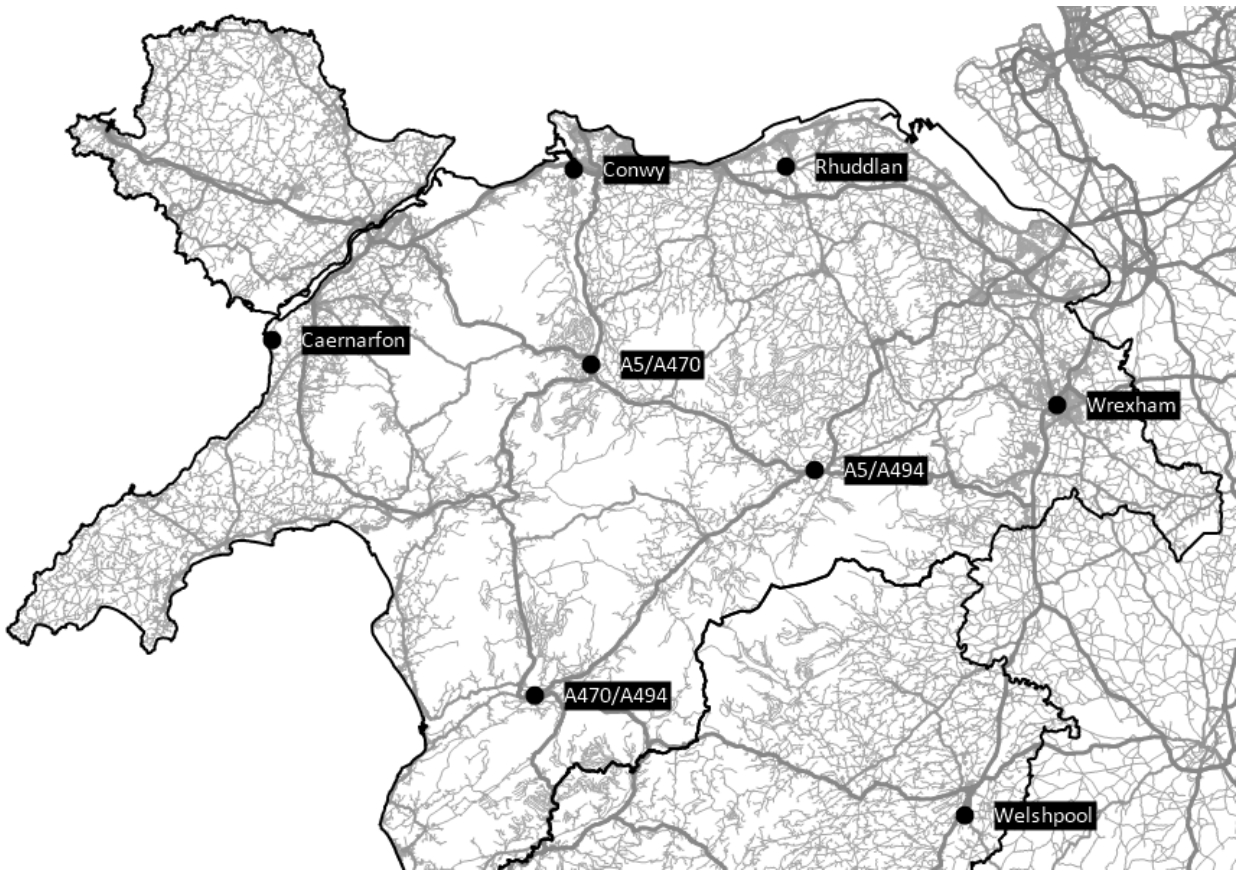
With 8 different locations and 3 different shift timings in scenario 4A, 4B, and 4C respectively, these 24 results have been evaluated. The best-performing variation of each has been shown in the results table at the beginning of the Results & Analysis chapter. The location and number of scene arrivals in the best-performing scenario variations are as follows:

- 4A (add a 08:00 - 20:00 car-only shift): best locations are Wrexham, Caernarfon, and A470/A494. Each of these options lead to an overall of 2861 simulated scene arrivals.
- 4B (add a 14:00 - 02:00 car-only shift): the best location is Wrexham (2888 scene arrivals).
- 4C (add a 20:00 - 08:00 car-only shift): the best location is Wrexham (2904 scene arrivals).

Therefore, if a car-only shift were to be added on top of the configuration of scenario 3D, Wrexham is the best location, particularly when timed at 20:00 - 08:00 hours.

The table below repeats the simulated results of the best performing variation (scenario 4C):

Overall results	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
4C) 3D + Extra car 20-08	3,859	2,904	649 (14%)	27%	52:33	24:12

The crew utilisation by base in scenario 4C is as follows:

Crew utilisation	Overall	Cardiff	Dafen	Rhuddlan	Wrexham
4C) 3D + Extra car 20-08	27%	27%	35%	21%	8%

The total count of scene arrivals of scenario 4C and the baseline by hour of day are as follows:
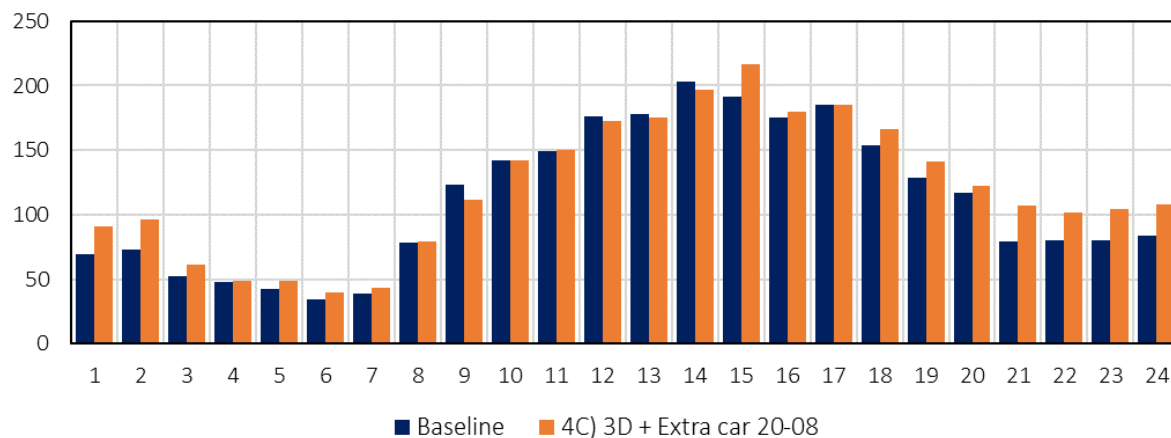
Scene arrivals by hour of day (total)

The simulated response duration statistics and distribution are as follows:

| Statistic (in minutes)	Median	Average	90th percentile
4C) 3D + Extra car 20-08	37:43	51:10	1:44:09

Response duration distribution (x: minutes, y: count)
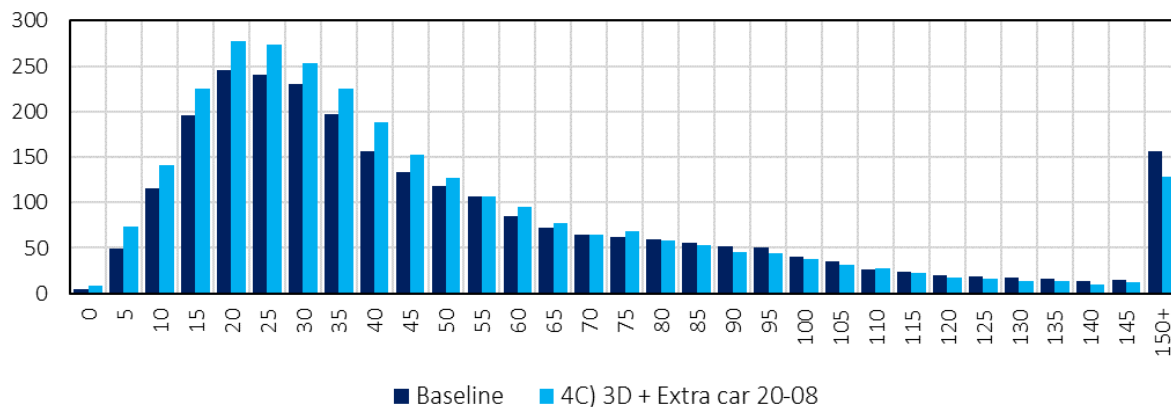
The simulated vehicle reflex duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
4C) 3D + Extra car 20-08	21:25	24:24	42:15

Vehicle reflex duration distribution (x: minutes, y: count)

■ Baseline ■ 4C) 3D + Extra car 20-08
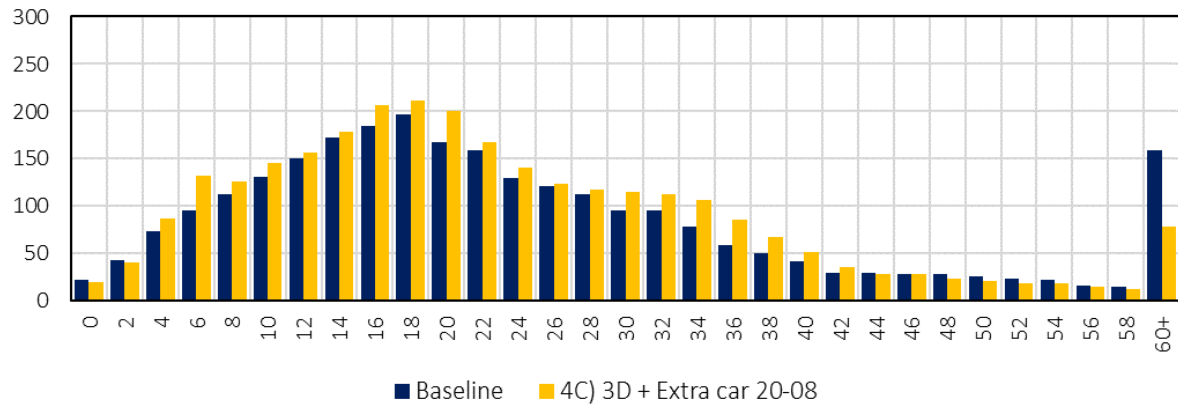
Left shows the difference in the simulated average response duration of scenario 4C compared to the baseline. **Right** shows the simulated residual unmet need in scenario 4C.
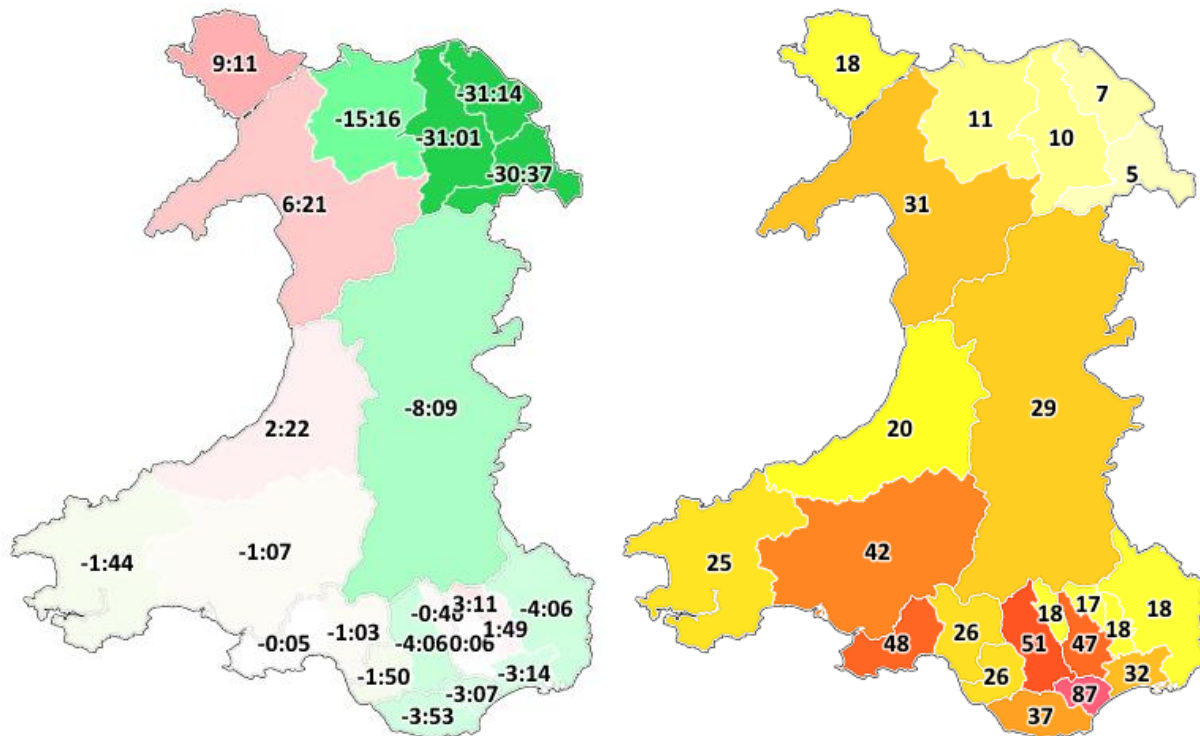
3.5 Scenario 5: Additional Capacity to Baseline

The table below repeats the simulated results of the best performing variation (scenario 5B):

Overall results	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
5C) BL + add 20-08 to Caernarfon	3,755	2,801	753 (17%)	26%	55:19	25:30

The crew utilisation by base in scenario 5C is as follows:

Crew utilisation	Overall	Caernarfon	Cardiff	Dafen	Welshpool
5C) BL + add 20-08 to Caernarfon	26%	13%	40%	36%	14%

The total count of scene arrivals of scenario 5B and the baseline by hour of day are as follows:
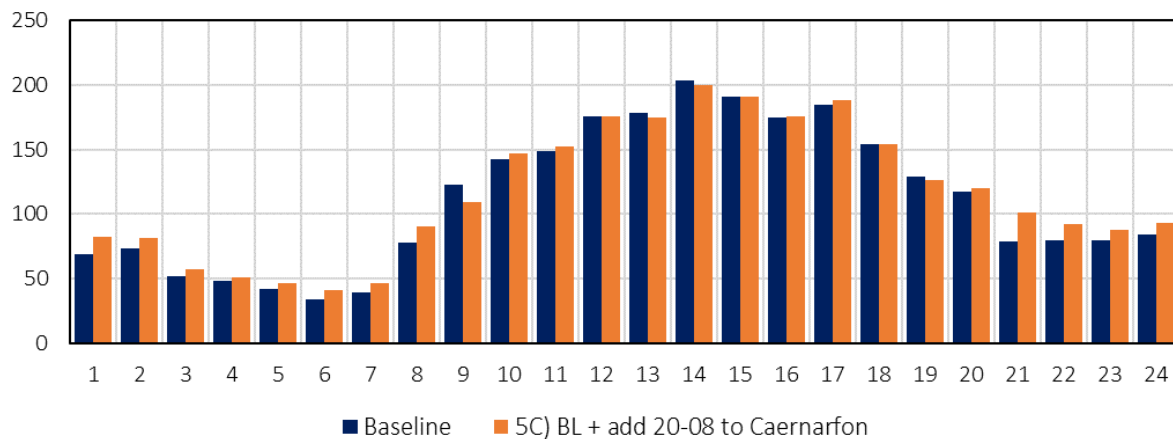
Scene arrivals by hour of day (total)

Baseline ■ 5C) BL + add 20-08 to Caernarfon

The simulated response duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
5C) BL + add 20-08 to Caernarfon	39:11	54:04	1:50:07

Response duration distribution (x: minutes, y: count)
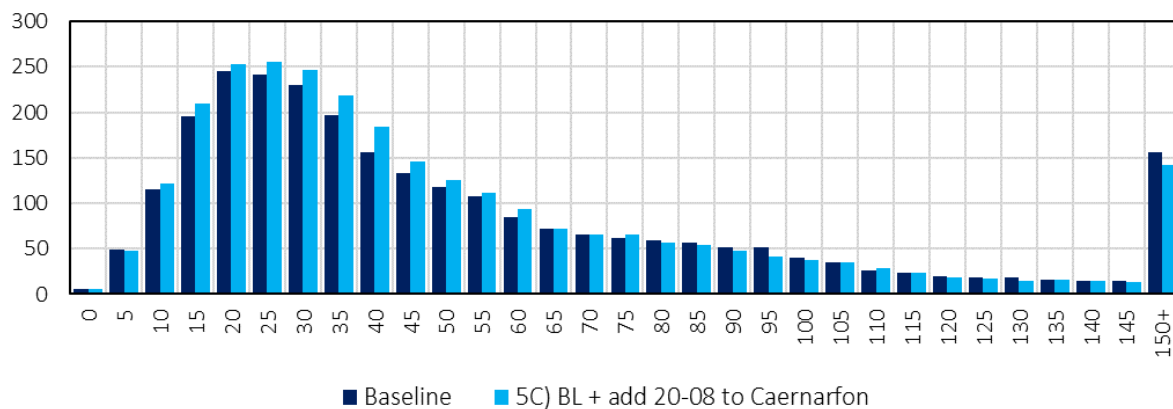
■ Baseline ■ 5C) BL + add 20-08 to Caernarfon

The simulated vehicle reflex duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
5C) BL + add 20-08 to Caernarfon	22:02	25:30	46:10

Vehicle reflex duration distribution (x: minutes, y: count)

■ Baseline   ■ 5C) BL + add 20-08 to Caernarfon
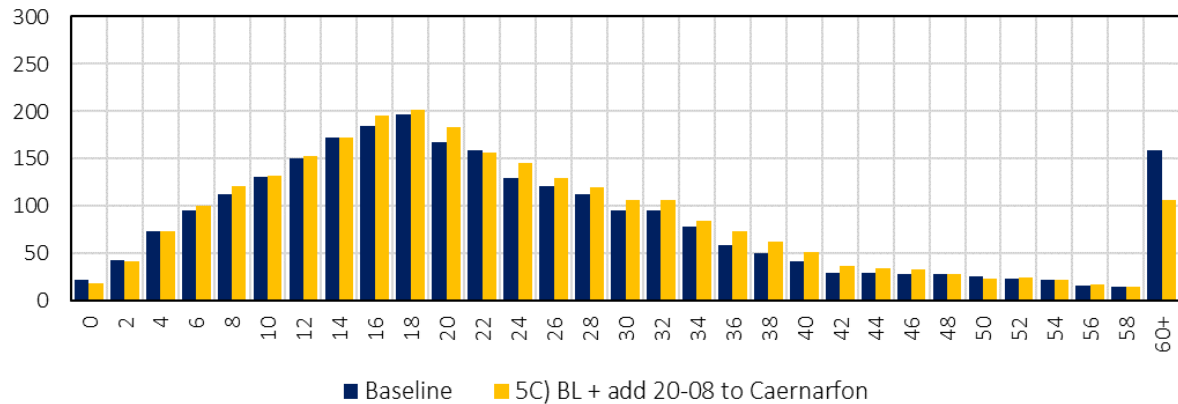
Left shows the difference in the simulated average response duration of scenario 5C compared to the baseline. **Right** shows the simulated residual unmet need in scenario 5C.
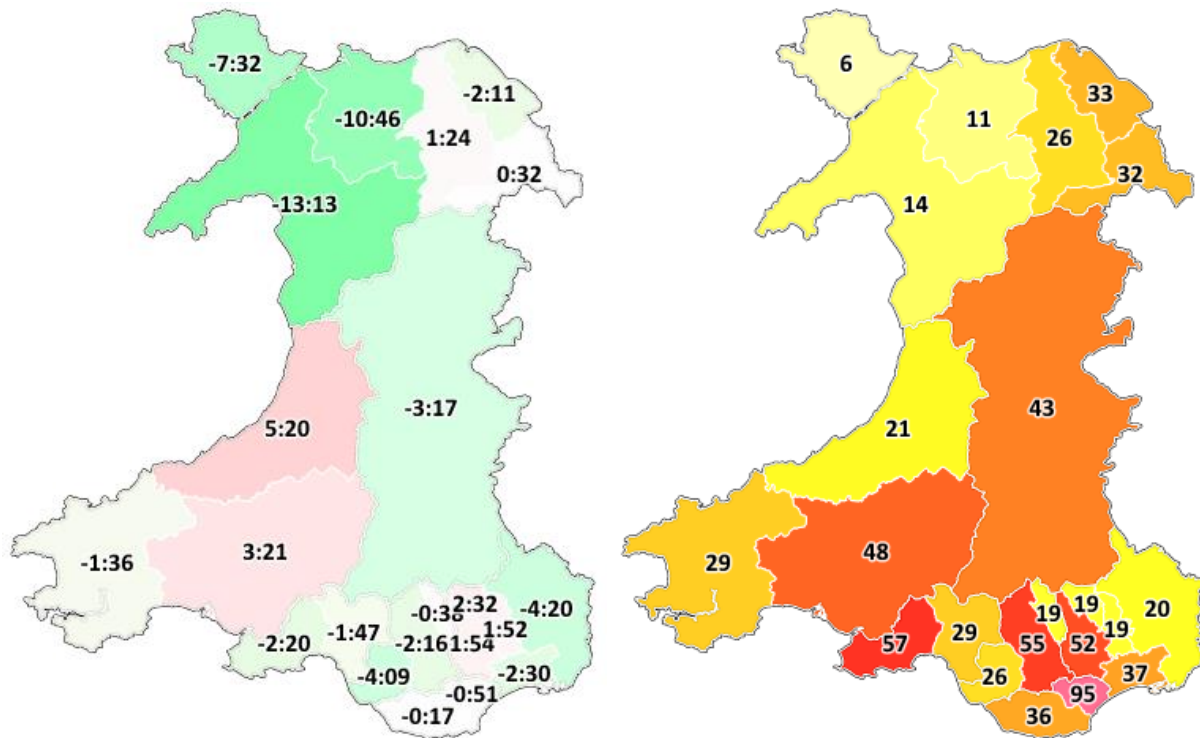
3.6 Scenario 6: Additional Capacity to Scenario 2

Scenario 6 investigates if the best-performing variation of scenario 2 can be improved upon further by adding a car-only shift. The best-performing variation of scenario 2 is variation "2B, Caernarfon 14-02". This is where the shift in Caernarfon was changed to 14:00 - 02:00 hours. Then, in variation 6A, the added car shift is 08:00 - 20:00 hours; in variation 6B this is 14:00 - 02:00 hours; in variation 6C this is 20:00 - 08:00 hours.

Scenario 6 uses the same 8 potential locations for an extra car-only shift as scenario 4 (Caernarfon, Conwy, Rhuddlan, Wrexham A5/A494, A5/A470, A470/A494, Welshpool). With 8 different locations and 3 different shift timings in scenario 6A, 6B, and 6C respectively, these 24 results have been evaluated. The best-performing variation of each has been shown in the results table at the beginning of the Results & Analysis chapter. The location and number of scene arrivals in the best-performing scenario variations are as follows:

- 6A (add a 08:00 - 20:00 car-only shift): best location is Rhuddlan (2823 scene arrival).
- 6B (add a 14:00 - 02:00 car-only shift): the best location is Wrexham (2878 scene arrivals).
- 6C (add a 20:00 - 08:00 car-only shift): the best locations are Rhuddlan (2901 scene arrivals) or Wrexham (2901 scene arrivals). In the results on maps below, the used location is Rhuddlan.

Therefore, if a car-only shift were to be added on top of the configuration of the best performing variation of scenario 2 (scenario 2B), Rhuddlan is the best location, particularly when timed at 20:00 - 08:00 hours. A good second-best would be Wrexham, also at 20:00 - 08:00 hours.

The table below repeats the simulated results of the best performing variation (scenario 6C):

Overall results	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
6C) Extra car 20-08	3,857	2,901	651 (14%)	27%	51:47	24:50

The crew utilisation by base in scenario 6 is as follows:

Crew utilisation	Overall	Caernarfon	Cardiff	Dafen	Rhuddlan	Welshpool
6C) 2B + Extra car 20-08	27%	20%	38%	35%	12%	19%

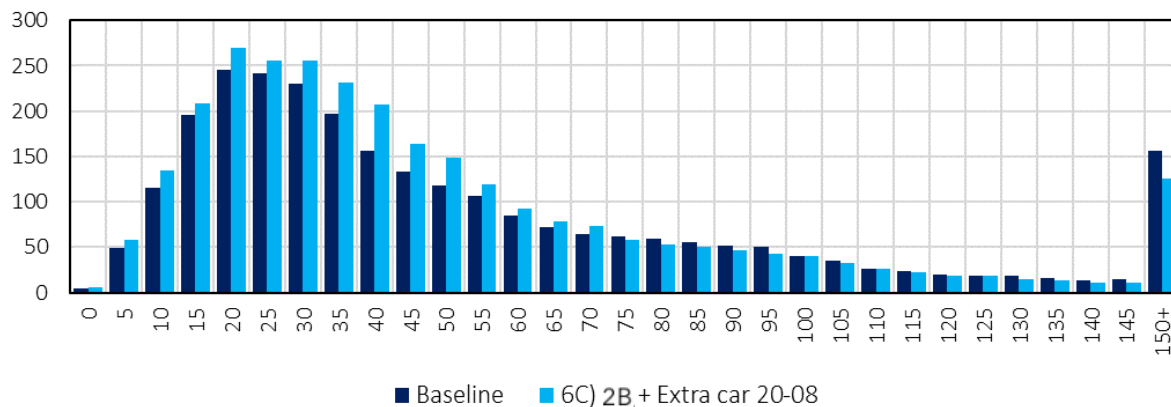The total count of scene arrivals of scenario 6C and the baseline by hour of day are as follows:
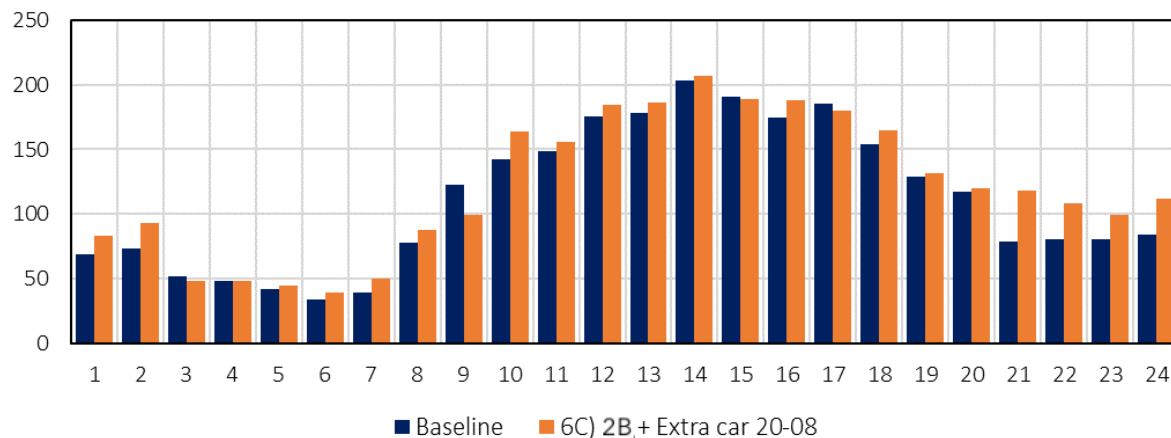
Scene arrivals by hour of day (total)

The simulated response duration statistics and distribution are as follows:

| Statistic (in minutes)	Median	Average	90th percentile
6C) 2B + Extra car 20-08	38:53	51:47	1:44:29

Response duration distribution (x: minutes, y:count)

The simulated vehicle reflex duration statistics and distribution are as follows:

Statistic (in minutes)	Median	Average	90th percentile
6C) 2B + Extra car 20-08	22:02	24:52	43:42

Vehicle reflex duration distribution (x: minutes, y: count)

■ Baseline   ■ 6C) 2B + Extra car 20-08
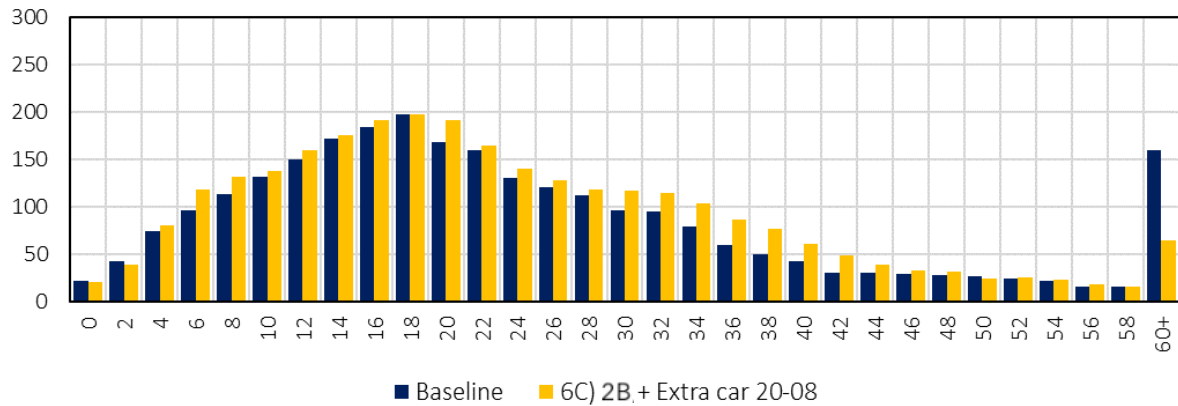
Left shows the difference in the simulated average response duration of scenario 6C compared to the baseline. **Right** shows the simulated residual unmet need in scenario 6C.
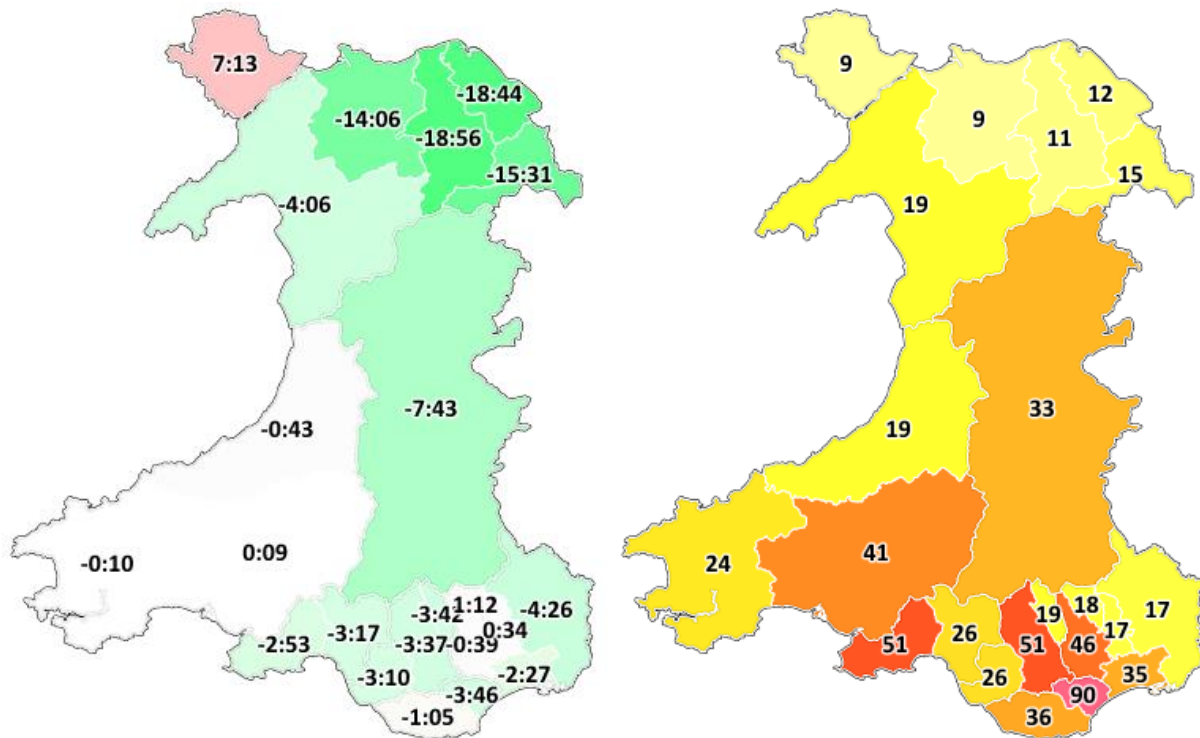
4 CONCLUSIONS & RECOMMENDATIONS

The high-level results of the best-performing variation of each scenario are repeated in the table **below**.

Selection of scenarios	Dispatches	Scene Arrivals	Residual Unmet Need	Crew Utilisation	Response Duration (avg)	Veh. Reflex Duration (avg)
1) Baseline (BL)	3,650	2,696	858 (19%)	30%	56:21	26:20
2B) Caernarfon: change to 14-02	3,748	2,793	760 (17%)	31%	55:25	26:36
3D) Rhuddlan 08-20 + 14-02	3,791	2,835	717 (16%)	32%	53:23	25:22
4C) 3D + Extra car 20-08	3,859	2,904	649 (14%)	27%	52:33	24:12
5C) BL + add 20-08 to Caernarfon	3,755	2,801	753 (17%)	26%	55:19	25:30
6C) Extra car 20-08	3,857	2,901	651 (14%)	27%	51:47	24:50

This shows that merging Caernarfon and Welshpool into Rhuddlan on its own (3D) can lead to stronger performance improvements than adding an extra shift to existing locations (5C). The combination of merging into Rhuddlan and adding an extra car to a new location leads to the strongest performance improvements (4C).

If the best performance improvements are the goal, then it is recommended to implement scenario 4C. A good second-best option is scenario 6C. Please contact Optima for questions or follow-up actions.

5   APPENDIX

Below is a higher resolution image of used locations, incidents, hospitals, etc for reference.
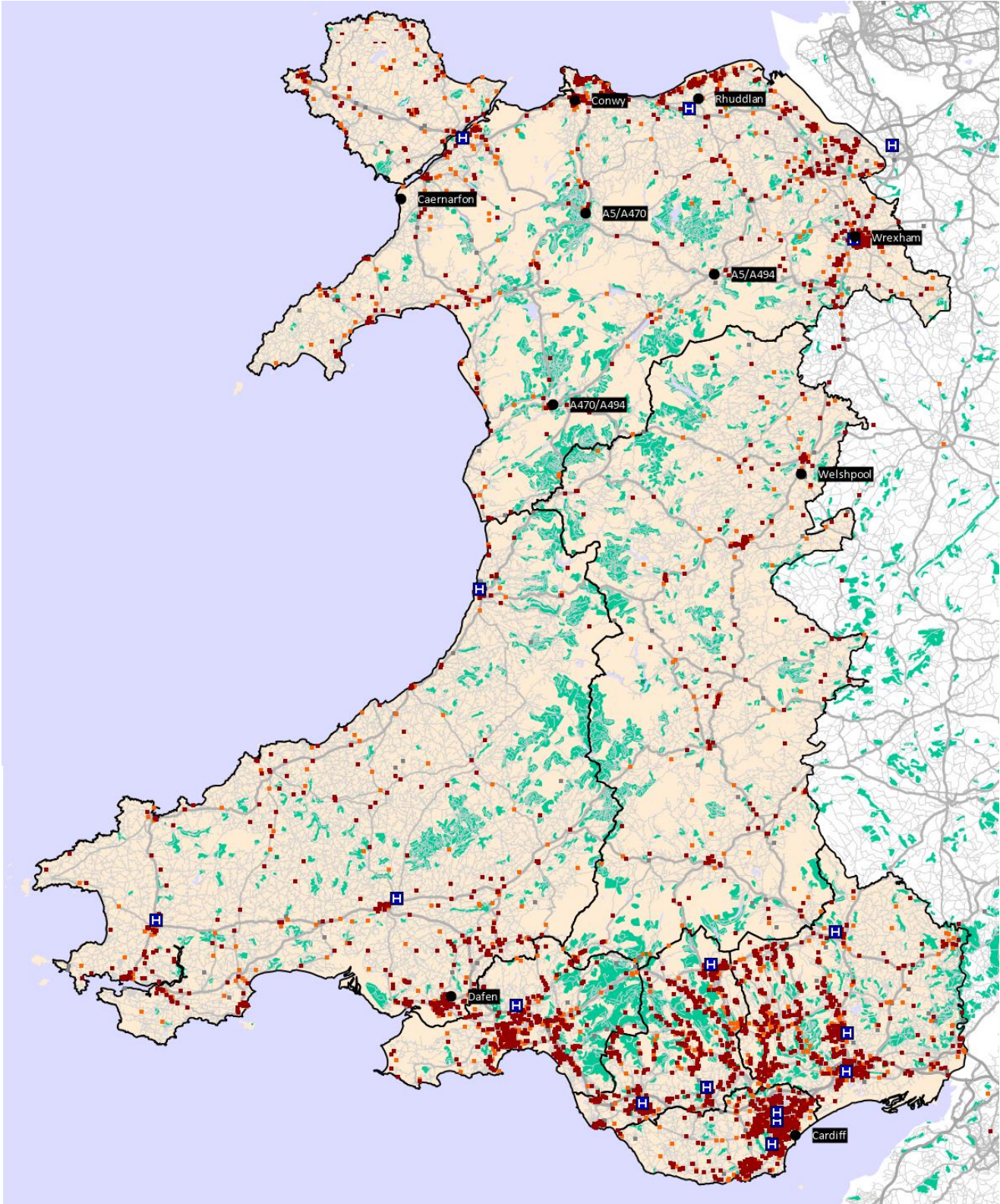
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