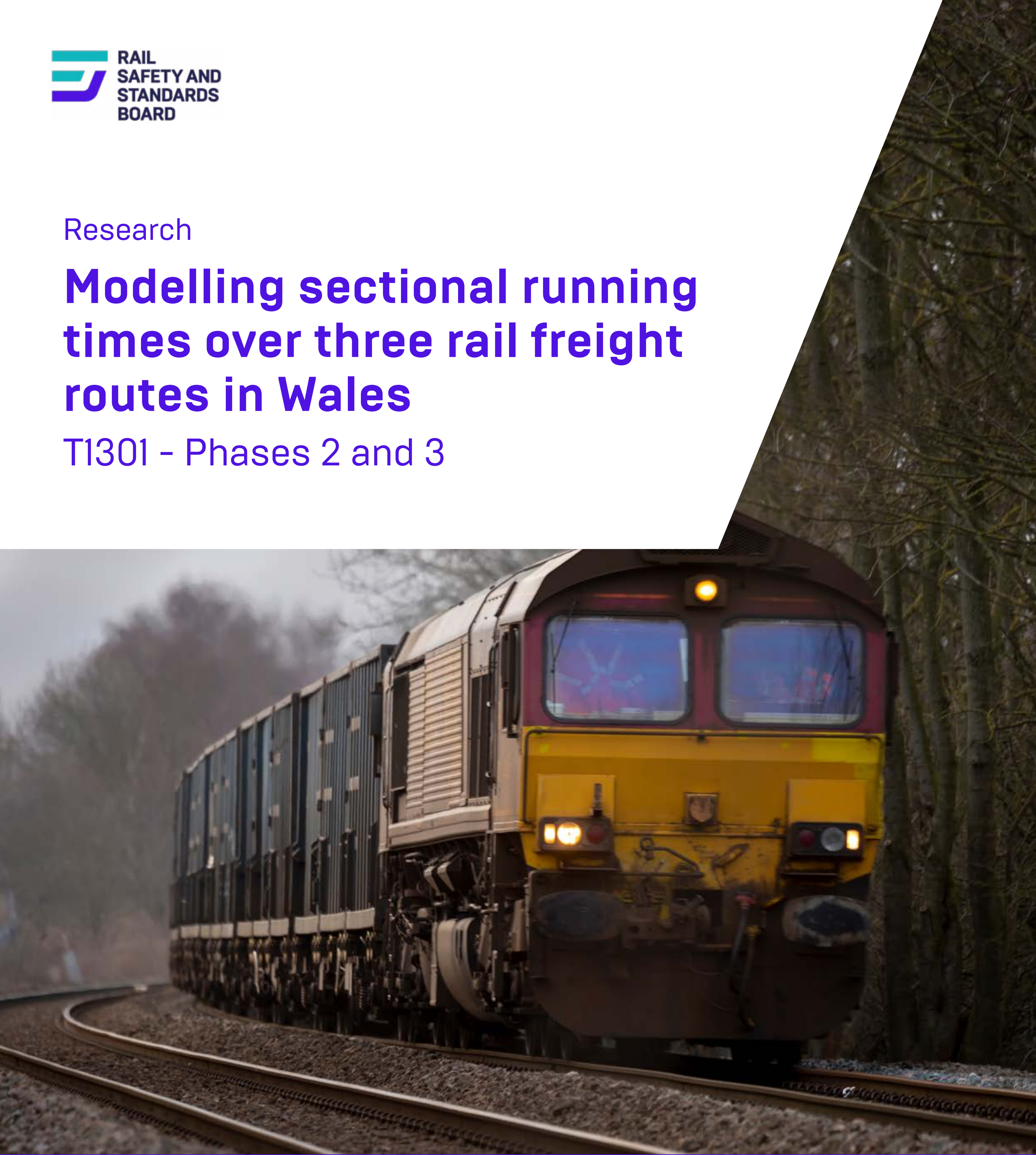
RAIL SAFETY AND STANDARDS BOARD

Research

Modelling sectional running times over three rail freight routes in Wales

T1301 - Phases 2 and 3



Written by

Ralph Goldney, Railfreight Consulting Limited

Neil Grennan-Heaven, Carrickarory Consulting Limited

Mark Gibbs, Aether Limited

Marcus Jones, Aether Limited

Steve Brown, Rail Aspects Limited

March 2025

Copyright

Executive summary

Approach

RSSB's research projects T1302 and T1301 have redefined the methodology for calculating resistance forces within a train and the available power from a locomotive. This will enable faster running or heavier trains in the same running times on all of the five case studies previously analysed. This report uses this new knowledge to identify opportunities to improve network capacity and resilience in Wales on three key freight corridors:

- Robeston–Pilning (South Wales main line from its western end through the Severn Tunnel)
- Margam to Newport via the Vale of Glamorgan line
- Shrewsbury to Dee Marsh and Chirk Kronespan.

An extension to this original scope of work was undertaken to look at the return workings of these routes, and those findings are also reported here.

Results

The table below summarises the results with respect to trailing load and timing.

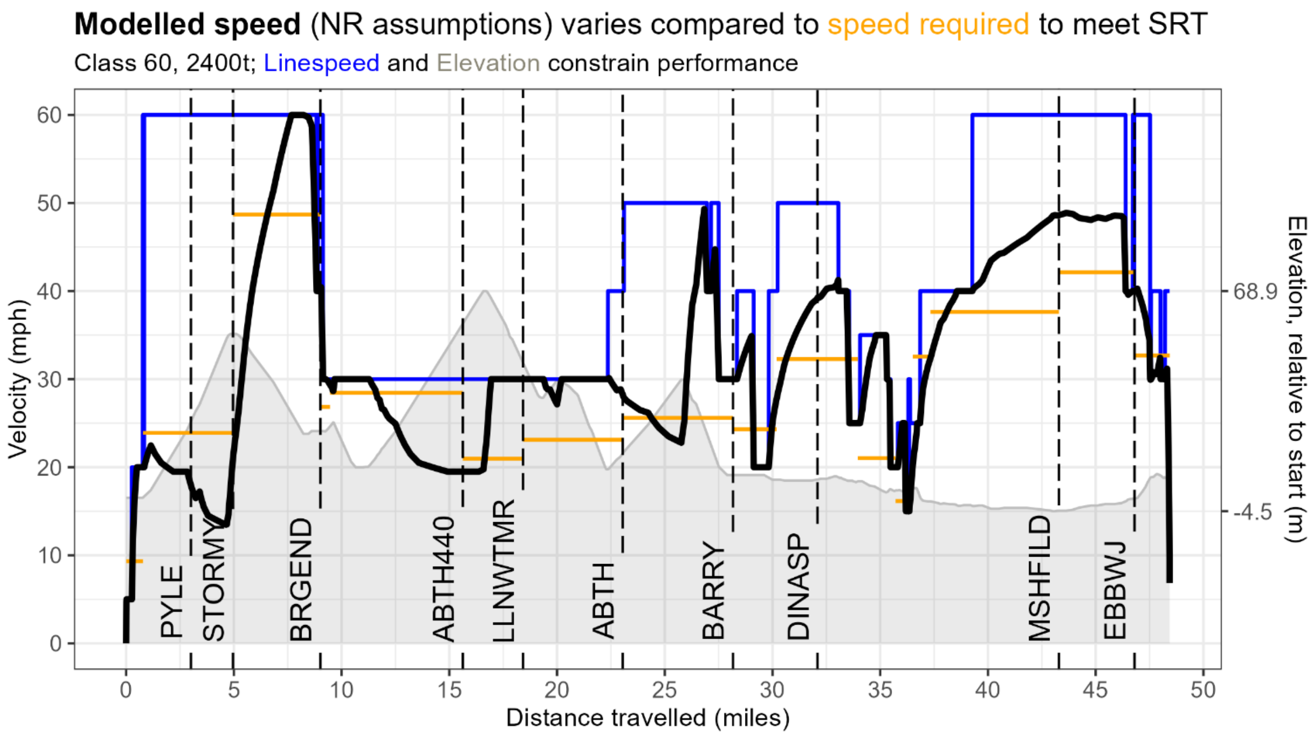
Table 1 Summary of timings

	1a, Robeson - Pilning		1b, Margam - Newport		2, Newport - Shrewsbury		3a, Shrewsbury - Dee Marsh		3b, Shrewsbury - Chirk	
	Payload	Improve.	Payload	Improve.	Payload	Improve.	Payload	Improve.	Payload	Improve.
Class 56									800	3%
									660	7%
Class 60	2800	10%	2400	7%						
	2900	9%	2200	5% (+5%)						
Class 66	2800	11%	2400	1%	2200	-3%	2200	16%	800	3%
	2800	11%	2200	5% (+5%)	2200	4%	2200	19%	660	7%
Class 70	2900	15%	2200	9% (+5%)	2200	10%	2200	23%	660	8%
	2800	17%								

Class 66 timings have been improved by at least 5% and Class 70 timings by up to 23%, though in some cases the actual result is less than this due to 'logic' issues within the existing timings. The most common of these is considering the train as a 'point' when going through a speed restriction, i.e., assuming the train can accelerate immediately after the locomotive clears the speed restriction rather than the 'correct' requirement that the back of the train needs to clear the restriction before acceleration can commence. This typically adds 2 minutes' delay into the journey. Appendix 1 of this report contains revised timings that could be used as a basis for increasing train weight or running speed through the Service Plan Review Process.

Line speed restrictions have a significant impact on all services, and opportunities may exist for improvement here, as shown below.

Figure 1 Modelled speed vs. minimum average speed implied by current SRT



Across the five case studies, there were 32 speed restrictions, with over a third of them because the train cannot run at more than 25 mph through a station.

Where the speed restrictions are just before a particularly steep gradient, they present a significant choke point. For example, the 20 mph speed restriction across Margam Moors Junction leads to this consistent speed up Stormy summit for 4 miles on a line where the train could run at 60 mph.

SRTs longer than 5 minutes are difficult to analyse. They potentially cover multiple periods of acceleration and, consequently, any discrepancies are hard to pinpoint. If intermediate timing points are available, long SRTs should be disaggregated.

There are a number of local ‘logic problems’ with current freight SRTs in Wales:

- Some SRTs are assumed to be based on old line speed assumptions and could be significantly accelerated.
- SRTs have been manually adjusted and are unrepresentative of performance in their section.
- Incorrect, higher line speeds (e.g., at Cardiff station) could also cause issues with passenger trains.

This report provides a basis for retiming some trains to avoid certain locations and times that are particularly sensitive to any freight delay by creating some additional time float within the train path. It also provides a number of locations where a simple risk analysis could enable higher running and thereby reduce train delay.

Contents

1 Introduction

This report sets out the findings from modelling and analysis of sectional running times (SRTs) on three rail freight routes in Wales. The main outputs provide Network Rail's (NR's) Timetable Taskforce with improved timing information for the December 2025 working timetable. The work is an extension to RSSB project T1301 SRT Optimisation and builds on previous project T1302 'Guidance on limits of freight train trailing length as governed by tractive effort'. In particular, the modelling was undertaken using the SRTcalc tool that was developed under T1302 and validated through five case studies as part of T1301.

The routes considered in this report are:

1. The South Wales Main Line between Robeston and the Severn Tunnel (Pilning), incorporating the main route and the Vale of Glamorgan diversionary route
2. Newport to Shrewsbury (i.e., the Marches Route)
3. Shrewsbury–Bidston (looking at services to Penyffordd and Chirk).

The project team benefited from the numerous learnings and insights that have emerged from the RSSB T1302 and T1301 projects, in particular:

- more accurate tractive effort (TE) and resistance data for existing locomotives
- accurate modelling of newer locomotives, such as the Class 93 and 99 hybrids, and double-heading of all locomotive types
- improved calibration of wagon resistances
- an improved understanding of local issues that can lead to unrealistic SRTs.

Although this extension was commissioned primarily to provide NR with improved SRTs for timetabling purposes, the opportunity was taken to use the data obtained to undertake calibration of oil and steel wagons and so provide additional evidence to inform the main T1301 report.

2 Methodology

2.1 Overview of methodology

The project methodology was based on the application of the SRTcalc modelling tool (developed for the T1302 project) to a sample of defined example freight movements (i.e., headcodes) operating on the three specified routes. The inputs to the SRTcalc model are:

- route data files, providing gradients, line speeds, locations of stopping points (from the headcode specific pathing) and Timing Point Location (TiPLocs), all mapped as appropriate at 10-metre intervals within the model
- consist data, with details of the locomotive specification, number of wagons, type of wagons, and wagon loadings.

The model generated a set of calculated SRTs that were compared with the currently available SRTs (from the BPlanGeo Timing Loads Database) and the actual running times observed for a sample of trains with a range of loadings. This enabled identification of TiPLoc-to-TiPLoc sections where revised SRTs could deliver benefits.

The main tasks can be summarised as:

- route building
- SRT modelling
- calibration
- comparison of modelled SRTs with both existing SRTs and observed actual timings
- interpretation and reporting.

The following services were chosen for modelling:

- 6B13 (between Robeston and Severn Tunnel Junction)
- 6M76 (between Margam T.C. and Newport via Vale of Glamorgan)
- 6M76 (between Newport and Shrewsbury)
- 6M76 (between Shrewsbury and Dee Marsh)
- 6M51 (between Shrewsbury and Chirk Kronospan, via Chester).

2.2 Route building

Route building is the process of creating the input files for the model with the network geography and characteristics recorded at 10-metre intervals along the routes. The first step was to ensure that the routes taken by the services (headcodes) to be evaluated were accurately defined (by reference to the Engineer's Line Reference [ELR] route description) and the correct TiPLocs identified. Route characteristic data (line speed and gradient) were extracted from NR shapefiles to a 10-metre resolution, and the TiPLocs were mapped to them. The route data files were built using processes developed for the previous projects. The available geographic data did not cover all of the modelled routes, in particular, private freight lines at the ends, but reasonable assumptions were made to cover the small number of data gaps.

Although much of the route building process can be automated using code written for this purpose, significant manual intervention is required to ensure accuracy. The pathing was checked to ensure that it was correct at both the 'route' level (for example, whether the train was routed via Swansea on the mainline or using the Swansea District Line) and at the 'track' level (for example, using platform information to determine which track is used when passing through main stations such as Hereford). Furthermore, as locations such as freight terminals may be found to be located 'off network', some initial work was required to manually expand the network mapping coverage and ensure that such TiPLocs can be incorporated within the route geography.

The route files were also reviewed once initial modelling was undertaken, as erroneous and missing data can also be identified at that stage. Examples include specific TiPLocs, typically junctions and loops, which have been found to be missing from the route geography output, as they are not located on tracks that the initial draft of the routing passes through.

2.3 SRT modelling

The resulting route files were imported into the SRTcalc tool and initial modelling runs undertaken to test the route data. This step identifies errors caused by missing or incorrectly located TiPLocs, errors in the route geography, or incorrect routing, which occurred on every case study.

Once the model inputs were revised to a satisfactory standard, SRTcalc was used to undertake all the necessary modelling runs. The consist assumptions for these modelling runs were identified through analysis of the range of observed consist information on the three routes under consideration and discussion with NR about how these may develop in the future.

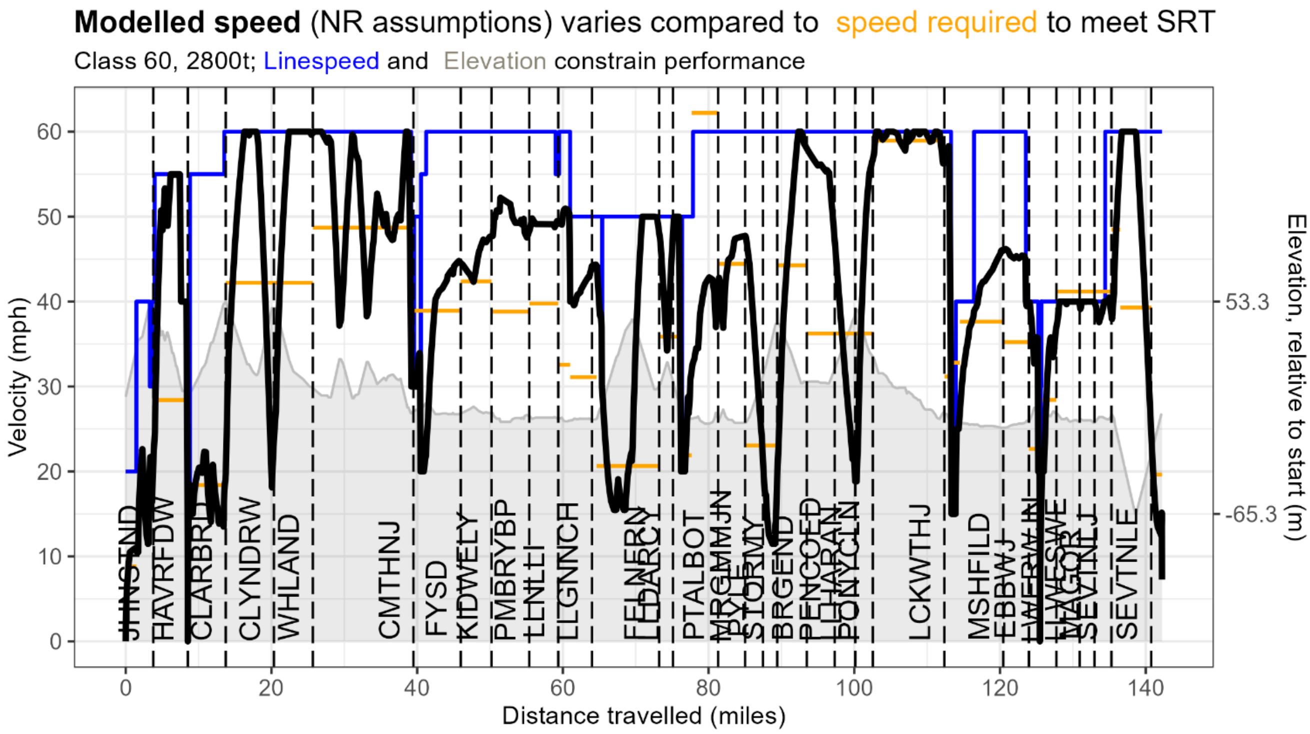
It is important to note that the work undertaken for T1302 and T1301 has identified a number of reasons why modelled SRTs differ from the existing ones, including inaccuracies and inconsistencies in the locomotive and wagon resistances used in previous SRT calculations. For this reason, the model was run twice:

1. initially (for a limited subset of the headcodes of interest) to calculate SRTs using the existing NR formula
2. subsequently with the updated formula derived for T1302.

The initial model runs, with the existing NR methodology, identify SRTs that have either been based on old route characteristic data (e.g., line speeds that have since been raised) or SRTs that have been manually adjusted. This process highlights locations where the existing SRTs are unrealistic and where increases to the SRT would improve resilience. It also highlights locations where unrealistic SRTs could be lowered, leading to a faster overall time performance.

To support the comparison of model performance and SRTs, graphs like Figure 2 below are used. These graphs show the modelled velocity-distance trace in black, and the average speed between TiPLocs required to meet the SRT in orange. For context, the elevation profile (grey) and route line speeds (blue) are also displayed.

Figure 2 Modelled speed vs. minimum average speed implied by current SRT



SRTs in the BplanGeo database store the expected time performance (rounded to the nearest 30 seconds) in each TiPLoc-to-TiPLoc section. Using the section distances calculated in route building, these can be converted to an average speed that acts as a point estimate for train performance in that section. The fact that SRTs are rounded to 30-second increments means there is uncertainty attached to the calculated SRTs, which is particularly problematic over very short sections. Long sections can also pose issues, as a train may be expected to accelerate/decelerate multiple times within a given section, meaning the SRT implied average speed will fail to fully capture the expected dynamics within the section.

Despite occasional difficulties with this comparison, it is very useful in achieving the twin objectives of SRT modelling. Focusing on the SRT average speeds enables individual SRTs to be viewed in context of the previous and subsequent SRTs. Any sudden drop or increase in SRT average speed indicates an erroneous data point, particularly when not backed up by changes in model speed. A holistic comparison between model velocity and SRT required average speeds highlights any large understatement or overstatement of achievable performance by the existing SRTs.

The elevation profile and line speeds can aid in the diagnostic of any disagreement between our SRT modelling and the BplanGeo SRTs. When considering the performance of the model in a particular section, the elevation aids the understanding of changes in model performance (i.e., decreases in speed correspond to uphill gradient). When it appears that the existing SRTs may have been calculated with a different line speed assumption (e.g., between 40 and 60 miles in Figure 2), the modelling characteristics are checked against the

NR Sectional Appendix. Infrastructure restrictions (such as weak bridges) and limits in the NR Timetable Planning Rules (TPR) were also considered to identify potential barriers to realising theoretical benefits.

Detailed analysis of Figure 2 takes places in Section 3.2.

2.4 Resistance calibration

Although this work was commissioned primarily to provide NR with improved SRTs for timetabling purposes, the opportunity was taken to use the data obtained to undertake calibration of oil and steel wagons and so provide additional evidence to inform the main T1301 report. The following information was received from NR to enable this to be undertaken:

- actual timings for all freight services on the relevant routes over a sample period of a year, from TRUST
- accurate information on train consists and loadings for these freight trains, from the Track Access Billing System (TABS).

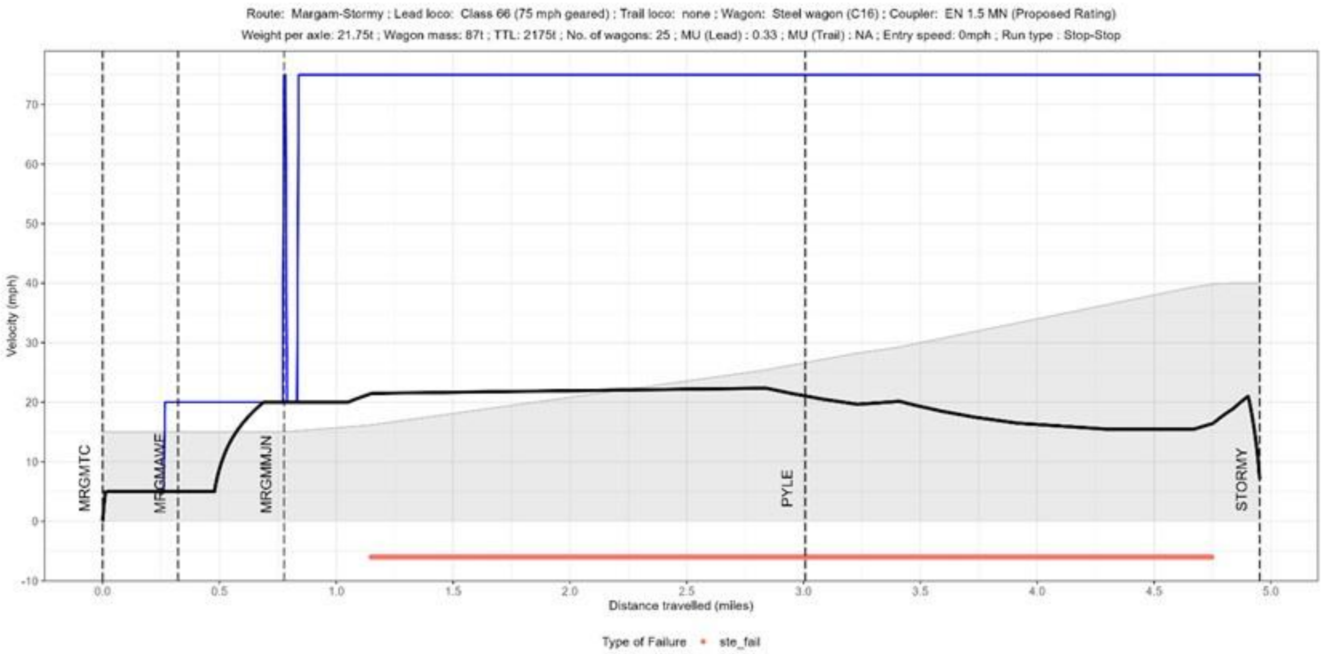
This information was used to validate the modelled times generated with our T1302 methodology (see Section 2.5) but was also used to verify old and generate new resistance coefficients for different wagon types. This ensures accuracy in modelling.

Calibration was undertaken on the section between Margam Moors Junction and Stormy. This section was chosen because it features a challenging climb. Resistance due to gravity is a limiting factor in this location, but one that can be controlled for, enabling analysis of mechanical resistance. Additionally, steel trains are pathed from Margam Yard and exposed to a 20 mph line speed limit as they cross the down mainline and proceed to the up mainline. Most trains are expected to be at this speed passing Margam Moors Junction. The consistent starting speed is advantageous for resistance calibration.

This section contains an intermediate TiPLoc, Pyle, but no observed timings were recorded at this location. Hence the modelled timings were compared to observed timings between Margam Moors Junction and Stormy only. This process was undertaken for steel wagons and oil tank wagons and the results for 25 steel wagons shown in Figure 3 below.

The train can be seen to very gradually lose speed as it climbs the summit. The starting speed of 20 mph gradually reduces to 15 mph around 4 miles further up the track. The 20 mph restriction on the Margam Moors crossing and the following hill significantly affect the train's performance on a route with an acceptable line speed of 75 mph.

Figure 3 Modelled velocity vs. distance (Margam T.C. to Stormy)



Steel wagons have not previous been studied in the T1302 or T1301 work. Observed loading for steel trains was typically 20–25 wagons with an axle-loading (Q) of 21.75. Model times were calculated for trains with trailing loads or 1,740 and 2,175 tonnes. The results are shown in Table 2.

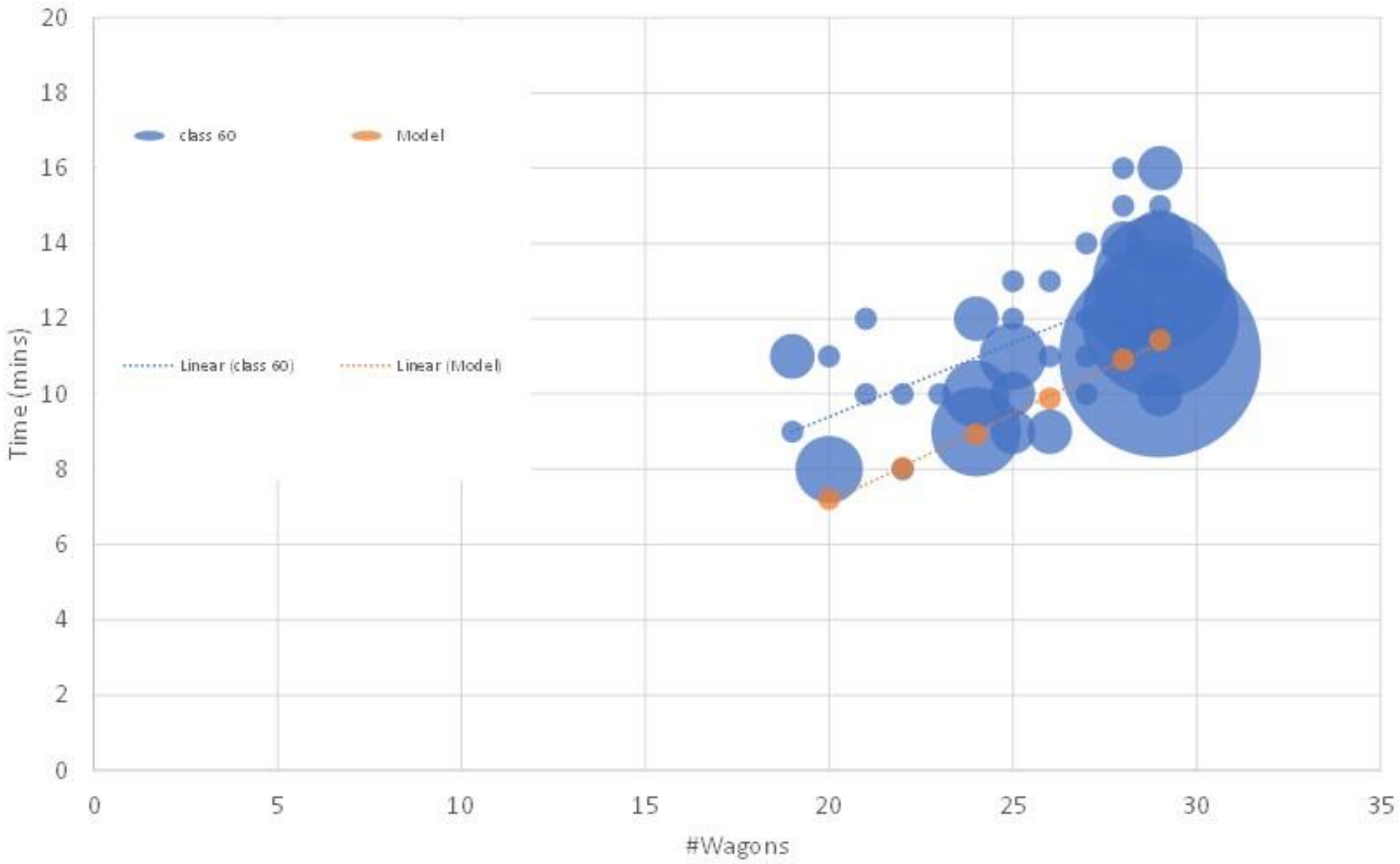
Table 2 Steel wagon resistance calibration

# Wagons	Trailing load (tonnes)	Modelled time
20	1,740	10 mins 43 secs
25	2,175	12 mins 54 secs

Observed times for steel trains with 25 wagons are typically in the range of 12–13 minutes. This corresponds well with the modelled time of 12 minutes 54 seconds, as the T1301 methodology aims to be slightly conservative.

Oil tank resistances have been studied in previous RSSB work. The heavier loadings (more wagons per train) here present an opportunity to refine these coefficients. Observed times were available for trains with between 20 and 29 wagons and a number of different locomotive haulage permutations (1x Cl 60, 1x Cl 66 [65 mph geared], 1x Cl 66 [75 mph geared], and 2x Cl 66 [75 mph geared]). The bubble chart, Figure 4 , displays the correlation between the trailing load and time performance. The size of the bubbles indicates the number of observations for each time, wagon combination. The observed timings are rounded to the nearest whole minute.

Figure 4 Time vs. number of wagons for observed and modelled timings



An oil tank train has been modelled with trailing loads of 2,000, 2,200, 24,00, 2,600, 2,800, and 2,900 tonnes (and an axle-loading of 25). These times are shown in orange on Figure 4 and follow a similar trend (have a similar gradient) to the linear trend of the observed timings.

The observed timings in this plot have been filtered to remove any trains experiencing obvious delays. This subset of timings does still contain services that were not driven to maximal performance. SRTs should reflect the maximal achievable performance but not match it (so as to allow for small delays). Learnings from T1301 suggest a large number of trains are not driven to maximal performance (particularly when ahead of schedule). This particularly impacts lightly loaded trains (those operated with 20 wagons in this example), which frequently get ahead of schedule early in their journey and are subsequently driven in a more relaxed manner to prevent them arriving at key nodes significantly ahead of schedule.

At 2,900 tonnes (the most commonly observed trailing load), the majority of observed timings lie in the 11–13-minute range. The observed timings are more variable for oil tank wagons than steel wagons, as the oil tank services are pathed on the mainline past Margam Yard, not exposed to the 20 mph line speed restriction at

Margam Moors Junction, and hence have a range of entry speeds to the section of interest, impacting time performance. The modelled time for this section is 11 minutes 26 seconds, which is suitably close to the commonly achieved 11 minutes.

Resistance coefficients could not be fully calibrated for the third type of wagon in this study, timber wagons. This is due to the fact these services are lightly loaded (under 800 tonnes), meaning their performance is not suitably constrained to undertake rigorous analysis on performance. End-to-end observed timings for these services were suitably comparable to model timings.

As well as calibrating wagon resistance coefficients, the modelling in this project revalidates T1301 calculations of locomotive resistances. Observed timings from the Chirk service give increased confidence to the TE values and resistance coefficients for this locomotive.

2.5 Comparison of modelled timings with existing SRTs and actual timings

Second stage modelling was undertaken to produce modelled timings for the three case studies using the methodology developed in the T1302 project. This methodology consists of more accurate wagon and loco resistance formulas and coefficients, as well as properly accounting for the length of the train as it clears line speed limits.

It was originally the intention to compare the model timings with actual timings, similar to the comparison between modelled times and SRTs. However, a detailed comparison was not possible due to the infrequency of observed timing locations and the large number of manual timing locations. The timings from manual signals are relatively inaccurate, preventing rigorous comparison in these locations.

End-to-end comparisons between modelled timings and observed timings was also made impossible, as the actual pathing is variable (i.e., observed services feature a range of one-off loopings). The large time allowances built in at planned stopping locations, often for crew changes, act to absorb delay, further complicating end-to-end analysis.

3 Modelled services

3.1 Introduction to the services

The services investigated in the course of this work run from Robeston–Pilning, Margam–Newport, Newport–Shrewsbury, Shrewsbury–Dee Marsh, and Shrewsbury–Chirk Kronospan. For each of these services, a number of variations were considered to the class of locomotive, the consist, and the trailing load. These variations were chosen to reflect both the real-world services in use on the routes and the timetabled SRT information.

The South Wales Main Line case study includes the Robeston–Pilning route and the route covering the Vale of Glamorgan (VoG) diversion from Margam to Newport. Beginning at the Robeston Oil terminal, route 1a covers the transport of oil tanks to the end of the NR Welsh region at Pilning on the English side of the Severn Tunnel. The VoG diversion services, covered by route 1b, are steel transport services that originate from the Port Talbot steelworks. The trains are modelled leaving the Margam Terminal Complex and follow the South West Main Line before switching onto the VoG line just past Bridgend. The service rejoins the Main Line at Cardiff, continuing on to Newport.

The second case study, the Newport–Shrewsbury route, is a continuation of the steel service from route 1b. This route travels along the Marches up to Shrewsbury.

The third case study covers the routes from Shrewsbury towards Bidston. It includes a continuation of the steel service from Shrewsbury to Dee Marsh (route 3a), culminating at the Dee Marsh Reception Sidings. Route 3b is a timber service between Shrewsbury and Chirk Kronospan, which features a reversal point at Chester, initially passing Chirk en route to Chester before returning to Chirk and reversing into the Kronospan siding.

Some notable geographic features occur on several of the routes. These include the previously discussed challenging climb between Margam Moors Junction and Stormy, followed by a steep downhill section. Other features include two significant climbs in route 2, between Maindee North Junction and Little Mill Junction, which features over 6 miles of almost continuous uphill running, and from Abergavenny to Abergavenny Signal 38. In route 3b, Rossett Junction to Wrexham General also includes a notable climb on the return journey from Chester. Such features will impact the running speed of the services and hence the performance over the journey and are helpful markers in comparison of the SRTs.

Table 3 shows the modelled consist permutations for the routes, based on the consists of observed operations. Additionally, all routes were examined with Class 70 traction, with the South Wales Main Line and VoG routes including Class 99 traction. All routes were examined with Class 66 traction, and routes 1a and 3b were additionally examined with Class 60 and Class 56 traction respectively. The Robeston–Pilning and Margam–Newport routes include sections of electrified track, which is taken into account for the estimations of the Class 99 journey times.

Table 3 Modelled case study consists

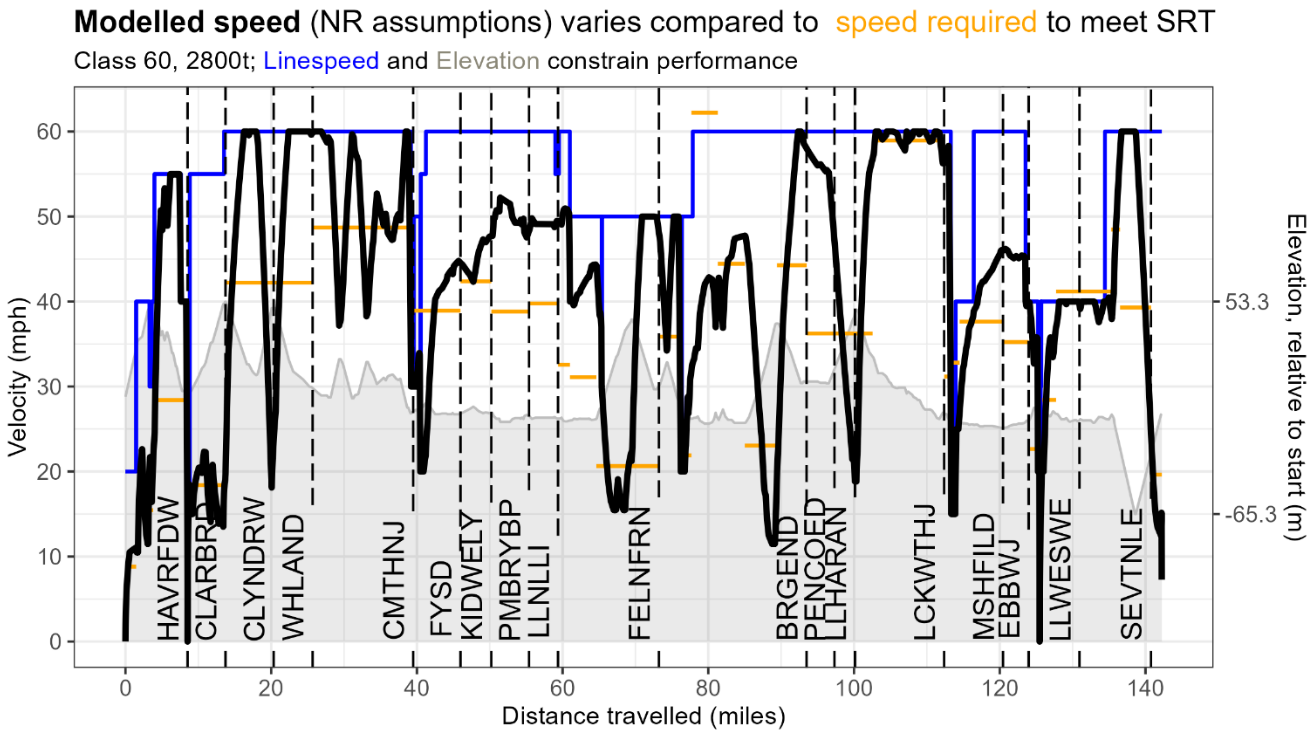
Case study	Loco	Wagons	# wagons	Trailing toad (tonnes)	Q (tonnes)	Wagon weight (tonnes)
1a	Cl 60	Loaded oil tanks	29	2,900	25.4	102
1a	Cl 66 (65 mph)	Loaded oil tanks	28	2,800	25.4	102
1b, 2, 3a	Cl 66 (75 mph)	Loaded steel on flat wagons	25	2,200	21.75	87
3b	Cl 56	Loaded timber on timber wagons	10	6,60	16.5	66
3b	Cl 66 (75 mph)	Loaded timber on timber wagons	10	6,60	16.5	66

'Q' is the axle load and leads the wagon weight on these four-axle wagons. Ten-tonne gross laden weight is 'normal' of this type of traffic, but the steel coils cannot not be loaded to maximise the available payload. The density of the timber is significantly less, leading to lower axle loads on these flows.

3.2 Route 1a: Robeston–Pilning

Figure 5 below displays the train's modelled performance and the average speed required to meet the SRTs for the Robeston–Pilning route for a Class 66 train based on the present overly conservative NR assumptions. For the majority of the route, the SRT average speeds are representative of the modelled performance. However, in two areas, some SRTs have lower speeds than is achievable. This provides the opportunity for significant improvement on the current overall timing of the train.

Figure 5 Modelled speed vs. minimum average speed implied by current SRT



There are four sections between Carmarthen Junction and Llanelli that require an average speed of around 40 mph to match the SRTs. These are immediately followed by two sections with an SRT average speed just above 30 mph (between Llanelli and Morlais Junction). This suggests that, when the SRTs were calculated, maximum achievable speeds of 40 mph between Carmarthen Jn and Llanelli and 30 mph between Llanelli and Morlais Jn were assumed. However, the line speed limit is now 60 mph, so the model shows that a Class 60 hauling 2,800 tonnes will be able to accelerate up to 50 mph between Carmarthen Jn and Llanelli and maintain this speed for around 10 miles. Between Llanelli and Morlais Jn, the model speed does not drop below 40 mph. Consequently, time savings of 1.85 minutes are achievable before any improvements in calculation methodology are considered.

Similarly, between Cardiff and Newport, there are two SRTs with average speeds of 37 mph and 35 mph, and the modelling suggests that this service can run above 40 mph for most of this distance, resulting in a time saving of 3.1 minutes. The time savings are expected to increase once the revised T1302 methodology is considered.

In some places, the SRTs are unrealistically higher than the model. For example, an average speed of 62 mph is required to match the SRT between Briton Ferry and Port Talbot, as determined when the SRT time is taken in conjunction with the section distance calculated in the route building, exceeding the 60 mph line speed. This can be explained by the fact that SRTs are rounded to the nearest 30-second increment (i.e., travelling at 60 mph would result in a running time within 30 seconds of the SRT). Regardless, this section features a line speed limit of 20 mph when joining the mainline, making an average speed of 60 mph here unrealistic to achieve. It is known that some pairs of SRTs have been adjusted away from realistic performance to provide additional allowance across key nodes. This appears to have taken place in this case.

The final times of each of the model runs are listed in Table 4, presented as the difference from the SRTs alongside the percentage increase of the total journey time. Using the T1302 methodology produces clear improvements in the modelled time in comparison to the NR methodology, and as expected, the 2,900-tonne trailing load runs are slower than their 2,800-tonne counterparts. The Class 99 trains only run on electrified track beyond Cardiff, a smaller segment of the route than is running on diesel, and hence do not show a great improvement in comparison to the other runs.

Table 4 Robeston–Pilning end-to-end timings

Run	Modelled time (mins)	Percentage improvement
Class 60 SRTs (2,800 tonnes)	258 (Current SRT allow.)	Baseline
NR Class 60 (2,800 tonnes)	-26.37	10%
NR Class 66 (2,800 tonnes)	-28.30	11%
T1301 Class 60 (2,900 tonnes)	-23.78	9%
T1301Class 66 (2,800 tonnes)	-29.55	11%
T1301 Class 70 (2,900 tonnes)	-39.90	15%
T1301 Class 70 (2,800 tonnes)	-42.82	17%
T1301 Class 99 (2,900 tonnes)	-14.55	6%
T1301 Class 99 (2,800 tonnes)	-19.08	7%

Recalculating the timings using the T1302 methodology and the current NR data inputs leads to a time saving of nearly half an hour for both the Class 60 and 66 timings. Using the improved T1301 data produces very similar data (the Class 60 improvement is reduced by 2.5 minutes, but the payload is increased by 100 tonnes, and the Class 66 improves its time by over a minute with the same payload).

The use of a Class 70 locomotive produces a 16-minute improvement against the (already improved) Class 60 timings and a 13-minute improvement against the Class 66, leading to an overall improvement of nearly 40 minutes.

Timings for the Class 99 do not show the same level of improvement, mainly because the ability to run in electric mode is quite short and has to resort to diesel power (which is comparatively lower at the rail than for Class 60 or 66) for the majority of the route.

Full modelling results are shown in Table 17.

3.3 Route 1a return: Pilning–Robeston

The route was analysed assuming empty tank wagons returning to be loaded. The table below shows a comparison of the timings with differences of over a minute ringed.

Table 5 Comparisons of timings for Pilning–Robeston

Pilning-Robeston		Class 66, 800t	Class 66, 766t	Class 70, 766t	
Tiploc-Tiploc Section	SRTs	NR	T1302	T1302	
PILNING - SEVTNLE	1	0.47	0.47	0.47	Unrealistic SRT, average speed 90mph
SEVTNLE - SEVTNLW	6	-1.22	-1.33	-1.43	
SEVTNLW - SEVTNLJ	2	0.00	-0.18	-0.35	
SEVTNLJ - LWERWJN	11	0.10	0.03	-0.07	
LWERWJN - MAINDWJ	4	-1.35	-1.28	-1.30	
MAINDWJ - NWPTRTG	1.5	-0.92	-0.92	-0.92	
NWPTRTG - EBBWJ	3	-0.73	-0.73	-0.73	
EBBWJ - MSHFILD	4	0.10	0.22	0.15	
MSHFILD - LNGDYKJ	8.5	-1.48	-1.43	-1.43	
LNGDYKJ - CRDFCEN	1	0.57	0.57	0.57	SRT above linespeed
CRDFCEN - LCKWTHJ	2.5	-0.23	0.20	0.17	
LCKWTHJ - PONYCLN	11	-0.30	-0.68	-0.88	
PONYCLN - BRGEND	10	-0.23	-0.53	-0.70	
BRGEND - STORMY	5.5	-0.83	-1.03	-1.18	
STORMY - MRGMMJN	4	0.28	0.23	0.20	
MRGMMJN - PTALBOT	5	-0.63	2.97	2.97	Low linespeed followed by climb, length isue
PTALBOT - CTSARTJ	6	-0.48	-0.70	-0.93	
CTSARTJ - DYNEVRJ	2	-0.05	-0.02	-0.02	
DYNEVRJ - FELNFRN	6	-0.93	-0.55	-0.77	
FELNFRN - MORLASJ	19	-5.22	-4.52	-4.63	
MORLASJ - LLDELOJ	5	-0.55	-0.55	-0.55	
LLDELOJ - LLNLLI	2	0.33	0.62	0.55	
LLNLLI - PMBRYBP	4	0.20	0.13	0.08	
PMBRYBP - KIDWELY	5	0.20	0.18	0.18	
KIDWELY - FYSD	5	-0.75	-0.77	-0.77	
FYSD - CMTHNJ	8	-0.22	0.37	0.32	
CMTHNJ - WHLAND	17	-0.53	-0.65	-1.02	
WHLAND - CLARBRD	14	0.17	-0.52	-0.97	
CLARBRD - HAVRFDW	7	-0.28	0.17	0.15	
HAVRFDW - JHNSTND	8	0.10	0.18	-0.22	
JHNSTND - HRBRNSJ	5	-1.17	-1.02	-1.02	
HRBRNSJ - ROBSTNS	10	-5.40	-5.42	-5.42	Movements into sidings difficult to callibrate
Totals	203	-21	-16.50	-19.5	

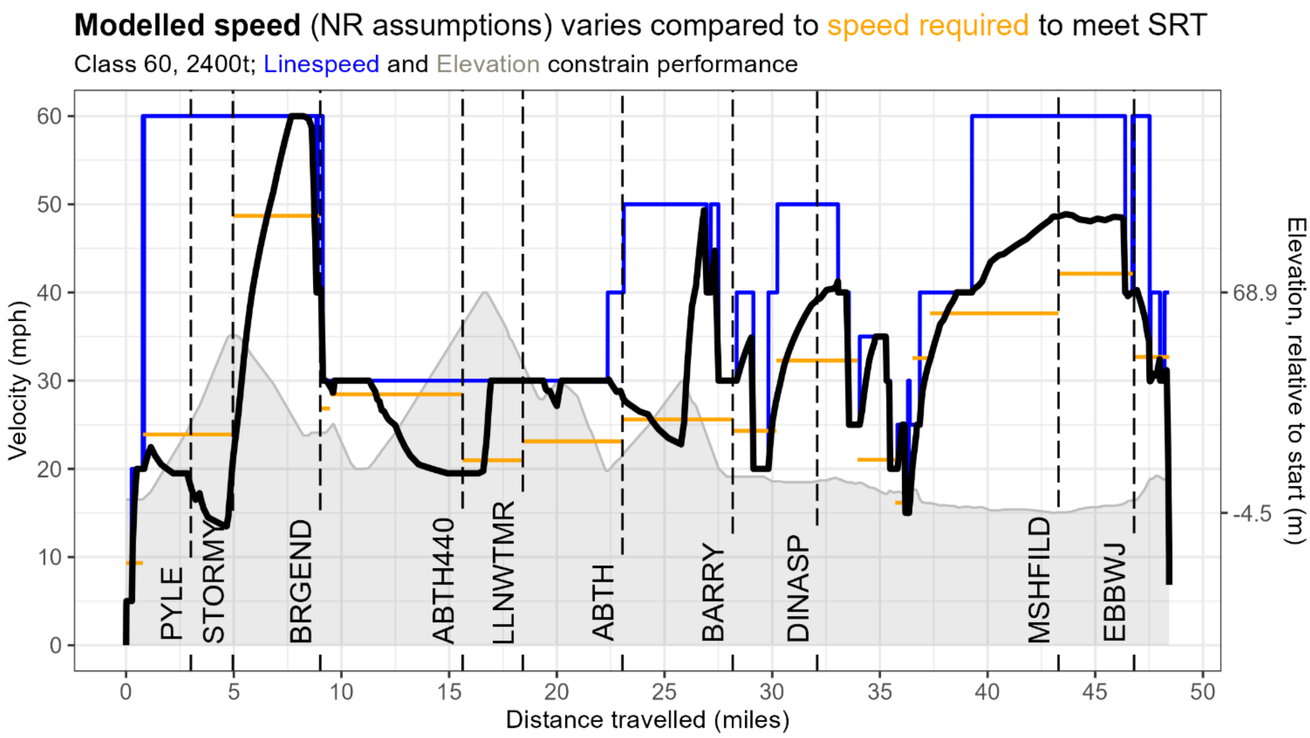
The total running time is given at 203 minutes, but our analysis concludes that this timing should be reduced by 21 minutes using current NR processes. Eleven minutes of this is in two locations: running into Morlais, the SRT has an average speed of 27 mph when 60 mph is possible, and at Robeston, there is a significant time buffer for entering the sidings, which may well reflect what is required in practice.

When we recalculate these timings using T1301 values, the early running is reduced by 4.5 minutes to 16.5 minutes. Although in most locations there is a performance benefit, there is a significant disbenefit at Margam, where the train length has not been properly considered when exiting the sidings, and then this low-speed exit leads directly on to a steep gradient, so time cannot be recovered. This location goes from a 0.63-minute improvement to a 2.97-minute worsening of the timings.

The final column shows the use of a Class 70 locomotive, which saves an additional 3 minutes against the Class 66 through slightly better performance across the route.

3.4 Route 1b: Margam–Newport (Vale of Glamorgan)

Figure 6 Modelled speed vs. minimum average speed implied by current SRT



For the Margam–Pilning diversionary route (via the VoG), the modelled speed follows the general trend of the SRT average speeds, as shown in Figure 6 . The model shows that the train is first able to accelerate up to 60 mph on the downhill section from Stormy. Performance is limited by low line speeds between Bridgend and Aberthaw, as predicted by the SRTs. For the rest of the route, the train will follow an acceleration and deceleration pattern, constrained by low line speeds at Cadoxten and Cardiff. The analysis terminates at Newport, as beyond here, the network is off mainline sidings with low-velocity manoeuvres, under local control.

With the exception of two TiPLoc-to-TiPLoc sections, the SRT modelling forecasts timings that are either within 30 seconds of the existing SRTs or faster. The first location where existing SRTs overstate realistic performance is between Margam and Stormy. It appears the impact of the climb to Stormy (1:135 or worse for 3.6 miles, including over 1 mile at 1:92) has not been fully considered within the existing SRT, and this would lead to a 4-

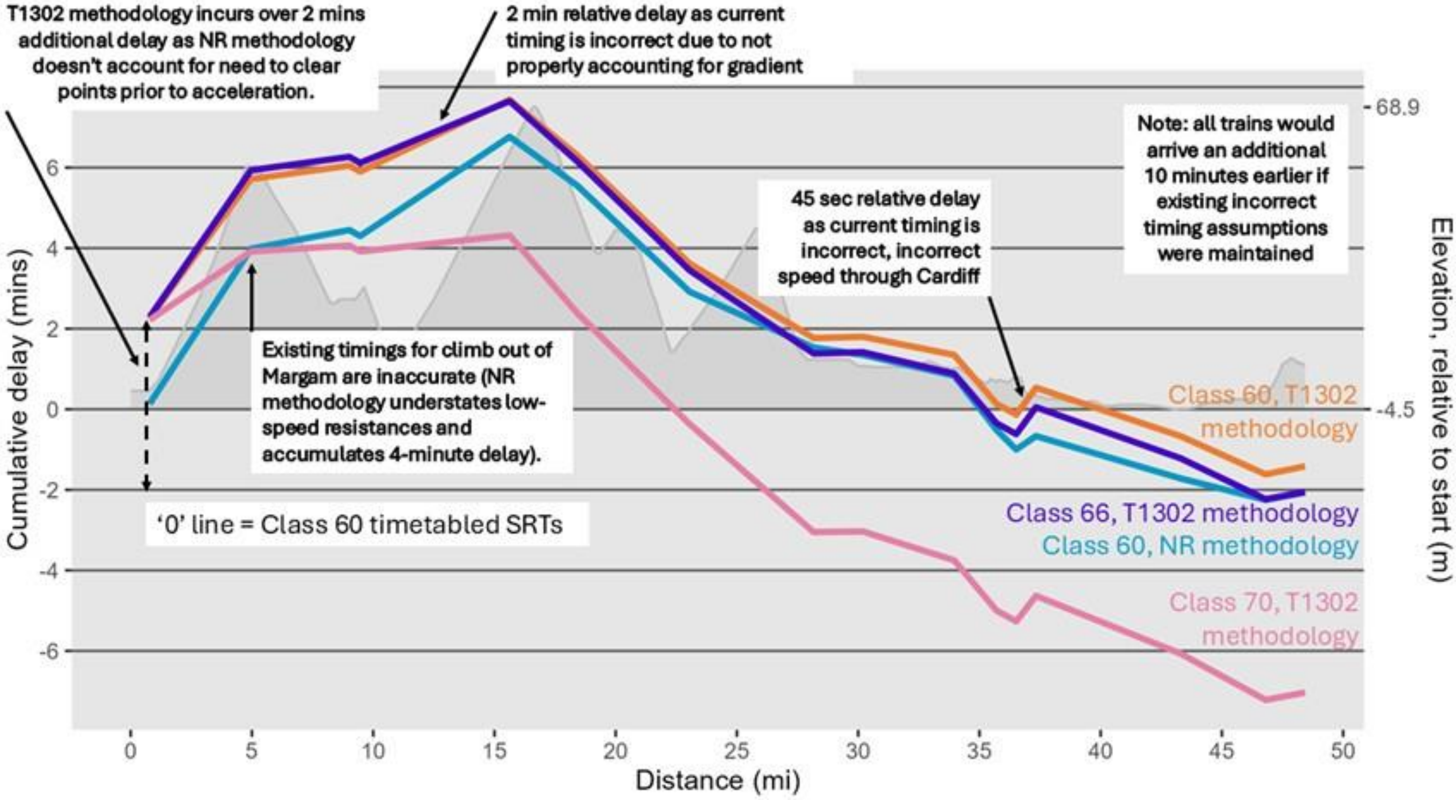
minute delay in this section using the NR methodology. Accounting for the requirement for the rear of the train to pass the end of a line speed limit before acceleration will further impact time performance (this is not currently accounted for in the SRTs). The size of the delay will lead to a train running behind schedule for most of this route, causing operational difficulties. This effect is explored in Figure 7.

The SRT velocities also differ from model between Cowbridge Road SB and Llantwit Major (with modelled speeds lower than the SRT average speed before Aberthaw signal Cf3440). Some of the SRT overstate of performance before Aberthaw Signal Cf3440 is offset by the understatement of performance in the subsequent section. This still represents a deviation from the expected travel times along the route, leading to local inaccuracies. The net delay across these two sections is 1 minute 15 seconds, suggesting that the impact of the 1:140 climb for 3.9 miles may not have been fully accounted for in existing SRTs.

The SRT modelling identifies a further four sections where SRTs are 30 seconds or more longer than they need to be. For two sections following Llantwit Major (before Barry), a train could travel 4 minutes faster than the current SRTs. Performance is also understated between Cadoxten (30.2 miles) and Cardiff Central (36.5 miles). Time savings increase in these sections when we consider the T1302 methodology, as NR methodology overstates resistances in the middle of the speed range.

The significant issue in this route is the unrealistic SRTs before Stormy that led to the modelled trains starting with a 6-minute delay and then running behind schedule for most, or all, of their journey. The cumulative route delay times for each service are shown in Figure 7 below, measured at each TiPLoc, shown here each with the same trailing load of 2,400 tonnes for ease of comparison (in contrast to the analysed final times of the runs). Regardless of the methodology of traction type, significant delay is forecast by the time a train reaches Aberthaw Signal Cf3440 (at 15 miles), as the inaccurate SRTs in the first few sections lead to the significant delay at this point. The delay is forecast to reduce as trains head towards Cardiff.

Figure 7 Cumulative delays for different traction types (Margam–Newport)



Modelling with the NR methodology produces end-to-end timings that are two minutes faster than existing SRTs. The overestimating and underestimating of SRTs balance out. The T1302 methodology differs from the NR assumptions in accounting for the length of the train—accounting for the acceleration delay waiting for the rear of the train to clear the end of line speed restrictions around Margam leads to an additional 2-minute delay in the first section. The impact here is amplified, as the low line speed around Margam is immediately followed by a steep climb to Stormy. Consequently, the T1302 methodology forecasts larger delay at Aberthaw Signal Cf3440. Performance between this location and Cardiff is better, with the more accurate resistances in the T1302 methodology modelling, and delays are fully recovered. The T1302 methodology forecasts a final delta of -2 minutes for a Class 60 service.

It is clear that the modelled Class 70 run shows the greatest improvement to the Class 60 timetabled SRTs, with a notable advantage over the Class 60 and Class 66 tractions in tackling the steeper gradients throughout the route. These climbs induce more severe delays in the other traction types, whereas the Class 70 run shows a less sharp delay at these locations on the route with a ~3-minute difference in cumulative delay at the peak of the second climb between the Class 70 and the other T1302 runs. The Class 70 is able to finish the journey 7 minutes quicker than existing SRTs due to smaller initial delay and the greater performance of this traction type in the middle of the route. All runs with T1302 methodology incur a cumulative loss to inaccurate SRTs of over 10 minutes. Accounting for this, significant improvement on existing SRTs are achievable.

The final times of each of the model runs are listed in Table 6, presented as the difference from the SRTs alongside the percentage increase of the total journey time. The T1302 methodology here produces a less clear trend in the improvement to the SRT times for the NR and T1302 runs, which is due to the additional delays incurred by the need to clear points before acceleration. The Class 99 model again only runs on electrified track beyond Cardiff, a smaller segment of the route than is running on diesel, and hence does not show a great improvement in comparison with the other runs.

Table 6 Margam to Newport end-to-end timings

Route	Run	Modelled time (mins)	Percentage improvement
1b. Margam–Newport	Class 60 SRTs (2,400 tonnes)	105.50 (current SRT allow)	Baseline
	NR Class 60 (2,400 tonnes)	-2.07	2%
	NR Class 66 (2,400 tonnes)	-1.18	1%
	Class 60 (2,200 tonnes)	-4.85	5%
	Class 66 (2,200 tonnes)	-5.43	5%
	Class 70 (2,200 tonnes)	-9.75	9%
	Class 99 (2,200 tonnes)	-0.33	0%

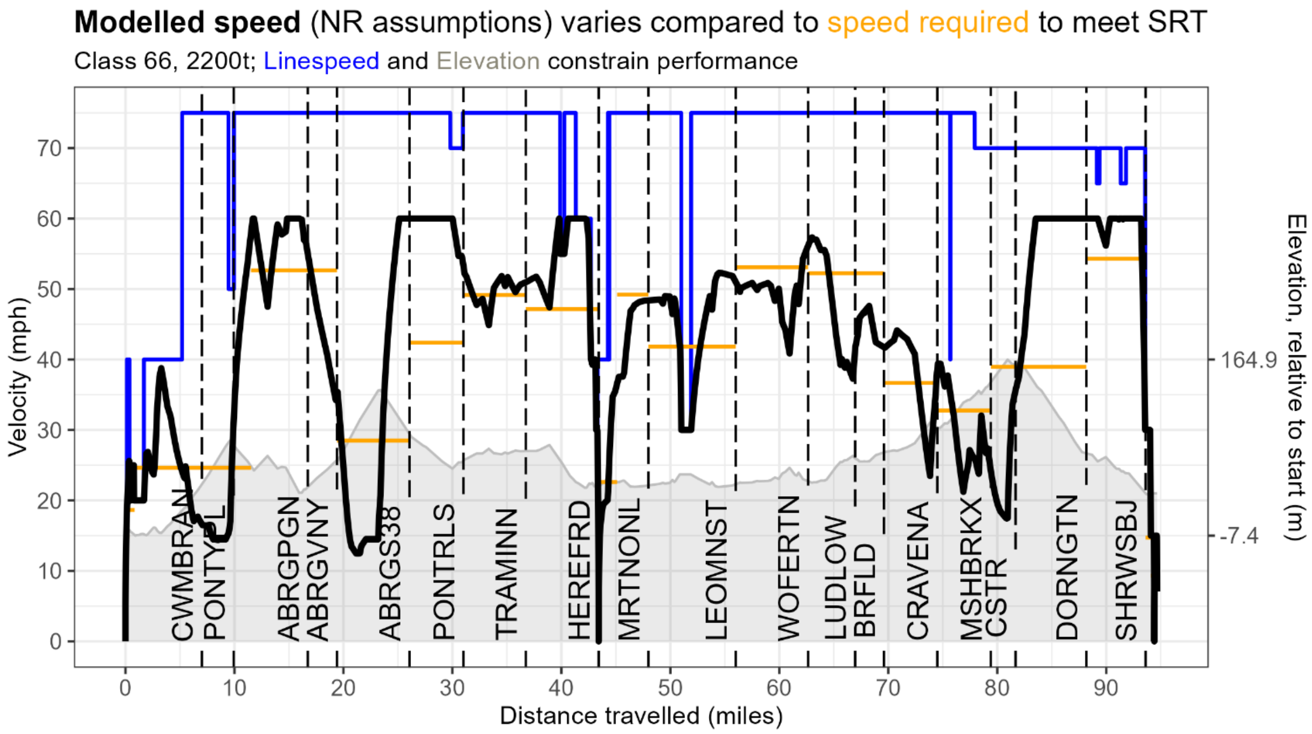
Big time savings cannot be made, as the existing inconsistencies in the timings need to be accommodated. However, again, the Class 70 significantly outperforms other traction types.

Modelled section times for all runs with T1302 methodology are shown in Table 18.

3.5 Route 2: Newport–Shrewsbury

For the Newport–Shrewsbury route shown in Figure 8 below, the end-to-end modelling timings are roughly comparable with the sum of the SRTs (5 minutes longer). However, there are five sections where modelling with NR methodology produces times significantly longer than SRTs (over 1 minute difference). Additionally, there are three sections with modelled times significantly shorter than the NR modelled SRTs.

Figure 8 Modelled speed vs. minimum average speed implied by current SRT



The first section where modelled times differ significantly from existing SRTs is between Maindee North Junction and Little Mill Junction, between 0.8 miles and 11.5 miles. Here, modelling with NR methodology produces a running time of 28 minutes 26 seconds compared with an SRT of 26 minutes. This section features over 6 miles of almost continuous uphill running (at worse than 1:150), leading to a train speed of 15 mph at Pontypool.

Similarly, in the next section featuring a significant climb, from Abergavenny to Abergavenny Signal 38, the modelled timing is 4 minutes 20 seconds slower than the SRT. In this case, the modelled time for Abergavenny Signal 38 to Pontrilas (the subsequent section) is 1 minute 59 seconds faster, offsetting part of the loss. This indicates that the Abergavenny Signal 38 may not be positioned correctly in our geographic model, and the signal position is difficult to exactly confirm.

The Wales and Western Sectional Appendix lists a speed limit of 30 mph at Ford Bridge. With this taken account of, modelled time between Moreton-on-Lugg and Leominster is 33 seconds faster than existing SRTs. This offsets with a modelled section time 34 seconds slower than the SRT between Leominster and Woofferton. Current SRTs account for the bridge speed restriction, but the accuracy of section times could be improved.

Table 7 Extract from table D5A – Route clearance of freight vehicles

Line of Route	Line of Route / Sector Description	RA	2 Axled (MAX RA)	4 Axled (MAX RA)	Location of Speed restriction	Up	Down
GW660	Goonbarrow Jn to Newquay	6	6	6	THROUGHOUT Class 66 only at Over Bridges: 289m 72ch, 295m 01 ¼ch, 297m 36 ¾ch	30 MPH 10 MPH 10 MPH 10 MPH	30 MPH 10 MPH 10 MPH 10 MPH
GW672	Burngullow to Drinnick Mill	6	9	9			
GW672	Drinnick Mill to Parkandillack	5	9	9			
GW680	Penwithers Jn to Falmouth	6	8	8			
GW690	St Erth to St Ives	5	5	5	THROUGHOUT	10 MPH	10 MPH
GW700	Gloucester Barnwood Jn to Severn Tunnel Jn	8	10	10			
GW710	Llanwern Works East to Works West via Steelworks	8	10	10			
GW720	Uskmouth to East Usk Jn	8	10	10			
GW730	Severn Bridge Jn to Newport, Maindee West Jn	8	10	10	Over Bridge at 42m 53 ¼ch (Dinmore Tnl - Leominster)	30 MPH	30 MPH
GW731	Abbey Foregate to Ruabon	8	10	10	Over Bridge No. 438 (170 MP) (Allscott GF – Abbey Foregate Jn)	20 MPH	20 MPH

The final two locations where initial modelling produced times significantly slower than SRTs were between Woofferton and Bromfield and Craven Arms and Marshbrook Signal Box. These sections again feature uphill running. When modelled with the T1301 methodology, with lower (more accurate) high speed resistances, the SRTs are comparable to modelled times. A similar pattern is noticed between Abergavenny and Pontrilas, showing that some SRTs more accurately reflect real-world performance than modelling with NR methodology.

SRT modelling indicates that existing SRTs understate performance in the final two sections before Shrewsbury. The SRTs between Shrewsbury Sutton Bridge Junction and Shrewsbury are almost 2 minutes slower than the modelled times with NR methodology. It could be that current SRTs incorporate pathing allowances approaching Shrewsbury. As this is typically handled by the Timetable Planning Rules, reducing these SRTs seem reasonable.

The final times of each of the model runs are listed in Table 8, presented as the difference from the SRTs alongside the percentage increase of the total journey time. Usage of the T1302 methodology produces clear improvements in the modelled time in comparison with the NR methodology, here showing a notable decrease in running time across most sections of the route.

Table 8 Newport to Shrewsbury end-to-end timings

Route	Run	Modelled time (mins)	Percentage improvement
2. Newport–Shrewsbury	Class 66 SRTs (2,200 tonnes)	150.00 (current SRT allow)	Baseline
	NR Class 66 (2,200 tonnes)	4.92	-3%
	Class 66 (2,200 tonnes)	-6.52	4%
	Class 70 (2,200 tonnes)	-15.63	10%

Table 19 contains full modelling results for the two runs with T1302 methodology.

3.6 Route 2 reverse: Shrewsbury–Margam limestone

When considering the return routing, it was agreed to model the limestone train that runs through from Shrewsbury to Margam. The table below shows a comparison of the timings, with differences of over a minute ringed.

Table 9 Comparisons of timings for Shrewsbury–Margam

Shrewsbury-Margam		Class 66, 1600t	Class 66, 1566t	Class 70, 1566t	
Tiploc-Tiploc Section	SRTs	NR	T1302	T1302	
SHRWBY - SHRWSBJ	3	-0.28	0.18	0.13	
SHRWSBJ - DORNGTN	10	-0.30	-0.63	-1.42	
DORNGTN - MSHBRKX	17.5	1.07	-1.15	-3.12	Climb - Improved with T1302
MSHBRKX - CRAVENA	5	0.30	0.40	0.38	
CRAVENA - BRFLD	5.5	-0.47	-0.48	-0.52	
BRFLD - WOFERTN	7	-1.50	-1.52	-1.52	
WOFERTN - LEOMNST	6.5	1.92	1.77	1.73	SRT above linespeed
LEOMNST - MRTNONL	8.5	0.90	0.82	0.70	Weak bridge
MRTNONL - SHIP	2.5	0.45	0.40	0.40	SRT above linespeed
SHIP - HEREFRD	3	-0.50	-0.53	-0.53	
HEREFRD - TRAMINN	12	0.58	-0.55	-1.52	Climb - Improved with T1302
TRAMINN - PONTRLS	6.5	-0.65	-0.98	-1.07	
PONTRLS - ABRGVNY	16	0.93	-0.83	-1.73	Climb - Improved with T1302
ABRGVNY - LTTLMLJ	9	0.28	-0.13	-0.33	
LTTLMLJ - MAINDNJ	15.5	-0.35	-0.83	-0.93	
MAINDNJ - MAINDWJ	1.5	-0.10	-0.03	-0.03	
MAINDWJ - NWPTRTG	1.5	0.30	0.62	0.62	
NWPTRTG - GAERJ	1.5	0.05	0.18	0.12	
GAERJ - EBBWJ	2.5	-1.48	-1.48	-1.48	
EBBWJ - MSHFILD	6	-1.63	-1.65	-1.73	
MSHFILD - LNGDYKJ	8.5	0.43	0.28	0.25	
LNGDYKJ - CRDFCEN	1	0.08	0.08	0.08	
CRDFCEN - LCKWTHJ	2.5	0.55	1.25	1.17	Low linespeeds (linked to length limit)
LCKWTHJ - PONYCLN	11	1.58	0.42	-0.15	Low linespeed followed by climb
PONYCLN - BRGEND	10	1.02	-0.13	-0.37	
BRGEND - STORMY	5	0.03	-0.28	-0.42	
STORMY - MRGMMJN	4	0.65	0.53	0.48	SRT above linespeed
MRGMMJN - MRGMTC	5	-0.13	-0.13	-0.13	
Totals	188	3.73	-4.43	-10.93	

The total running time is given at 188 minutes, but our analysis concludes that this timing should be increased by 3 minutes using current NR processes. There are two significant issues: in several places, the stated SRT would require running at above line speed, and in two places, the length of the train has not been allowed for when clearing a speed restriction.

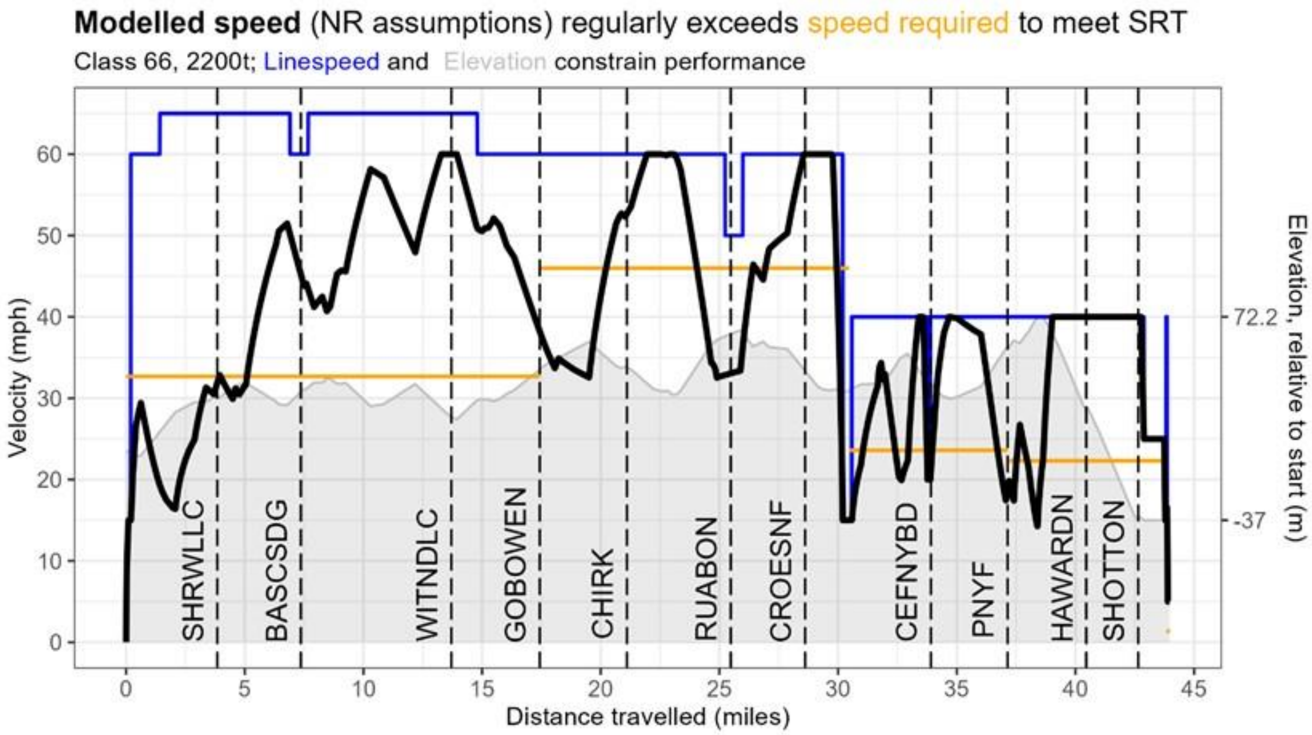
When we recalculate these timings using T1301 values, the timing is improved by over 8 minutes through incremental improvements across the route through improved running times.

The final column shows the use of a Class 70 locomotive, which saves an additional 6.5 minutes against the Class 66 through slightly better performance across the route.

3.7 Route 3a: Shrewsbury–Dee Marsh

The modelled speed on the route between Shrewsbury to Dee Marsh regularly exceeds the speed required to meet the SRTs, as shown in Figure 9 , and as such, the four or five SRTs covering this route can be significantly improved upon. As suggested by the small number of SRTs, each one spans a long timeframe. The longest SRT is from Shrewsbury to Gobowen and is 32 minutes. This makes it difficult to accurately compare SRTs and modelled times (each section will contain multiple reactions to elevation or line speed changes, so determining which of these is responsible for differences in the timing is impossible).

Figure 9 Modelled speed vs. minimum average speed implied by current SRT



The modelled time between Shrewsbury and Gobowen (which has a 32-minute SRT) is 28 minutes 13 seconds when using NR methodology. This near 4-minute difference in time performance is apparent in the above graphic. Figure 9 shows an average speed of 32.5 mph would be sufficient between Shrewsbury and Gobowen to match the SRT. The modelled train exceeds 40 mph for a third of this section, running at or above 50 mph for a quarter of the section.

The second SRT (between Gobowen and Wrexham General) is the only one shorter than the initial modelled times. The NR methodology produces a section time 1 minute 21 seconds longer than the SRT. Given that this section contains a couple of uphill sections, and the NR methodology understates performance on these, this is likely the cause of the difference. It is not possible to pinpoint the exact reason for discrepancies between SRT and model performance in this section, as it is over 13 miles in length.

The two SRTs between Wrexham General and Dee Marsh Junction have implied average speeds around 23 mph. Modelling suggests that trains should be able to exceed these speeds for the majority of this section with sustained running at the line speed of 40 mph. Consequently, modelling suggests that trains should be able to outperform these two SRTs by a cumulative time exceeding 7 minutes.

All SRTs are comparatively long until Dee Marsh Junction to Dee Marsh, which has a 6-minute SRT, as shown in Table 10. Modelling suggests that this short section could be traversed in 1 minute 16 seconds. Further investigation is required to determine if this SRT can be reduced or whether it is constrained by shunting manoeuvres in Dee Marsh Sidings.

Table 10 Shrewsbury to Dee Marsh SRTs

TiPLoc-TiPLoc section	SRT (mins)	Modelled time (mins)	Improvement (mins)
SHRWBY - GOBOWEN	32	28.22	3.78
GOBOWEN - WREXHMG	17	18.35	-1.35
WREXHMG - PNYF	17	14.35	2.65
PNYF - DMARSHJ	18	13.45	4.55
DMARSHJ - DMARSRS	6	1.27	4.73

The issue of long SRTs arises due to the infrequency of timing positions along the route, an infrastructure problem. The value of the SRTs as a point of comparison diminishes when considered over such long sections of the route, as it is not possible to determine what features (i.e., which of the multiple line speed and elevation changes) may be responsible for discrepancies in the timings.

The final times of each of the model runs are listed in Table 11, presented as the difference from the SRTs alongside the percentage increase of the total journey time. The modelled times all show a clear improvement to the SRTs, with the T1302 methodology further decreasing the total modelled time from the NR methodology.

Table 11 Shrewsbury–Dee Marsh end-to-end timings

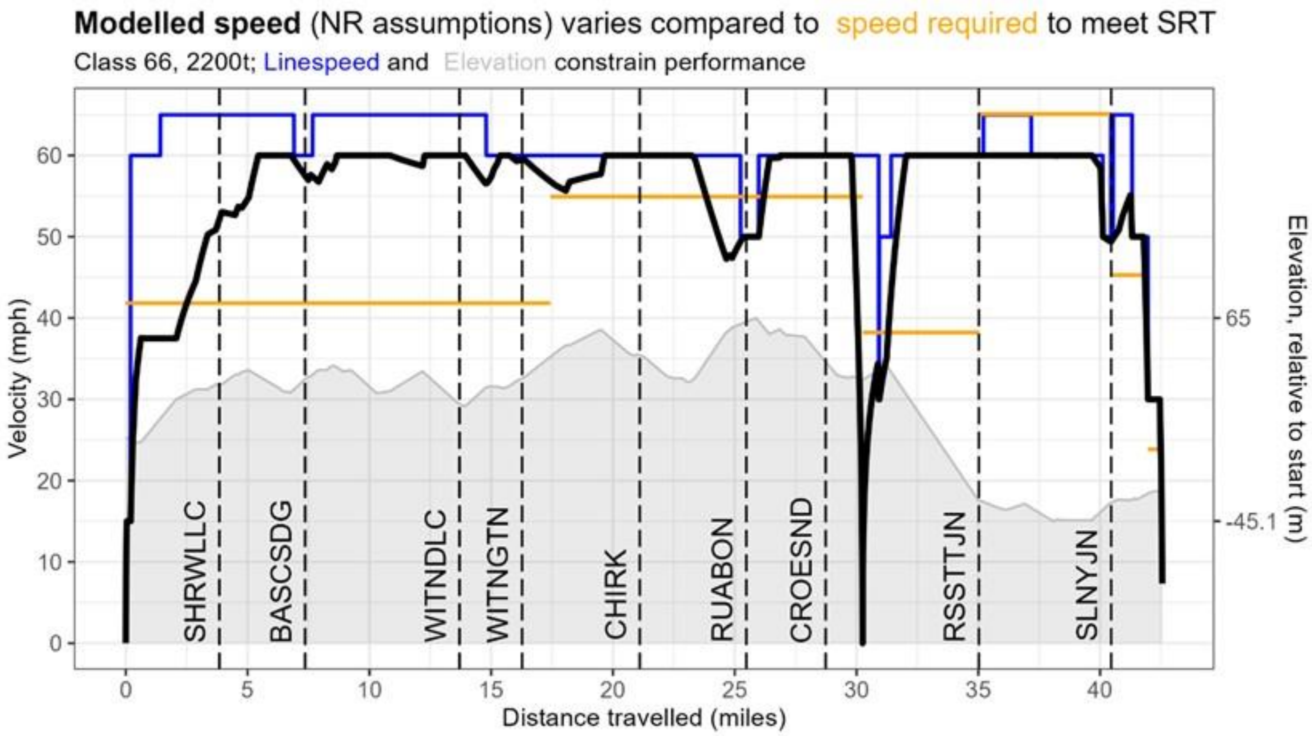
Route	Run	Modelled time (mins)	Percentage improvement
3a. Shrewsbury–Dee Marsh	Class 66 SRTs (2,200 tonnes)	90 (current SRT allow)	Baseline
	NR Class 66 (2,200 tonnes)	-14.37	16%
	Class 66 (2,200 tonnes)	-16.80	19%
	Class 70 (2,200 tonnes)	-20.52	23%

Table 20 contains the modelled sections times with T1302 methodology.

3.8 Route 3b: Shrewsbury–Chirk Kronospan

As the train arrives at Chester and reverses back to Chirk (as access to the siding is only from the southbound direction), this route is split where the train runs around at Chester to simplify modelling. Results for Shrewsbury to Chester are shown in Figure 10 . The modelled times are significantly faster than existing SRTs in five sections and slower in just one of the six sections.

Figure 10 Modelled speed vs. minimum average speed implied by current SRT



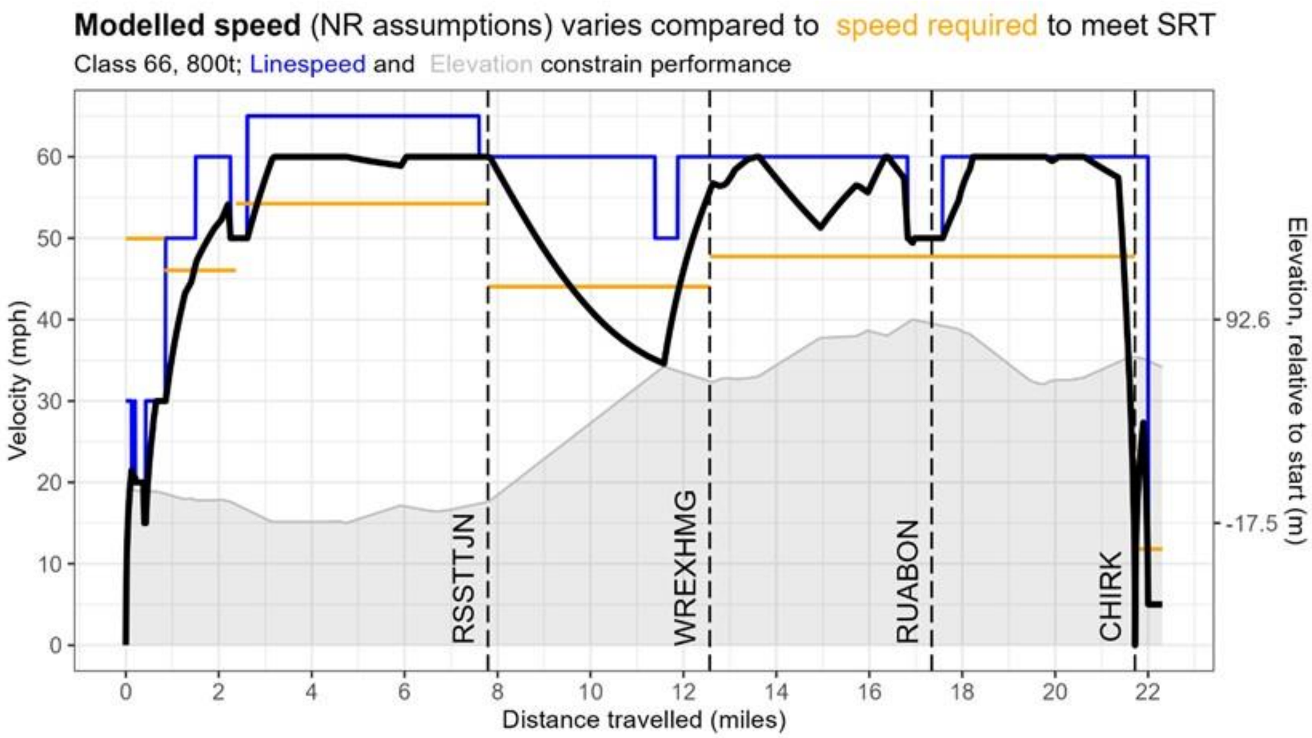
The SRT between Shrewsbury to Gobowen had to be infilled from the timetable, as there was no available SRT for a Class 66 train at an 800-tonne trailing load in the BplanGeo database. This 25-minute timing was checked against SRTs for similar trailing loads and found to be comparable. The average speed required to meet this timing is just over 40 mph, while modelling suggests that a train would be able to run at, or close to, the maximum permitted freight speed in Wales of 60 mph. A lower SRT of 20.5 minutes is realistic for this section, before considering the improved T1302 methodology.

The other northbound section where a significant reduction can be achieved is between Wrexham General and Rossett Junction. The modelled time for this section is 1 minute 13 seconds faster than the existing 7 minute 30 seconds SRT.

Between Rossett Junction and Saltney Junction, an average speed of 65 mph is required to match the SRT. This exceeds the maximum permitted speed for this service (60 mph). Were this SRT reduced by 30 seconds, the implied average speed would fall to 60 mph, and the performance be comparable to the modelling with NR methodology. It can be concluded that this SRT has been subject to a manual adjustment, but the motivation for this adjustment is unclear.

The modelled velocity between Chester to Chirk Kronospan is shown in Figure 11 . There are two sections (the first and last) on this portion of the route where SRTs are significantly faster than the modelling suggests is realistic and one section with an SRT significantly slower than necessary.

Figure 11 Modelled speed vs. minimum average speed implied by current SRT



Figure

A speed of 50 mph is required to match the 1-minute SRT following Chester (to Chester South Junction). The line speeds in this section vary between 15 mph and 30 mph. As this is a short section, the impact of this discrepancy between line speed and SRT average speed has just under a 90-second impact on time performance. This delay increases slightly when modelling with the T1302 methodology, which considers the 15 mph line speed limit continuing to prevent acceleration until the rear of the train has cleared it.

Between Wrexham General and Chirk, modelling suggests that a train could run at, or above, 50 mph almost all the time. A train should be able to sustain 60 mph for a considerable period of time in this section. In contrast, the average speed required to match this section's SRT is under 50 mph. Consequently, with the NR methodology, the existing SRT could be reduced by 90 seconds.

The final SRT on this route, covering the movement from Chirk into Kronospan sidings, is flagged as unrealistic by SRT modelling. As seen in the T1301 project, movements into, and out of, sidings are hard to accurately model due to difficulty defining distances and line speeds. In this section, the 3-minute SRT should be sufficient for the train to move into the sidings (corresponding to the 5 mph line speed limit).

The final times of each of the model runs are listed in Table 12, presented as the difference from the SRTs alongside the percentage increase of the total journey time. The modelled times all show an improvement to the SRTs, with the T1302 methodology further decreasing the total modelled time from the NR methodology.

Table 12 Shrewsbury to Chirk Kronospan end-to-end timings

Route	Run	Modelled time (mins)	Percentage improvement
3b. Shrewsbury–Chirk Kronospan	Class 66 SRTs (800 tonnes)	85.00 (current SRT allow)	Baseline
	NR Class 56 (800 tonnes)	-2.43	3%
	NR Class 66 (800 tonnes)	-2.90	3%
	Class 56 (660 tonnes)	-5.55	7%
	Class 66 (660 tonnes)	-5.73	7%
	Class 70 (660 tonnes)	-6.82	8%

Modelled sections times are contained within Table 21.

3.9 Route 3b reverse: Dee Marsh–Margam

The return flow from Dee Marsh to Margam (via Llanwern) was modelled with a lighter loading of 1,400 tonnes. Differences with each SRT are shown for four runs in Table 13.

Table 13 Comparisons of timings for Shrewsbury–Margam

Dee Marsh–Margam		Class 66, 1,400 tonnes			Class 70, 1,400 tonnes
TiPLoc–TiPLoc section	SRTs	NR	T1302 (No LL)	T1302	T1302
DMARSRS - DMARSHJ	4	-2.67	-2.67	-2.33	-2.35
DMARSHJ - PNYF	19	2.08	1.60	3.58	0.90
PNYF - WREXHMG	13	-0.83	-0.95	-0.88	-1.08
WREXHMG - GOBOWEN	15	3.95	3.12	3.70	3.00
GOBOWEN - SHRWBY	21	-1.85	-2.13	-2.13	-2.28
SHRWBY - SHRWEBJ	2	-0.52	-0.52	-0.52	-0.57
SHRWEBJ - SHRWSBJ	2	-0.80	-0.82	-0.38	-0.42
SHRWSBJ - DORNGTN	9.5	-0.45	-0.90	-0.63	-1.32
DORNGTN - MSHBRKX	16	0.67	-0.70	-0.68	-2.30
MSHBRKX - CRAVENA	5	0.28	0.27	0.38	0.37
CRAVENA - BRFLD	5.5	-0.52	-0.57	-0.50	-0.55
BRFLD - WOFERTN	7	-1.48	-1.50	-1.50	-1.52
WOFERTN - LEOMNST	6.5	1.85	1.77	1.77	1.72

LEOMNST - MRTNONL	10.5	-1.25	-1.43	-1.27	-1.37
MRTNONL - SHIP	2.5	0.42	0.40	0.40	0.38
SHIP - HEREFRD	3	-0.52	-0.53	-0.53	-0.53
HEREFRD - TRAMINN	11.5	0.15	-0.50	-0.50	-1.38
TRAMINN - PONTRLS	6	-0.38	-0.53	-0.53	-0.58
PONTRLS - ABRGVNY	15	0.93	-0.18	-0.18	-1.03
ABRGVNY - LTTLMLJ	9	0.08	-0.20	-0.20	-0.38
LTTLMLJ - MAINDNJ	15	0.18	-0.07	-0.05	-0.13
MAINDNJ - MAINDEJ	2	-0.18	-0.18	-0.18	-0.18
MAINDEJ - LWERWJN	3	0.05	0.02	0.62	0.55
LWERWJN - LLWEGBF	15	-6.73	-6.73	-6.73	-6.73
LLWEGBF - LWERWJN	15	1.98	1.98	2.28	2.23
LWERWJN - MAINDEJ	4.5	-1.73	-1.80	-1.58	-1.68
MAINDEJ - MAINDWJ	1	-0.63	-0.63	-0.63	-0.63
MAINDWJ - NWPTRTG	1.5	-0.92	-0.92	-0.92	-0.92
NWPTRTG - EBBWJ	3	-0.73	-0.73	-0.73	-0.73
EBBWJ - MSHFILD	6	-1.72	-1.85	-1.70	-1.80
MSHFILD - LNGDYKJ	8.5	-1.47	-1.53	-1.52	-1.52
LNGDYKJ - CRDFCEN	1	0.85	0.85	0.85	0.83
CRDFCEN - PENACSJ	3	-0.35	-0.37	-0.03	-0.05
PENACSJ - COGANJ	5	-0.82	-0.87	-0.43	-0.52
COGANJ - CADOXTN	9	-2.55	-2.67	-2.32	-2.48
CADOXTN - BARRY	5	-0.83	-0.87	-0.58	-0.62
BARRY - ABTH	11.5	-1.98	-2.22	-2.20	-2.65
ABTH - LLNWTMR	8	-0.23	-0.55	-0.47	-0.80
LLNWTMR - ABTH433	1	-0.78	-0.80	-0.80	-0.80
ABTH433 - CWBRDSB	14	-0.30	-0.72	-0.55	-0.82
CWBRDSB - BRGEND	1	-0.12	-0.12	-0.10	-0.10
BRGEND - STORMY	6	0.75	0.35	0.62	0.18
STORMY - MRGMMJN	5	-0.30	-0.38	-0.37	-0.45
MRGMMJN - MRGMTC	5	-0.13	-0.13	-0.13	-0.13
Totals	332	-19.55	-27.92	-20.62	-31.25

Table 14 explains the differences between modelling runs for selected sections (those with large changes).

Table 14 Reasons for timing differences for Shrewsbury–Margam

TiPLoc–TiPLoc section	Notes
DMARSRS - DMARSHJ	Sidings movements: section too short (compensated for in next section)
DMARSHJ - PNYF	SRTs unrealistic for climb, section starts at low line speed (15–25 mph) - affected by length limits
WREXHMG - GOBOWEN	Wrexham SRT has insufficient TPR adjustment of 1 min - SRT is unrealistic with the line speed of 15 through Wrexham, and impacted by two climbs
DORNGTN - MSHBRKX	SRT more realistic than NR modelling, possibly calculate with stopwatch

WOFERTN - LEOMNST	SRT unrealistic, and out of keeping with neighbours (see average speed plot)
LEOMNST - MRTNONL	Weak bridge present
MRTNONL - SHIP	Speed above line speed is required to meet SRT, and out of keeping with neighbours
PONTRLS - ABRGVNY	SRT more realistic than NR modelling, possibly calculate with stopwatch
MAINDEJ - LWERWJN	Low line speeds around junctions - length limit impacts results
LWERWJN - LLWEGBF	Moving into sidings, large allowances built into SRT
LLWEGBF - LWERWJN	Modelling includes motion in sidings that are sometimes excluded from SRTs
LNGDYKJ - CRDFCEN	Modelling for different services suggests SRTs through Cardiff station are based on old line speeds

Using current NR methodology, a 20-minute reduction to the 332-minute journey time is possible. Ten minutes of this reduction comes from excessive SRTs covering sidings movements from Dee Marsh and to Llanwen (part of these sections are off network, so the train will not be impacting others for part of these allowances).

Switching to the T1302 methodology brings a net 1 minute further reduction to journey time (column 5 in Table 13). Modelling with no length limit (modelling the train as a point so that acceleration was instantaneous after clearing line speed restrictions), this shows that the more accurate resistances with the T1302 methodology bring an 8-minute time reduction (column 5 in Table 13). Hence, accounting for length limit increases journey time by 7 minutes.

Class 70 traction offers a further 11-minute reduction to total journey time.

3.10 Speed restrictions

Table 15 below shows the location and 'type' of speed restriction within the five case studies analysed.

Table 15 Location and type of speed restrictions

Locations of ≤25mph sections in each route					
Route	Nearest Tiploc to section start	Linespeed	Section commencement location in route (m)	Section length (m)	Reason
Robeston-Pilning	Robeston Sidings	20	0	2360	Sidings movements
	Haverfordwest	15	14110	100	Station
	Carmarthen Junction	20	65130	100	Pointwork
	Llandeilo Junction	25	98980	220	Pointwork
	Jersey Marine North Junction	20	122660	250	Bridge
	Cardiff Central	25	183140	240	Station
	Newport (South Wales)	20	201580	610	Station
Margam-Newport	Margam Abbey East Junction	5	430	430	Sidings movements
	Margam Abbey East Junction	20	430	820	Sidings movements
	Margam Moors Junction	20	1270	80	Pointwork
	Barry Docks	20	46880	1120	Station
	Cogan	25	54020	800	Pointwork
	Penarth Curve South Junction	20	57640	540	Pointwork
	Penarth Curve South Junction	25	58240	600	Pointwork
	Penarth Curve South Junction	15	58240	200	Pointwork
	Cardiff West Junction	15	58450	50	Station
	Cardiff Central	25	58560	750	Station
Newport-Shrewsbury	Newport (South Wales)	20	0	210	Station
	Maindee West Junction	20	790	190	Pointwork
	Maindee North Junction	25	1270	480	Pointwork
	Maindee North Junction	20	1270	1450	Pointwork
Shrewsbury-DeeMarsh	Shrewsbury	15	0	320	Station
	Wrexham General	15	48600	610	Station
	Cefn-y-Bedd	20	54340	200	Station
	Dee Marsh Junction	25	70470	1450	Pointwork
	Dee Marsh Junction	15	70470	60	Sidings movements
	Dee Marsh Junction	15	70640	50	Sidings movements
Shrewsbury-ChirkKronospan	Shrewsbury	15	0	320	Station
	Chester	20	210	100	Station
	Chester West Junction	20	640	310	Station
	Chester West Junction	15	640	50	Station

Of the 32 locations, 12 of them are related to station through running. These locations may present an opportunity for improvement, as in many locations nationally, freight trains go through stations at a higher speed. There is one bridge-related PSR, and the other locations are around the passage of trains through points, which each have a limited speed restrictions.

Each one of these locations presents an opportunity for improvement if the local speed restriction can be raised. This is particularly the case at Margam, where the speed restriction is immediately before a significant gradient and therefore restricts the train speed for 4 miles, as the train is unable to accelerate.

4 Conclusions

The table below summarises the results of the analysis.

Table 16 Summary of timings

	1a, Robeson - Pilning		1b, Margam - Newport		2, Newport - Shrewsbury		3a, Shrewsbury - Dee Marsh		3b, Shrewsbury - Chirk	
	Payload	Improve.	Payload	Improve.	Payload	Improve.	Payload	Improve.	Payload	Improve.
Class 56									800	3%
									660	7%
Class 60	2800	10%	2400	7%						
	2900	9%	2200	5% (+5%)						
Class 66	2800	11%	2400	1%	2200	-3%	2200	16%	800	3%
	2800	11%	2200	5% (+5%)	2200	4%	2200	19%	660	7%
Class 70	2900	15%	2200	9% (+5%)	2200	10%	2200	23%	660	8%
	2800	17%								

1. Significant improvements can be made to timings by using both the same and different traction types. The table above summarises the timing comparisons.
   a) In all bar one situation, recalculating the timings using the T1302 principles and the existing NR timing methodology produces a positive timing benefit.
   b) Reworking the timings with the T1301 assumptions generally provides an additional 3–4% of benefit.
   c) Class 60 and 66 timings improve by similar amounts. Class 70 timings are always larger by around 4%.
   d) Care has to be taken when making comparisons because existing issues in the timings need to be accommodated/overcome within the recalculated timings.
2. Line speed restrictions have a significant impact on all services, and opportunities may exist for improvement here. For example, over a third of restrictions are because the train cannot run at more than 25 mph through a station.
3. Where speed restrictions are in front of a particularly steep gradient, they present a significant choke point. For example, the 20 mph speed restriction across Margam Moors Junction leads to this consistent speed up Stormy summit for 4 miles on a line where the train could run at 60 mph.
4. Typical modelled running times are included in Appendix 1, which could be the basis for recalculating the SRTs.
5. Times calculated with the T1302 methodology are slower than current timings when starting out but faster than current timings at higher speeds. This is in accordance with the more accurate wagon resistance formula used in the T1302 methodology.

6. Train length must be accurately accounted for when considering increases in line speed. Trains are prevented from accelerating until the rear has cleared any line speed restriction—current SRTs do not fully account for this, leading to SRTs that are not achievable in practice.
7. SRT trailing loads should be reflective of real operations. In cases such as Chirk, where trains are regularly operated with a lower trailing load, they will be able to complete journeys significantly ahead of time.
8. SRTs longer than 5 minutes are problematic. These potentially cover multiple periods of acceleration, and, consequently, any discrepancies are hard to pinpoint. If intermediate timing points are available, long SRTs should be disaggregated.
9. There are a number of local ‘logic problems’ with current freight SRTs in Wales:
    a) SRTs are based on old line speed assumptions and could be significantly accelerated.
    b) SRTs have been manually adjusted and are unrepresentative of performance in their section.
    c) Incorrect, higher line speeds (e.g., at Cardiff station) could also cause issues with passenger trains.
10. Timing improvements are possible across most case studies, with improvements limited by the number of sections along a route with ‘logic problems’.
11. New internal resistance values have been established for steel wagons.

5 Appendix 1: Modelled running times

5.1 A. Robeston–Pilning

Table 17 Modelled running times for Route 1a: Robeston–Pilning

Section TiPLocs	Modelled time (mins)					
	Class 60 (2,900 tonnes)	Class 66 (2,800 tonnes)	Class 70 (2,900 tonnes)	Class 70 (2,800 tonnes)	Class 99 (2,900 tonnes)	Class 99 (2,800 tonnes)
ROBSTNS - HRBRNSJ	10.55	10.43	8.63	8.17	13.00	11.60
HRBRNSJ - JHNSTND	8.93	8.63	7.60	7.37	10.35	9.92
JHNSTND - HAVRFDW	6.67	6.62	6.55	6.52	6.83	6.80
HAVRFDW - CLARBRD	18.57	17.90	16.40	15.97	21.12	20.55
CLARBRD - WHLAND	15.28	15.03	14.70	14.58	15.83	15.72
WHLAND - CMTHNJ	15.77	15.57	15.38	15.33	16.10	16.03
CMTHNJ - FYSD	11.17	10.97	10.73	10.65	11.58	11.48
FYSD - KIDWELY	5.12	4.92	4.72	4.65	5.48	5.42
KIDWELY - PMBRYBP	5.48	5.30	5.23	5.22	5.88	5.80
PMBRYBP - LLNLLI	4.20	4.05	4.02	4.02	4.50	4.43
LLNLLI - LLDELOJ	1.78	1.77	1.77	1.77	1.82	1.80
LLDELOJ - MORLASJ	5.00	4.95	4.87	4.83	5.13	5.12
MORLASJ - FELNFRN	19.55	18.95	17.62	17.28	21.83	21.33
FELNFRN - DYNEVRJ	4.15	4.12	4.07	4.07	4.22	4.20
DYNEVRJ - BRITFWJ	3.70	3.65	3.62	3.58	3.77	3.73
BRITFWJ - PTALBOT	5.37	5.23	5.03	4.97	5.72	5.63
PTALBOT - MRGMMJN	4.58	4.40	4.25	4.18	4.92	4.83
MRGMMJN - STORMY	11.18	10.10	8.62	8.25	13.58	13.17
STORMY - BRGEND	5.43	5.35	5.22	5.17	5.62	5.58
BRGEND - PONYCLN	11.88	11.53	11.22	11.13	12.90	12.68
PONYCLN - LCKWTHJ	9.85	9.85	9.85	9.85	9.87	9.87
LCKWTHJ - CRDFCEN	2.50	2.50	2.50	2.50	2.52	2.52
CRDFCEN - LNGDYKJ	2.43	2.42	2.43	2.40	2.40	2.38
LNGDYKJ - MSHFILD	8.75	8.60	8.47	8.40	7.53	7.50
MSHFILD - EBBWJ	4.38	4.27	4.15	4.12	3.78	3.78
EBBWJ - NWPTRTG	2.95	2.95	2.92	2.92	2.82	2.82
NWPTRTG - MAINDWJ	1.93	1.93	1.85	1.82	1.95	1.92

MAINDWJ - LWERWJN	3.75	3.68	3.63	3.60	3.42	3.38
LWERWJN - SEVTNLJ	11.37	11.35	11.33	11.32	11.27	11.27
SEVTNLJ - SEVTNLW	1.53	1.52	1.50	1.50	1.33	1.32
SEVTNLW - SEVTNLE	5.10	5.03	4.98	4.97	4.48	4.47
SEVTNLE - PILNING	5.30	4.88	4.25	4.10	1.90	1.87

5.2 B. Margam–Newport

Table 18 Modelled running times for Route 1b: Margam – Newport

Section TiPLocs	Modelled time (mins)			
	Class 60 (2,200 tonnes)	Class 66 (2,200 tonnes)	Class 70 (2,200 tonnes)	Class 99 (2,200 tonnes)
MRGMTC - MRGMMJN	7.00	7.02	6.95	7.03
MRGMMJN - STORMY	13.08	13.03	11.40	15.00
STORMY - BRGEND	5.25	5.22	5.05	5.43
BRGEND - CWBRDSB	0.85	0.85	0.85	0.85
CWBRDSB - ABTH440	14.10	13.82	12.87	15.60
ABTH440 - LLNWTMR	6.32	6.25	5.87	6.90
LLNWTMR - ABTH	9.27	9.25	9.22	9.35
ABTH - BARRY	9.72	9.50	8.98	10.62
BARRY - CADOXTN	5.02	5.02	5.00	5.03
CADOXTN - COGANJ	6.38	6.33	6.13	6.65
COGANJ - PENACSJ	3.75	3.75	3.73	3.78
PENACSJ - CRDFCEN	2.73	2.73	2.72	2.73
CRDFCEN - LNGDYKJ	2.12	2.12	2.08	2.03
LNGDYKJ - MSHFILD	8.17	8.10	7.93	7.28
MSHFILD - EBBWJ	3.95	3.90	3.78	3.77
EBBWJ - NWPTRTG	2.95	3.18	3.18	3.10

5.3 C. Newport–Shrewsbury

Table 19 Modelled running times for Route 2: Newport–Shrewsbury

Section TiPLocs	Modelled time (mins)	
	Class 66 (2,200 tonnes)	Class 70 (2,200 tonnes)
NWPTRTG - MAINDWJ	1.57	1.50
MAINDWJ - MAINDNJ	1.42	1.42
MAINDNJ - LTTLMLJ	27.23	24.33
LTTLMLJ - ABRGVNY	8.82	8.67
ABRGVNY - ABRGS38	16.53	14.10
ABRGS38 - PONTRLS	5.00	4.98
PONTRLS - TRAMINN	6.20	6.03
TRAMINN - HEREFRD	7.55	7.53
HEREFRD - SHIP	4.65	4.27
SHIP - MRTNONL	3.63	3.45
MRTNONL - LEOMNST	10.48	10.18
LEOMNST - WOFERTN	6.97	6.77
WOFERTN - BRFLD	7.92	7.68
BRFLD - CRAVENA	6.23	5.72
CRAVENA - MSHBRKX	8.77	8.12
MSHBRKX - DORNGTN	12.52	11.63
DORNGTN - SHRWSBJ	5.62	5.60
SHRWSBJ - SHRWEBJ	1.03	1.03
SHRWEBJ - SHRWBY	1.35	1.35

5.4 D. Shrewsbury–Dee Marsh

Table 20 Modelled running times for Route 3a: Shrewsbury–Dee Marsh

Section TiPLocs	Modelled time (mins)	
	Class 66 (2,200 tonnes)	Class 70 (2,200 tonnes)
SHRWBY - GOBOWEN	27.58	25.83
GOBOWEN - WREXHMG	16.80	16.22
WREXHMG - PNYF	14.52	13.75
PNYF - DMARSHJ	13.03	12.42
DMARSHJ - DMARSRS	1.27	1.27

5.5 E. Shrewsbury–Chirk Kronospan

Table 21 Modelled running times for Route 3b: Shrewsbury–Chirk Kronospan

Section TiPLocs	Modelled time (mins)		
	Class 56 (660 tonnes)	Class 66 (660 tonnes)	Class 70 (660 tonnes)
SHRWBY - GOBOWEN	20.02	20.03	19.68
GOBOWEN - WREXHMG	13.63	13.65	13.57
WREXHMG - RSSTTJN	6.30	6.18	6.05
RSSTTJN - SLNYJN	5.50	5.50	5.50
SLNYJN - CHSTRSJ	1.82	1.82	1.80
CHSTRSJ - CHST	1.40	1.40	1.40
CHST - CHSTRSJ	2.82	2.70	2.63
CHSTRSJ - SLNYJN	2.12	2.12	2.10
SLNYJN - RSSTTJN	5.55	5.55	5.53
RSSTTJN - WREXHMG	5.63	5.70	5.40
WREXHMG - CHIRK	9.88	9.90	9.85
CHIRK - CHIRKKA	4.78	4.72	4.67

6 Acknowledgements

With thanks to the following technical contributors:

- Jack Pocock (Rail Aspects Limited)
- Jack Neil (Rail Aspects Limited)
- Karol Tyszka (D2 Global Limited)
- Jessica Tandy (D2 Global Limited)
- Kieran Lee (Aether Limited)
- Lewis Blannin (Aether Limited)
- Kate Attard (Aether Limited).

RAIL SAFETY AND STANDARDS BOARD

Contact: https://customer-portal.rssb.co.uk/
Web: www.rssb.co.uk

RSSB
25 Fenchurch Avenue
London
EC3M 5AD