TECHNICAL NOTE 1

DATE:	August 2023	**CONFIDENTIALITY:**	Internal
SUBJECT:	SWMWTM – Base model review for Hywel Dda Study		
PROJECT:	Hywel Dda Care Hospital Study	**AUTHOR:**	David Fifer
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INTRODUCTION

Background

Hywel Dda University Health Board (HDdUHB) are proposing to construct a new Urgent and Planned Care Hospital as part of their estate strategy designed to support a future model of care based around a network of integrated health & wellbeing centres and community hospitals.

The new Urgent and Planned Care Hospital in the South of the region would centralise all specialist children and adult services. It will be the main site for the network of hospitals providing urgent and planned care services across the Health Board catchment area, offer a more centralised model for all acute services and will also include specialist mental health facilities.

To facilitate the construction of the Urgent and Planned Care Hospital, HDdUHB are carrying out due diligence on a shortlist of sites across South-West Wales to allow the selection of the most appropriate site.

It is proposed to use the South-West and Mid-Wales Transport Model (SWMWTM) to assess the impacts of the planned Urgent and Planned Care Hospital on traffic and travel patterns. The SWMWTM is a regional, multi-modal transport model, and comprises: a highway assignment component representing travel by car (business, commute and other purposes), and road freight (light goods vehicles (LGVs) and heavy goods vehicles (HGVs)); a public transport assignment component including bus, rail and national coach services; and a variable demand model (VDM). It has a base year of 2019 and represents a neutral month of October.

This Technical Note provides a review of the South-West and Mid-Wales Transport Model (SWMWTM) focusing on the area around, and within the towns Whitland and St Clears associated with the delivery of three proposed sites, as shown in Figure 1. Both towns are located in the county of Carmarthenshire and are connected by the A40, which connects them to Carmarthen to the east, and Haverfordwest to the west.

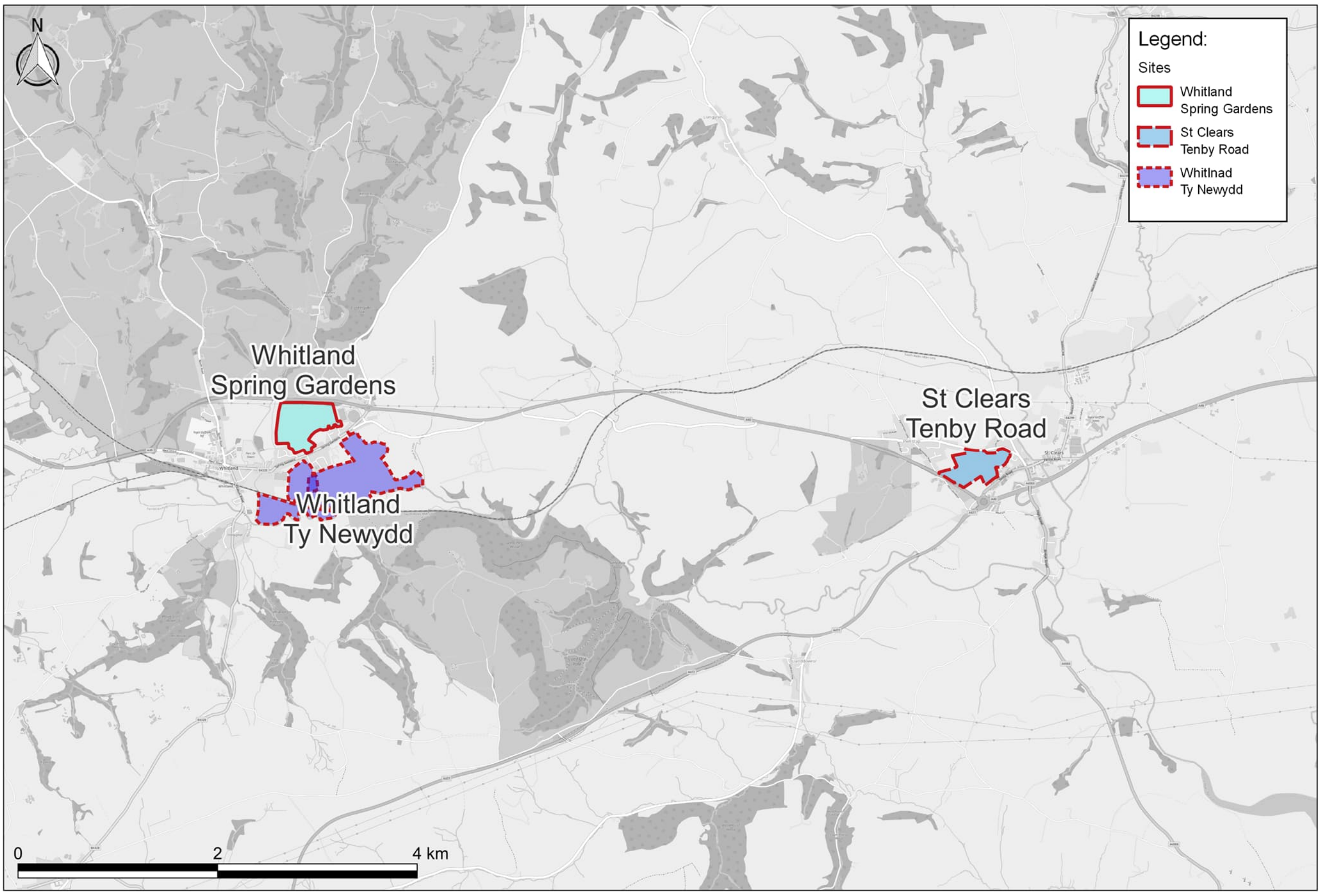

Figure 1 - Proposed site locations

MODEL FEATURES

Introduction

This section provides information on key features of the 2019 base year SWMWTM, its composition, and general form. Detailed information is provided in the SWMWTM Model Validation Report (MVR).

Base Year

The SWMWTM was developed to a base year of 2019 and represents an average Monday-Thursday weekday in September/October 2019, excluding the first week of September (end of the Summer holidays) and excluding the half-term period in October.

It should be noted that the model was developed, calibrated, and validated using data collected prior to the Covid-19 pandemic. Therefore, the base year model, and any forecasts derived from it, do not reflect the ongoing impacts of the Covid-19 pandemic on travel behaviours. As part of this study, it is not proposed to update the base year model to reflect these impacts on travel behaviours.

Demand Data

The primary source of demand data input into the base year SWMWTM was mobile phone origin-destination (MPOD) data, provided by Telefonica. In principle, MPOD datasets capture a larger sample of trips undertaken within the surveyed area of interest than more 'traditional' methods such as roadside interviews (RSIs). At the time of developing the SWMWTM, it was estimated that Telefonica represented around 32% of the UK mobile phone network market, although this varied across different regions and local areas.

MPOD datasets are built from mobile phone 'event' records. Mobile phones generate events as they communicate with the national cell network. These events were collected by Telefonica for the period Monday 4 March to Friday 12 April 2019, and analysed to determine users' movement patterns. Both active[1] and passive[2] events were collected and used to build a representative dataset of OD trip movements.

The supplied MPOD data included all events captured within South-West and Mid-Wales including those trips starting, ending, or travelling through the model area but excluding trips entirely external to the study area.

A MPOD data verification process took place using independent data sources to provide sufficient confidence that the matrices met required standards. The key findings from the MPOD data verification process were the following:

- The MPOD data had high levels of symmetry.
- The MPOD rail identification was incomplete. In this instance, rail demand matrices were created from ticket data obtained from LENNON, and the rail MPOD data was discarded.
- The MPOD data underrepresented short distance trips. In this instance, synthetic travel demand was used to infill car and bus trips occurring over distances of less than 10km in urban areas and 15km in rural areas.

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[1] Active mobile phone events include switching a phone on or off, losing or regaining connection, or making or receiving calls, texts and data.

[2] Passive mobile phone events include a phone moving from one cell location area to another, or where the phone 'checks-in' to the network after being inactive for three hours.

- The MPOD HGV data was consistent with land use patterns at a county level but volumes were underrepresented. In this instance, HGV trips were factored to match annual volumes of HGV trip making represented in the Continuing Survey of Road Goods Transport Great Britain (CSRGT GB).

In addition to the MPOD data, Trafficmaster Origin-Destination (OD) data was used to develop LGV matrices as there was no reliable method of isolating LGV trips from the MPOD data. Indicative active travel demand matrices were developed based on National Trip End Model (NTEM) data as active travel trips are not reliably captured by mobile phone sampling as they occur over distances which are generally too short.

The calibration, validation, and verification of base year demand in the SWMWTM was undertaken for the whole of the FMA at a strategic level. Given the nature of the area of focus for this study, and its more rural setting, it is likely that the existing SWMWTM demand matrices will have a higher proportion of synthetic demand to and from the zones than would be observed for zones in urban settings within the Areas of Detailed Modelling (AoDMs). This is a limitation that will need to be considered when analysing results of any impact assessments.

Modelled Time Periods

The assignment models consider the following time periods:

- Highway assignment model (HAM)
  - AM peak hour (0800-0900)
  - Interpeak (IP) average hour (average of 1000-1500)
  - PM peak hour (1700-1800)
- Public transport assignment model (PTAM)
  - AM period (0700-1000)
  - IP period (1000-1500)
  - PM period (1500-1800)

The variable demand model (VDM) operates on demand represented at an all-day level.

Modelled Areas

The SWMWTM comprises a Fully Modelled Area (FMA), where all trip movements are modelled and which includes four separate AoDMs, and an External Area with simplified coding and only trip movements to/from the FMA represented. These areas are shown in Figure 2.

Carmarthenshire, including the towns of Whitland and St Clears, and the area of focus for this study, are outside of any of the AoDMs in the model and are within the Rest of the FMA (RoFMA).

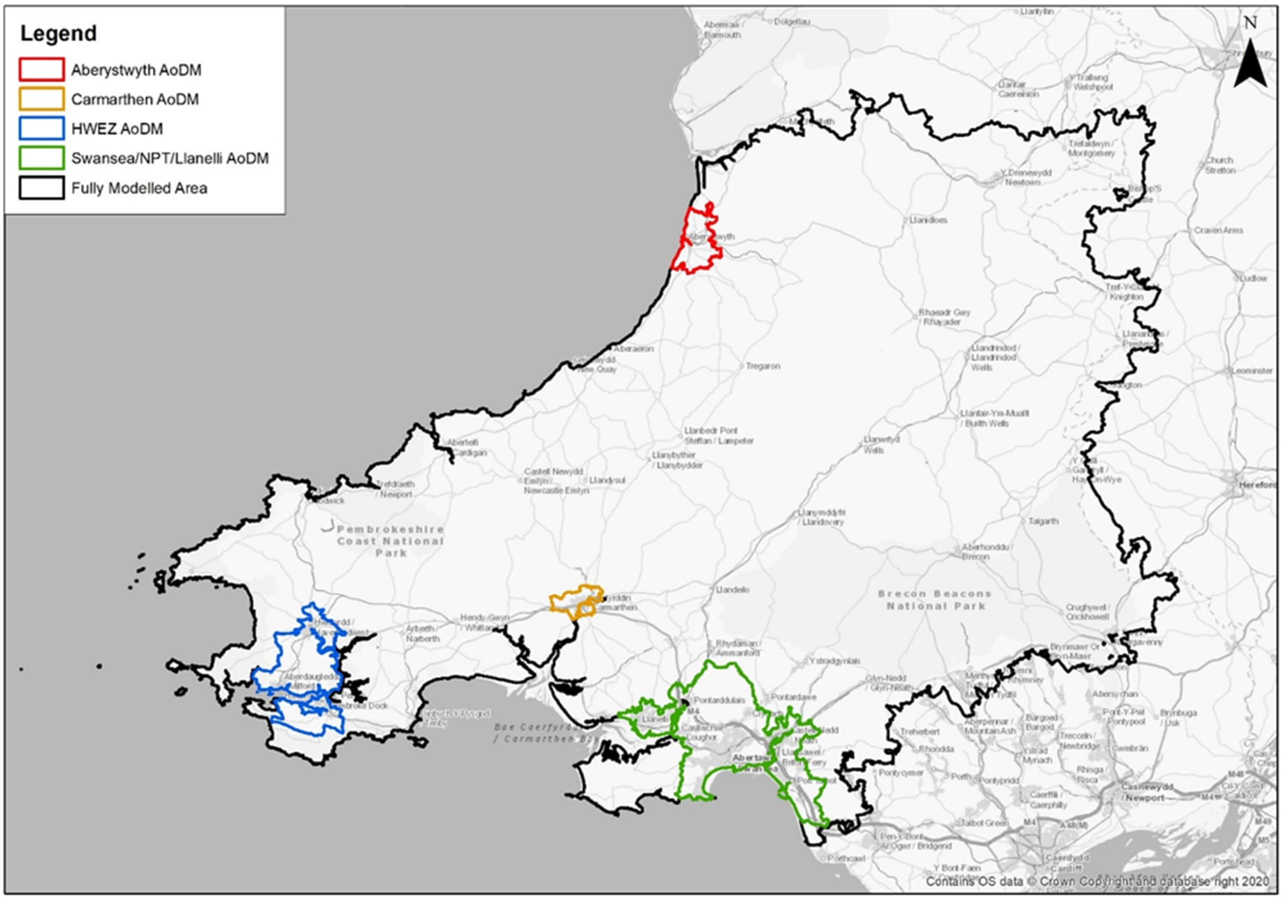

Figure 2 – SWMWTM modelled areas

Zoning System

The SWMWTM contains 1,756 zones. The zones are consistent across the HAM, PTAM, and VDM and either represent geographical areas, or represent specific special generators or rail and large bus stations.

Zones are connected to the assignment network via centroid connectors, which connect to the population-weighted centroid for the zone.

In the HAM, centroid connectors join the zone to the highway network at an appropriate point to represent access to and egress from the modelled network. Single centroid connectors were used within the AoDMs whilst the numbers of centroid connectors per zone in the RoFMA were 'minimised', with an expectation of no more than two connectors per zone.

In the PTAM, centroid connectors join the zone directly to appropriate bus stops and rail stations. A 400m catchment area around the zone centroid was used to select appropriate bus stops to connect to. Similarly, a 1.2km radius around zone centroids was used to identify appropriate rail stations to connect to.

Network Structure

HIGHWAY ASSIGNMENT MODEL

The greatest topographical detail in the highway network is in the AoDMs (comprising all Motorways, A-roads, B-roads and many C- or unclassified routes). A high-level of detail is represented in the RoFMA (comprising all Motorways, A-roads, B-roads and strategically important C- or unclassified roads), and a more skeletal network is represented in the External Area.

In the FMA, all links have defined Volume Delay Functions (VDFs) and capacities; in the External Area, links have unlimited capacity and are typically fixed speed to reflect the less detailed network and zonal structure.

Detailed representation of the junctions, their geometry and method of operation is used in the AoDMs and across the Trunk Road Network in the FMA. Elsewhere, a less detailed form of junction simulation is modelled, helping to achieve a balance between model complexity and runtimes.

PUBLIC TRANSPORT ASSIGNMENT MODEL

The PTAM network comprises detailed bus, long-distance coach, and rail services within, to, and from the FMA. Detailed timetable information was input for all modelled services to inform routeing, timing, and stopping patterns. All active bus stops and rail stations within the FMA were coded into the model. In the External Area, key bus stops and rail stations, to provide connectivity for services into and out of the FMA, were included.

The PTAM also includes pedestrian-only walk links to provide access to public transport stops and interchanges between the rail and bus networks.

Modes and User Classes

The base year SWMWTM represents the following modes and user classes:

- HAM:
  - Car Commuting (home-based work);
  - Car Employers' Business;
  - Car Other;
  - LGV; and
  - HGV.
- PTAM:
  - PT Commuting (home-based work);
  - PT Employers' Business; and
  - PT Other.

In addition, the PTAM includes bus, national coach, and train sub-modes.

Highway assignments represent travel demand in vehicle trips, whilst the public transport assignments represent travel demand in person trips.

Model Integration

The VDM integrates with the highway and public transport assignment models. The highway and public transport assignment models provide the primary generalised cost of travel information required by the VDM. The generalised costs of travel are used to model mode, sub-mode, and destination choice responses and produce updated assignment matrices reflecting changes in travel cost. These assignment matrices are then fed back into the assignment models and the system iterates until a suitable demand and cost equilibrium is found.

ZONING REVIEW

Introduction

This section provides detail on the zoning system within the towns of Whitland and St Clears in the 2019 base year of the SWMWTM. The SWMWTM model comprises 1,756 zones that either represent geographical areas, or represent specific special generators or rail and large bus stations.

Whitland

Whitland, and the immediate surrounding area, is comprised of six zones, as shown in Figure 3. Zone 10316 (not marked) represents Whitland rail station, whilst the remaining five zones represent distinct geographic areas within the model.

Each zone is connected to the highway network with a single zone connector. These connectors allow highway traffic to and from a zone to access the network at the most appropriate point based on the land use within the zone. Each zone is also directly connected to Whitland rail station via a single walk connector, which represents passenger access to, and egress from, trains. Similarly, the three geographic zones within the main urban area of Whitland are connected to the nearest bus stop(s) via walk connectors. Zones 10095 and 10292 are not connected to any bus stops as there are none located within a 400m catchment area of the centroids.

Both proposed sites in Whitland: Whitland Spring Gardens (formally Site 12) and Whitland Ty Newydd (formally Site C) fall within the geographical boundary of zone 10232.

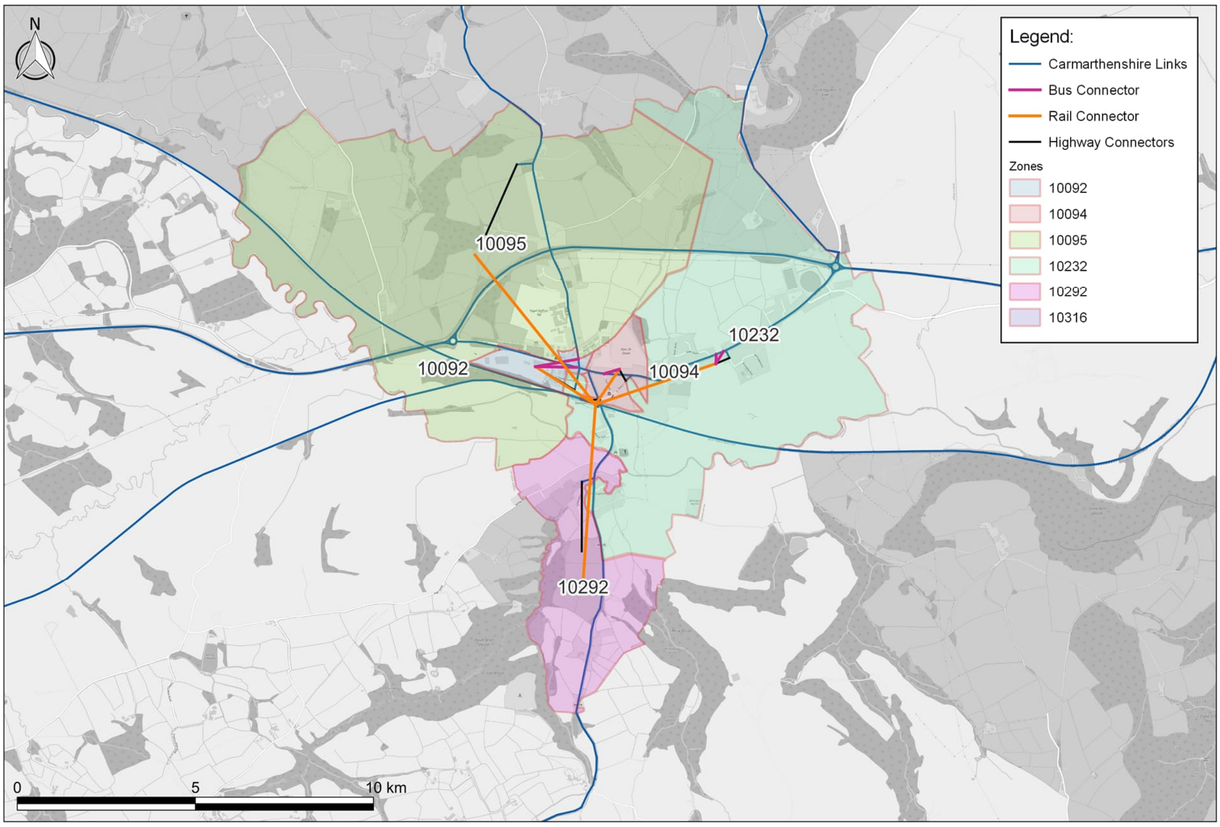

Figure 3 – Zones in and around Whitland

The base year trip ends at each of the zones shown in Figure 3 are provided in Table 1. The average trip length for car trips to and from each of the zones in Whitland in the 2019 base year is 21km, and for public transport trips is 70km. Analysis of desire lines shows the majority of car travel demand occurs between the zones in Figure 3 but there is also notable (relative to the trip end totals shown in Table 1) travel demand between Whitland and the following areas:

- Rural zones immediately surrounding Whitland
- Carmarthen
- St Clears
- Narberth

The public transport desire lines show longer distance trips to and from the west, between Whitland and Swansea, Cardiff, Brecon, Bristol, and London.

Table 1 - 2019 Car and PT trip ends within Whitland

Zone	Time Period	Car Origins	Car Destinations	PT Origins	PT Destinations
10092	AM	18	13	5	2
	IP	12	11	3	4
	PM	15	15	2	2
10094	AM	38	47	6	6
	IP	32	28	7	6
	PM	45	33	5	4
10095	AM	44	30	7	5
	IP	30	22	8	6
	PM	32	30	6	4
10232	AM	118	77	18	9
	IP	79	74	14	13
	PM	92	101	10	11
10292	AM	37	21	6	2
	IP	24	23	7	4
	PM	26	32	3	3
10316	AM	1	1	0	0
	IP	1	1	2	2
	PM	1	1	1	1

St Clears

The area of St Clears is comprised of three zones, as shown in Figure 4. All three zones represent distinct geographic areas within the model.

Each zone is connected to the highway network with a single zone connector. These connectors allow highway traffic to and from the zone to access the network at the most appropriate point based on the land use within the zone. Each zone is also connected to bus stop(s) within a 400m radius of the zone centroid via walk connectors.

The proposed St Clears Tenby Road site (formally Site 17) falls within the geographical boundary of two zones in the SWMWTM, which are 10236 and 10238.

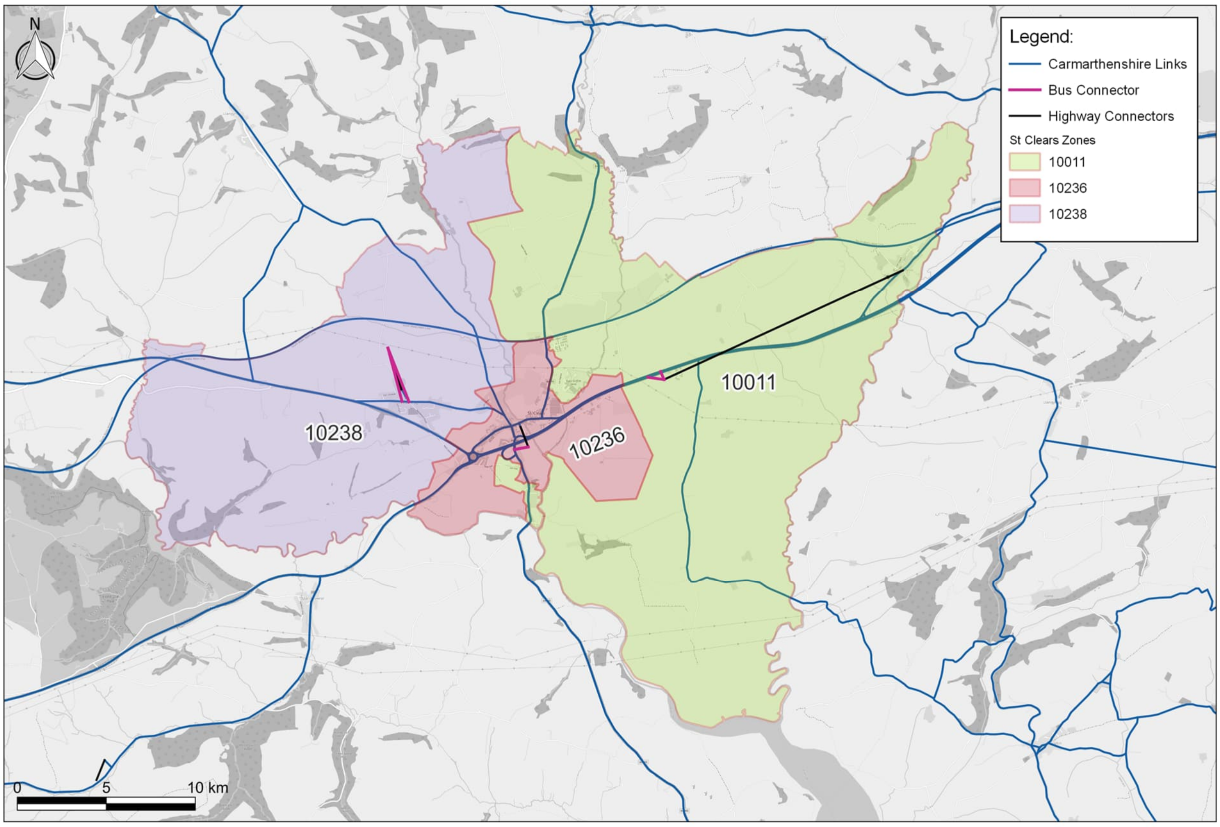

Figure 4 – Zones in and around St Clears

The base year trip ends at each of the zones shown in Figure 4 are shown in. The average trip length for car trips to and from each of the zones in St Clears in the 2019 base year is 20km, and for public transport trips is 26km. Analysis of desire lines shows the majority of car travel demand occurs between the zones in Figure 4 but there is also notable (relative to the trip end totals shown in Table 2) travel demand between St Clears and Carmarthen. The public transport desire lines show a similar pattern.

Table 2 - 2019 Car and PT trip ends within St Clears

Zone	Time Period	Car Origins	Car Destinations	PT Origins	PT Destinations
10011	AM	243	153	4	4
	IP	145	141	7	15
	PM	164	188	4	7
10236	AM	160	144	3	5
	IP	126	115	6	9
	PM	154	140	4	5
10238	AM	104	60	4	2
	IP	70	64	4	4
	PM	66	87	1	3

Recommendations

It is recommended that the zone connectors for existing zones in St Clears are reviewed during forecasting to add relevant walk to rail zone connectors for the proposed reopening of the St Clears train station[3] in 2024.

It is proposed that, to undertake the impact analysis of the proposed hospital sites, development zones are added to the model to enable better representation of access points for the development. Where a development zone is added, it will take relevant attributes from its parent zone, which will be defined as the geographic zone that the majority of the development site is located within.

Finally, any analysis on the base model, or forecasts, will need to consider the limitations of the local demand, and travel patterns, and its development from largely synthetic data sources.

[3] https://tfw.wales/projects/metro/swansea-bay-metro/work-early-development

HIGHWAY ASSIGNMENT MODEL

This section reviews the existing network definition within the area of focus in the 2019 base year of the SWMWTM. The review considers the highway network, and public transport network assumptions in the model.

Highway Coverage

The model has a good general representation of the highway network around Whitland and St Clears, which is shown below in Figure 5. For the model to better reflect the actual road network in the study area some changes are needed including changes to the number of lanes and adjustments to the free flow speeds along links, which will represent the study area for detailed analysis.

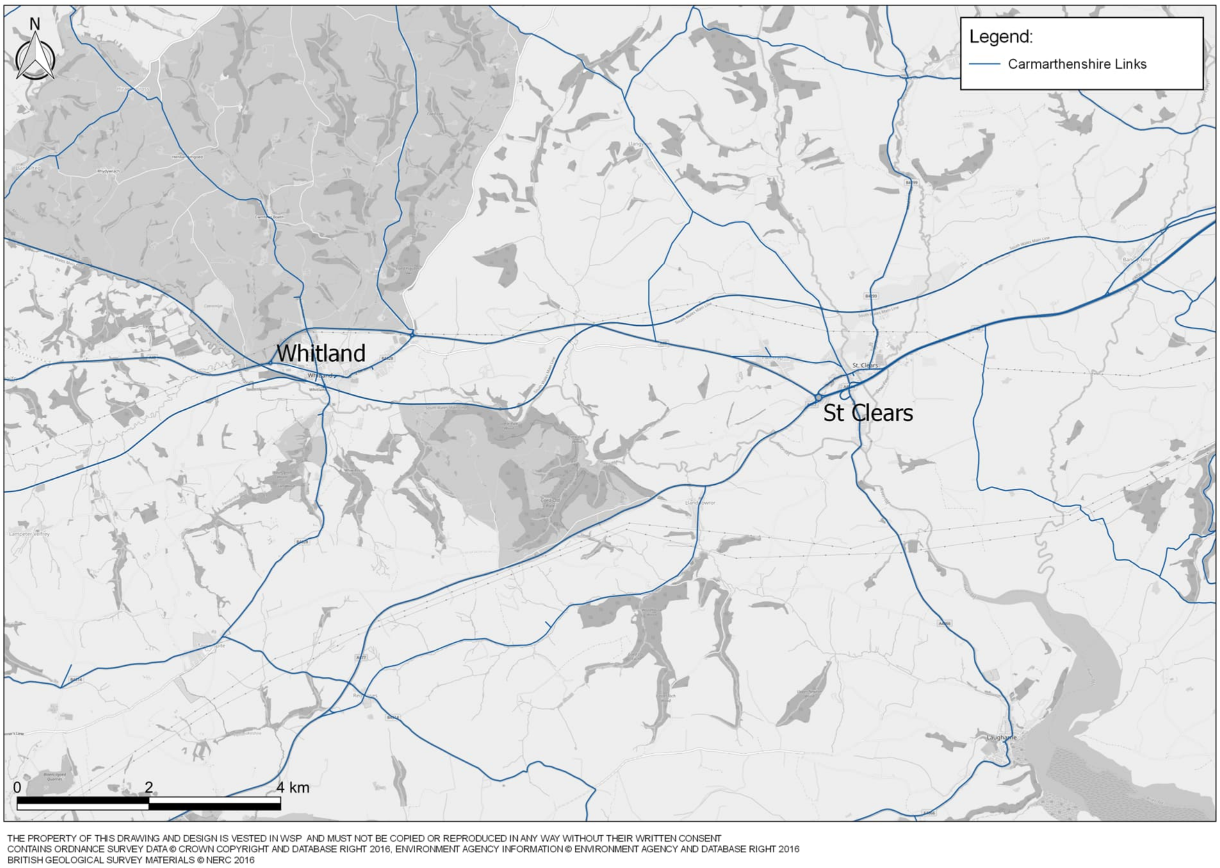

Figure 5 - A plot of the model in the area around and within Whitland and St Clears

The network coverage around Whitland and St Clears is generally very good with all the major roads included in the network. But an additional link should be added to the network so access to the nearby village of Llanboidy is better reflected in the model.

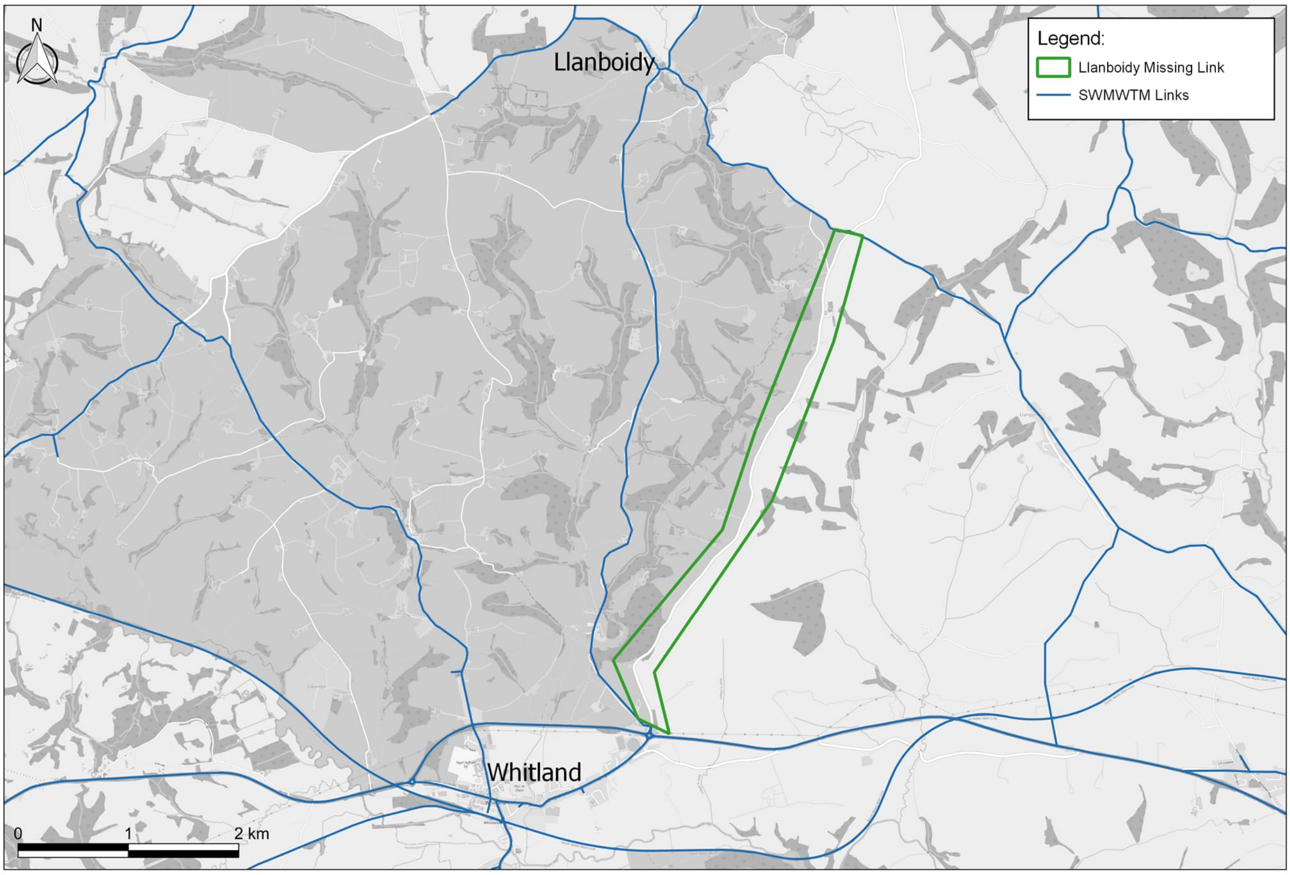

Figure 6 - The model network between Whitland and Llanboidy

Figure 6 shows that a single lane track connecting Whitland to Llanboidy which is present in the model. Traffic between Whitland and Llanboidy in reality is directed along the parallel route to the East which is not present in the model. The model will be refined to include this parallel route and join the road in the North connecting Llanboidy and St Clears (which will be split to accommodate this). The proposed amended network structure is given in Figure 7.

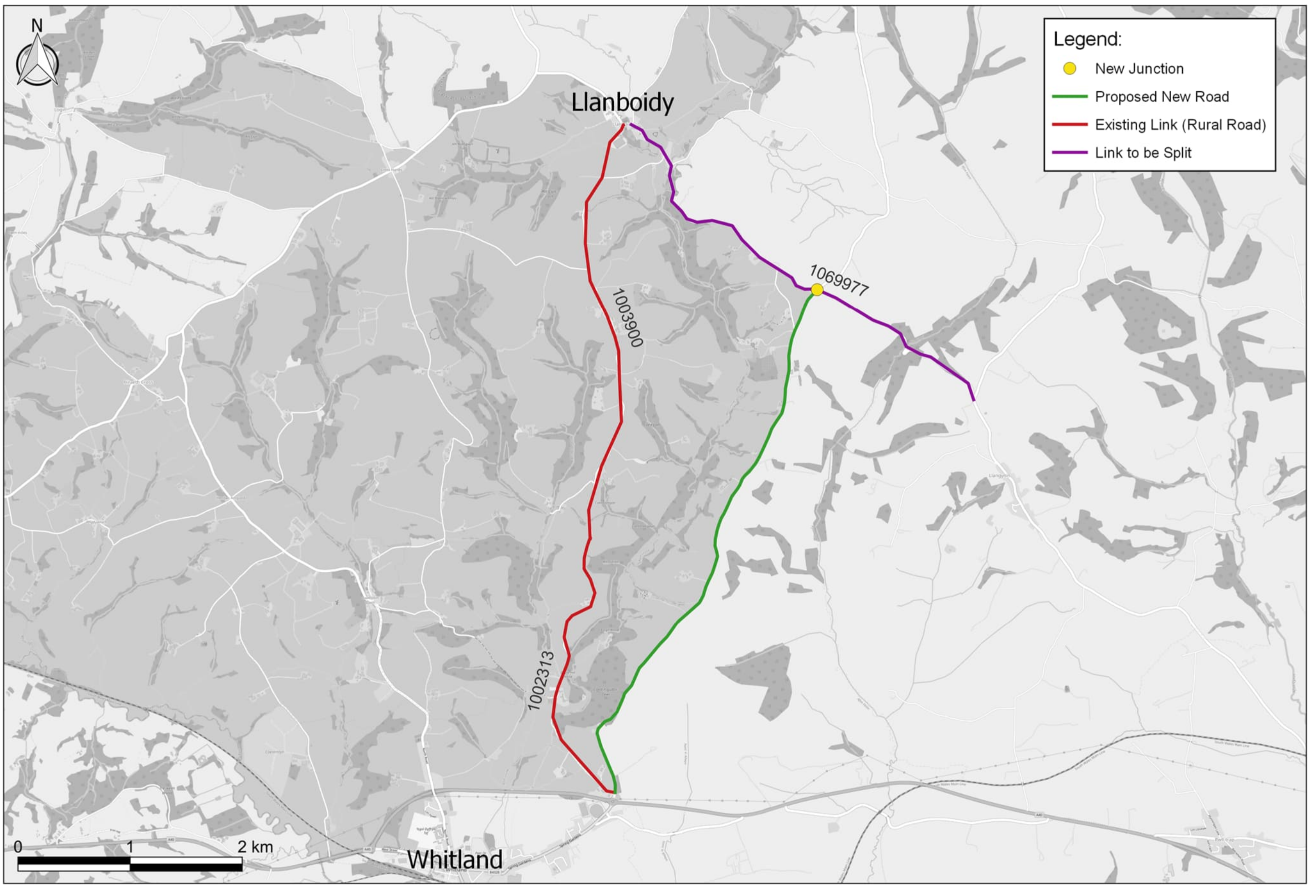

Figure 7 - Llanboidy Road which to be added to the SWMWTM highway network, connecting Whitland to Llanboidy

Proposed Highway Link Changes

A review of the highway network has been undertaken. Overall, the coverage and detail in the highway network is good and suggests the model is suitable to support an assessment of the proposed sites. Several small refinements have been identified as being necessary in the vicinity of the proposed sites. These are summarised in the following section.

- Links 1301135, 1301134 on the A40
  Currently these two links are set as two-lane roads in both directions whereas they should be coded as a single lane traveling eastbound and 2 lanes traveling westbound Figure 8
- Links 301133, 1301132
  Currently set as two lanes in both directions but should be single in both directions see Figure 8
- Links 1000088
  Currently set to a single lane in both directions but should be two lanes westbound and a single lane eastbound seen in Figure 8
- Links 1001956, 1001957, 1001978, 1009037, 1009036
  Westbound direction currently set as single lane but needs to be set as two lanes shown below in Figure 8.

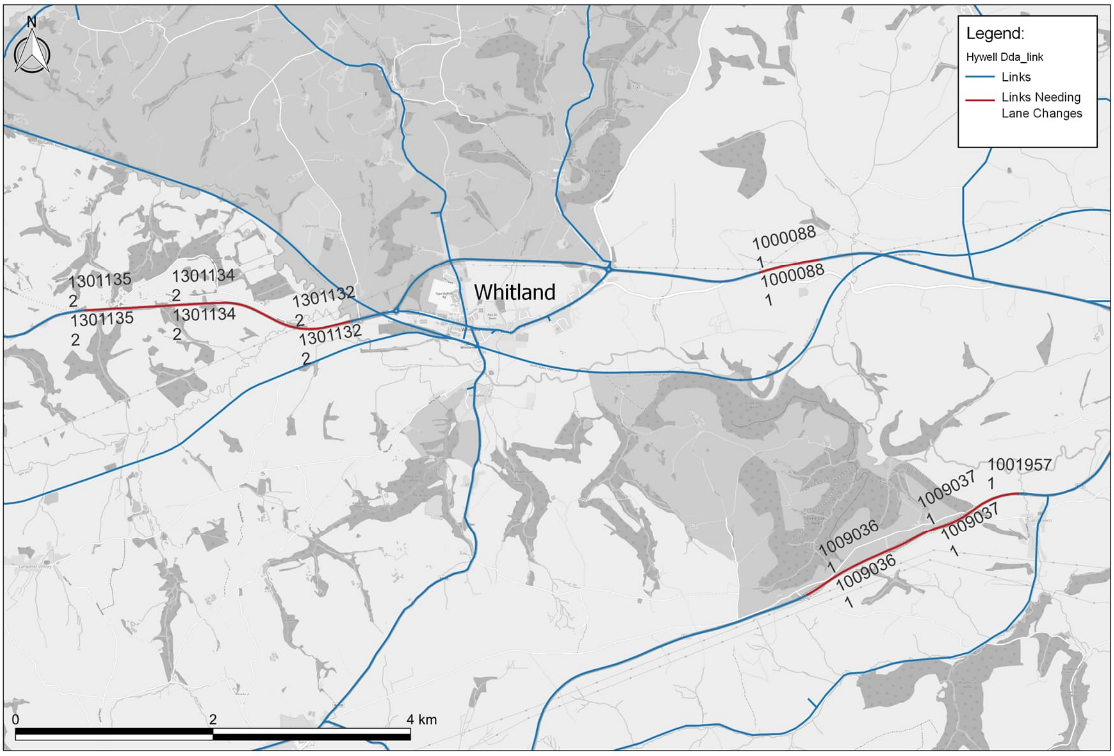

Figure 8 - Links in the network where the number of lanes require adjustment

Proposed Highway Link Speed Changes

The following links are all shown below in Figure 9 which shows the modelled network and the node number and free flow speed for the links discussed below.

- Link 1000087
  Speed currently set to 83km/h, should be at the national speed limit 96 km/h (60 mph).
- Links 1001151, 1001152, 1001153, 1001154,1009039, 1009038
  Speeds currently set to 70 km/h (and on link 1009038 it is set to 64 km/h) but they should be set to 96 km/h
- Links 1001289, 1001954, 1001955
  Speeds are currently set to 96 km/h, but they should be set to 64 km/h.
- Links 1003243, 1003244, 1002313
  Free flow speed should be increased to the national speed limit.
- Links 1002138, 1002137
  Free flow speed set to 96km/h but needs reducing to 50km/h.
- Links 1000176, 1002034
  Speed set to 50km/h but should be reduced to 30km/h.
- Link 1003891
  There is a change of speed limit between 30 mph and national speed limit along the link, to better reflect this the link should be split and the free flow speeds updated. This can be achieved by adjusting both links 1003891 and 1005930 position so that they end where the speed limit change occurs.
- Links: 1003265, 1003790
  Both links are currently set with speeds of 64 km/h.
  For link 1003790 this should be set to 96 km/h the change in speed limit occurs part way along 1003265.

![wsp logo]

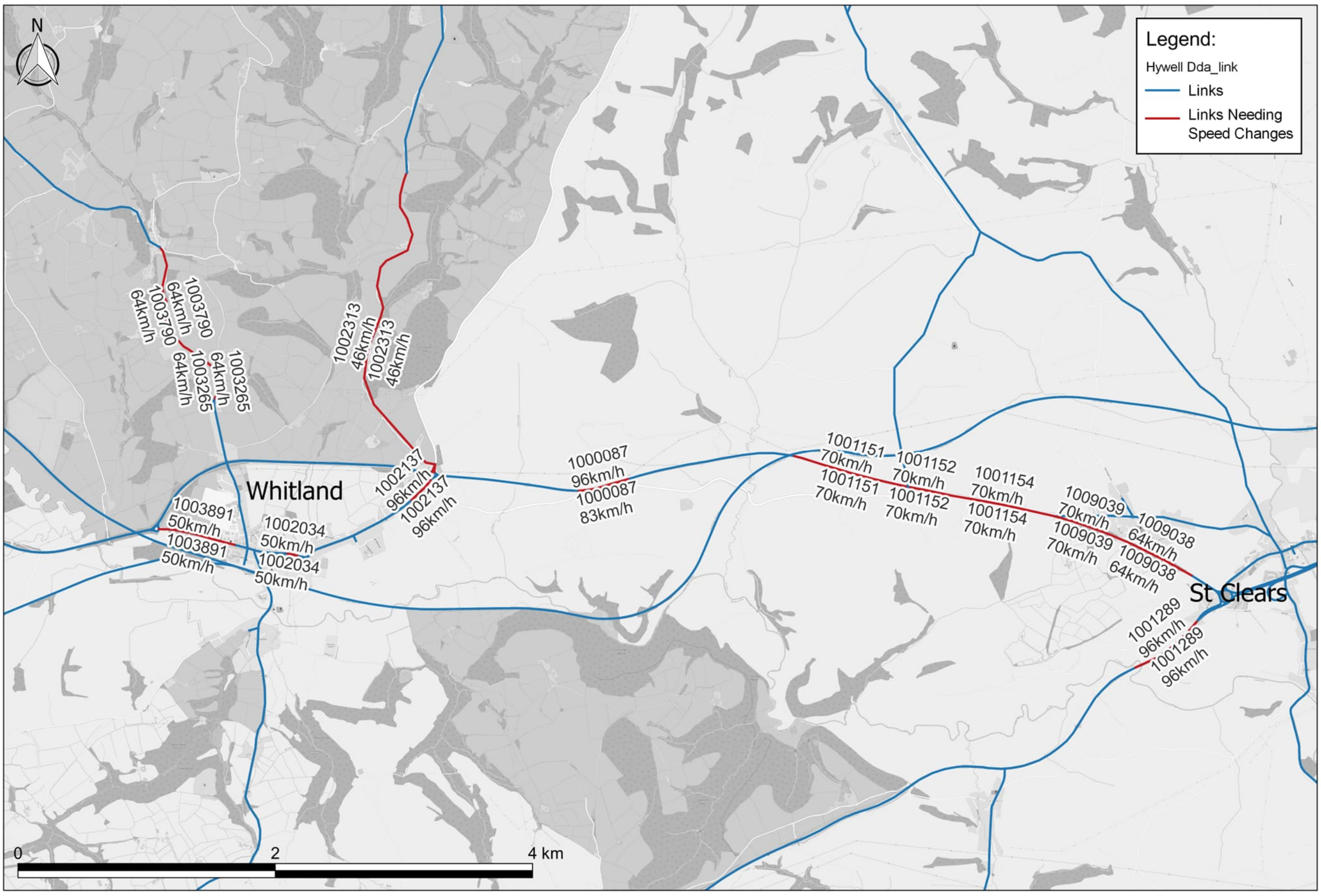

Figure 9 - Links where speeds do not match the speed limit

The review of highway network in the area shows the network is generally accurate, detailed and suitable for modelling around the proposed sites. Some small changes to the existing network are needed, which include adding in link to the network and updating the number of lanes and the free flow speed on a small number of links to represent the current ground conditions. For the development sites, network might be required to provide suitable accesses.

Highway Model Calibration/Validation

This section reviews the available data, in the study area, used the calibrate and validate the 2019 base year SWMWTM. Two types of counts are present, calibration and validation counts. Calibration is used to develop and refine the model. Validation is an independent dataset used to assess the quality of the model. The review considered available highway traffic link counts, highway traffic turning counts, highway journey times, and public transport passenger counts.

The comparisons between observed and modelled data makes use of a calculated value called the GEH value. The GEH value is used for comparing flows of different scales since it is similar to a chi-squared test. The formula used to calculate the GEH values is shown below in Equation 1.

Equation 1 - GEH Value Formula

$$GEH = \sqrt{\frac{2(M - C)^2}{M + C}}$$

Whereby: M is the modelled hourly traffic count

C is the observed hourly traffic count

HIGHWAY SCREENLINES

Screenlines are typically used to assess the quality of the underlying demand data in the model and its ability to represent observed traffic flows once the effects of reassignment are excluded. There are no screenlines present in Whitland or St Clears study area, the nearest screenlines are found in Carmarthen and in Pembroke. Therefore, it has not been possible to assess the quality of the underlying demand within the area of focus. However, calibration and validation checks at individual link level is reported in the following section.

HIGHWAY COUNT DATA

In the area around Whitland and St Clears there are a series of count sites shown in Figure 10. The count locations around Whitland have been used in calibrating the base year highway model while count locations around St Clears been used for validating the model (see Figure 10).

Figure 10 - Count locations around Whitland and St Clears in the highway model

Two sets of criteria have been used during this review for determining the quality of the model. These criteria have been taken from TAG Unit M3.1 are shown below in Table 3.

Table 3 - Link flow acceptability criteria

Measure	TAG Criteria
GEH	≤ 5
Observed flow ≤ 700 veh/h	Flow difference ≤ 100 veh/h
700 veh/h < Observed flow < 2700 veh/h	Flow difference ≤ 15%
Observed flow ≥ 2700	Flow difference ≤ 400 veh/h

Table 4 and Table 5 show the observed and modelled values for the calibration and validation links in Whitland and St Clears. Most of the sites have an observed flow of less than 700 veh/h with the exception of the A40 link East of St Clears in the AM and PM peaks. All links pass at least the GEH criteria and most pass both the GEH and link flow criteria. The model is therefore considered to be an adequate representation of current conditions across the area of focus.

Table 4 - Whitland and St Clears SWMWTM calibration links observed and modelled values

Road Name	Count Location No	Count ID	AM				IP				PM			
			Observed	Modelled	GEH	Difference	Observed	Modelled	GEH	Difference	Observed	Modelled	GEH	Difference
North Road	744	ATC Site 164	54	61	0.93	7	26	30	0.78	4	28	34	0.95	6
	749	ATC Site 164	19	25	1.21	6	26	30	0.74	4	40	45	0.71	5
B4328	742	ATC Site 949	83	88	0.56	5	35	43	1.23	8	46	56	1.35	10
	747	ATC Site 949	72	81	1.00	9	33	42	1.53	9	41	49	1.09	8
A40 West of Whitland	743	ATC Whitland Spring Gardens92	552	503	2.15	-49	413	414	0.05	1	476	456	0.95	-20
	748	ATC Whitland Spring Gardens92	582	529	2.26	-53	369	350	0.97	-19	489	453	1.68	-36

Table 5 - Whitland and St Clears SWMWTM validation links observed and modelled values

Road Name	Count Location No	Count ID	AM				IP				PM			
			Observed	Modelled	GEH	Difference	Observed	Modelled	GEH	Difference	Observed	Modelled	GEH	Difference
A40 West of St Clears	979	ATC Site 260_1	555	557	0.07	2	437	442	0.24	5	551	467	3.74	-84
	980	ATC Site 260_2	577	504	3.17	-73	390	365	1.29	-25	505	490	0.67	-15
A40 St Clears	1025	ATC Site 341_1	841	989	4.90	18%	680	790	4.07	110	685	775	3.31	90
	1026	ATC Site 341_2	704	794	3.29	11%	595	658	2.51	63	768	886	4.10	15%
A4066	1087	ATC Site 636_1	114	126	1.07	12	83	85	0.24	2	70	96	2.89	26
	1088	ATC Site 636_2	94	81	1.39	-13	83	76	0.71	-7	105	108	0.33	3
B4299	1095	ATC Site 644_1	35	47	1.91	12	33	36	0.42	3	52	47	0.70	-5
	1096	ATC Site 644_2	78	54	2.87	-24	34	36	0.36	2	41	51	1.45	10
A477	894	ATC Whitland Spring Gardens84_1	479	424	2.55	-55	328	350	1.18	22	307	339	1.77	32
	895	ATC Whitland Spring Gardens84_2	299	332	1.84	33	281	308	1.56	27	413	410	0.16	-3

HIGHWAY JOURNEY TIMES

Modelled journey times in the base year highway model were validated against observed data, including on the A40 between Carmarthen and Haverford West, and on the A40 passing through Whitland and St Clears, see Figure 11. The journey time route is made up of 6 sections, two of the sections are part of the area of focus, these are sections 3 and 4.

The criterion used to validate the model journey times is summarised below in Table 6.

Table 6 - Journey time validation criteria

Criteria	Acceptability guideline
Modelled time along **routes** should be within 15% of surveyed times (or 1 minute, if higher)	85% of routes
Modelled time along **segments** should be within 15% of surveyed times (or 1 minute, if higher)	85% of routes

The results for the eastbound and westbound journey time routes are shown in Table 7 and Table 8 respectively. All of the sections individually also pass the criteria set out in Table 6 above. Most of the sections have a percentage difference of less than 15% including sections 3 and 4. For those sections where the percentage difference is greater than 15%, these also pass since the time difference is less than 1 minute (60s).

The journey time results provide some confidence that conditions within the area of focus are represented in the model, however it is not possible to discern whether conditions are recreated accurately at the individual junction level due to the relatively coarse nature of the original analysis (i.e. 28km of road represented by only two timings points).

Table 7 – Journey time for route 23 A40: Carmarthen – Haverford West eastbound

ID	Section No	A Node	B Node	Distance		AM Assigned				IP Assigned				PM Assigned				Free Flow	
				Observed (m)	Modelled (m)	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time (s)
163	1	101016	101550	680	800	78	60	-18	-23%	79	61	-18	-23%	83	64	-19	-23%	44	39
164	2	101127	101016	1932	1886	108	157	49	45%	109	90	-19	-17%	101	90	-11	-11%	88	85
165	3	102595	101127	13216	12086	492	493	1	0%	502	487	-15	-3%	487	486	-1	0%	484	481
166	4	131734	102595	15510	16113	762	789	27	4%	785	767	-18	-2%	764	767	3	0%	699	698
167	5	131030	131734	5865	5360	293	272	-21	-7%	304	265	-39	-13%	292	272	-20	-7%	274	236
168	6	131708	131030	11082	11057	517	487	-30	-6%	561	484	-77	-14%	525	517	-8	-2%	486	429
23	**A40: Carmarthen – Haverford West EB**			**48285**	**47302**	**2250**	**2258**	8	0%	**2340**	**2154**	-186	-8%	**2252**	**2196**	-56	-2%	**2075**	**1968**

Table 8 - Journey time for route 23 A40: Carmarthen – Haverford West westbound

ID	Section No	A Node	B Node	Distance		AM Assigned				IP Assigned				PM Assigned				Free Flow	
				Observed (m)	Modelled (m)	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time(s)	Absolute Difference	Percentage Difference	Observed Time (s)	Modelled Time (s)
157	1	101014	101739	710	704	61	49	-12	-20%	50	46	-4	-8%	58	47	-11	-19%	44	42
158	2	101739	101768	2005	1977	88	90	2	2%	84	90	6	7%	89	91	2	2%	84	89
159	3	101768	100997	11883	11962	432	472	40	9%	431	470	39	9%	425	474	49	12%	427	468
160	4	100997	130139	15558	16240	741	785	44	6%	744	753	9	1%	728	770	42	6%	679	710
161	5	130139	130904	5864	5359	311	296	-15	-5%	312	275	-37	-12%	303	284	-19	-6%	278	249
162	6	130904	131733	11089	11123	535	551	16	3%	564	485	-79	-14%	525	506	-19	-4%	488	443
23	**A40: Carmarthen – Haverford West WB**			**47109**	**47365**	**2168**	**2243**	75	3%	**2185**	**2119**	-66	-3%	**2128**	**2172**	44	2%	**2000**	**2001**

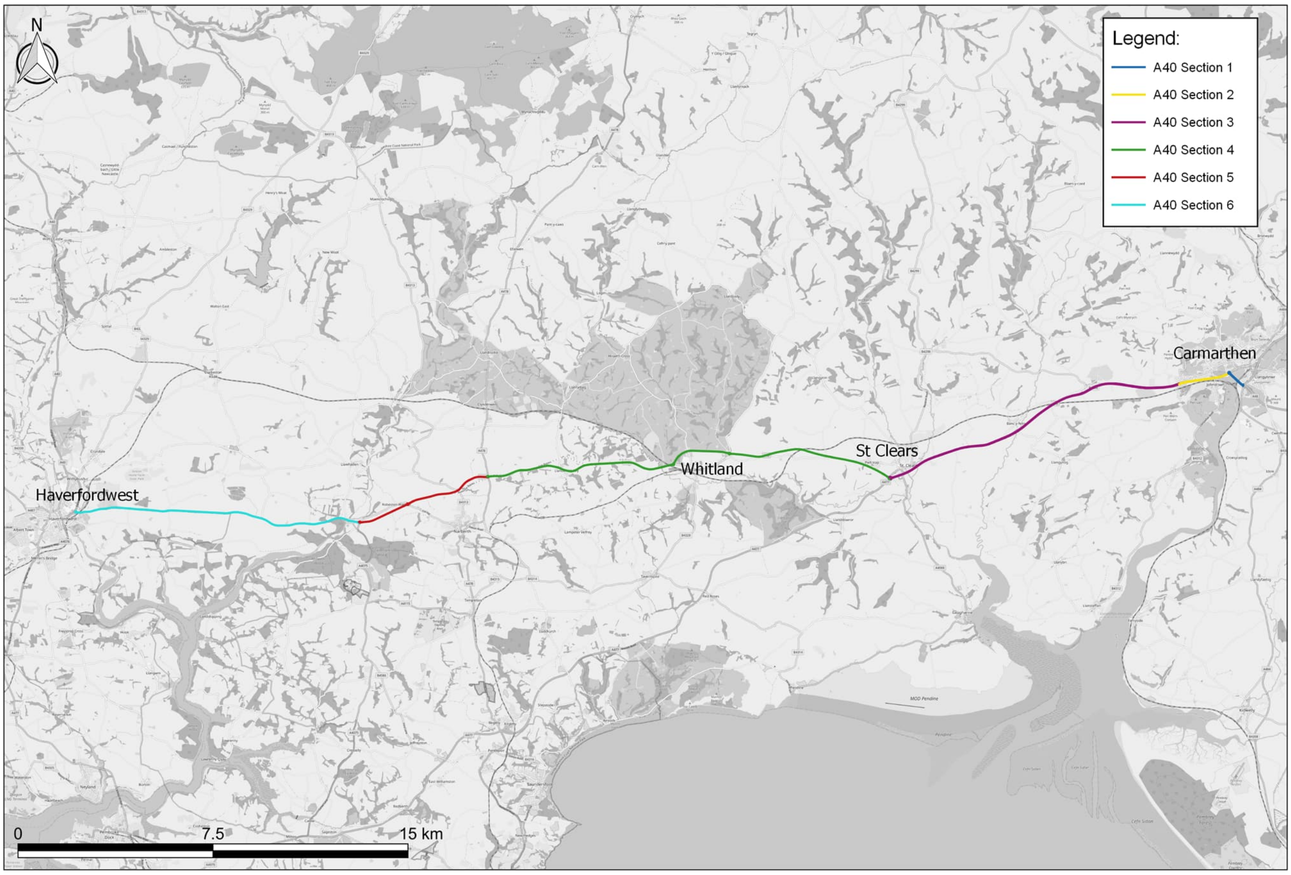

Figure 11 – A40 Journey time route sections in SWMWTM

HIGHWAY TURNING FLOWS

Due to their proximity to the proposed development sites two of the roundabouts along the A40 have been identified for their importance on how the developments will impact them. The first of these is located on the South West edge of St Clears, where the A40 meets the A477, this is shown in Figure 12. The second roundabout is located in Whitland on the North East side where the A40 meets the B4328, and is shown in Figure 13.

Observed data was collected on 16-18 May 2023. A comparison between observed and modelled flows is shown in Table 9 and Table 10. Note that the model base year is 2019 and the observed data was collected in 2023, therefore some differences are expected.

Figure 12 – Junction arms of roundabout in St Clears where the A40 and A477 meet.

Junction Arms A – Tenby Road, B – A40 East, C – A477, D – A40 West

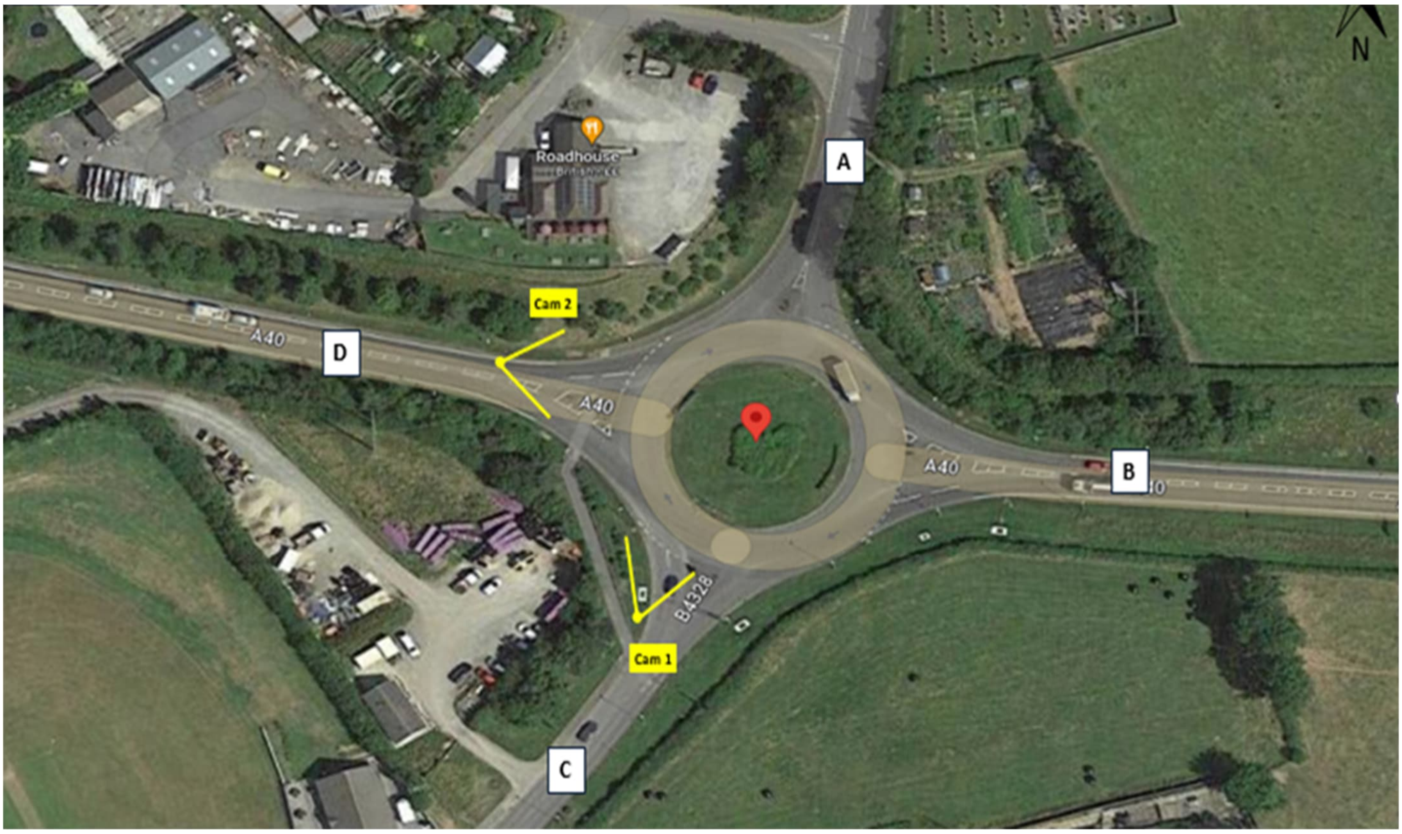

Figure 13 - Junction arms of roundabout in Whitland where the A40 meets the B4328.
Junction Arms A – Unnamed Rural Road, B – A40 East, C B4328, D – A40 West.

Table 9 - Comparison of flows for the Whitland roundabout where the A40 meets the A477.

		Out of junction									
		A		B		C		D		Total	
		Obs	Mod	Obs	Mod	Obs	Mod	Obs	Mod	Obs	Mod
	AM										
Into junction	A	1	-	75	0	100	45	138	39	314	84
	B	74	0	5	-	308	360	415	449	802	809
	C	127	39	375	482	0	-	17	1	519	522
	D	102	38	404	507	17	0	0	-	523	545
	Total	304	77	859	989	425	405	570	489	2158	1960
	PM										
Into junction	A	0	0	56	0	86	44	97	32	239	76
	B	46	0	5	0	404	440	373	446	828	886
	C	116	40	360	362	0	0	16	4	492	406
	D	104	36	426	413	17	0	0	0	547	449
	Total	266	76	847	775	507	484	486	482	2106	1817

Note: AM 0800-0900; PM 1700-1800

Table 10 – Comparison of flows for the Whitland roundabout where the A40 meets the B4328.

		Out of junction									
		A		B		C		D		Total	
		Obs	Mod	Obs	Mod	Obs	Mod	Obs	Mod	Obs	Mod
	AM										
Into junction	A	0	-	16	0	41	36	11	127	68	163
	B	9	-	1	-	167	26	414	428	591	454
	C	25	34	141	25	1	-	10	0	177	59
	D	6	67	365	441	4	0	0	-	375	508
	Total	40	101	523	466	213	62	435	555	1211	1184
	PM										
Into junction	A	0	-	7	0	26	31	7	89	40	120
	B	14	0	0	-	135	30	343	375	492	405
	C	41	31	130	24	1	-	9	0	181	55
	D	17	108	419	380	10	0	0	-	446	488
	Total	72	139	556	404	172	61	359	464	1159	1068

Note: AM 0800-0900; PM 1700-1800

The flow difference between the observed and the modelled are considered reasonable for a strategic model. There appears to be strong correlation for the A road arms between observed and modelled flows but with larger relative differences for turns from or into minor road arms. The above differences are noted and will be accounted for during future scenario tests; care will be taken not be utilise turning flows directly from the model.

PUBLIC TRANSPORT MODEL

Public Transport Network

The public transport model uses the same network structure as the highway model, with the addition of bus and rail stops. The stops included in the model have been compared with the locations of stops taken from the National Transport Access Nodes (NaPTAN) database, a database available on the Department for Transport website[4]. Figure 14, Figure 15 and Figure 16 below show plots of the public transport stops in Whitland, St Clears and the surrounding area. The plots use circular markers to represent bus stops and triangular markers for the rail stops. Marker locations are approximate due to offsets being applied to ensure adjacent markers in close proximity are clearly visible.

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https://www.data.gov.uk/dataset/ff93ffc1-6656-47d8-9155-85ea0b8f2251/national-public-transport-access-nodes-naptan[4]

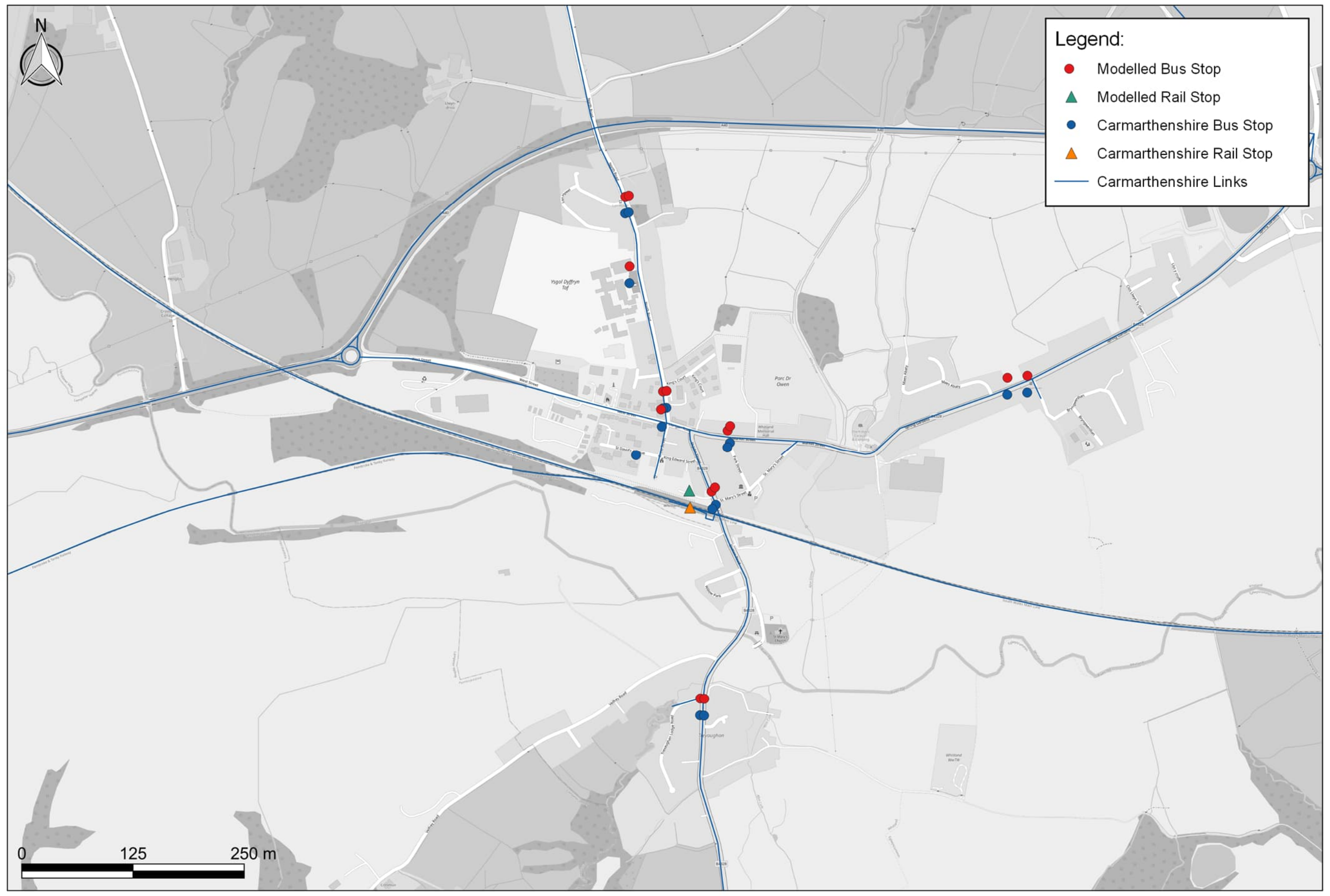

Figure 14 - A comparrison of Whitland public transport stops from the model and NapTAN

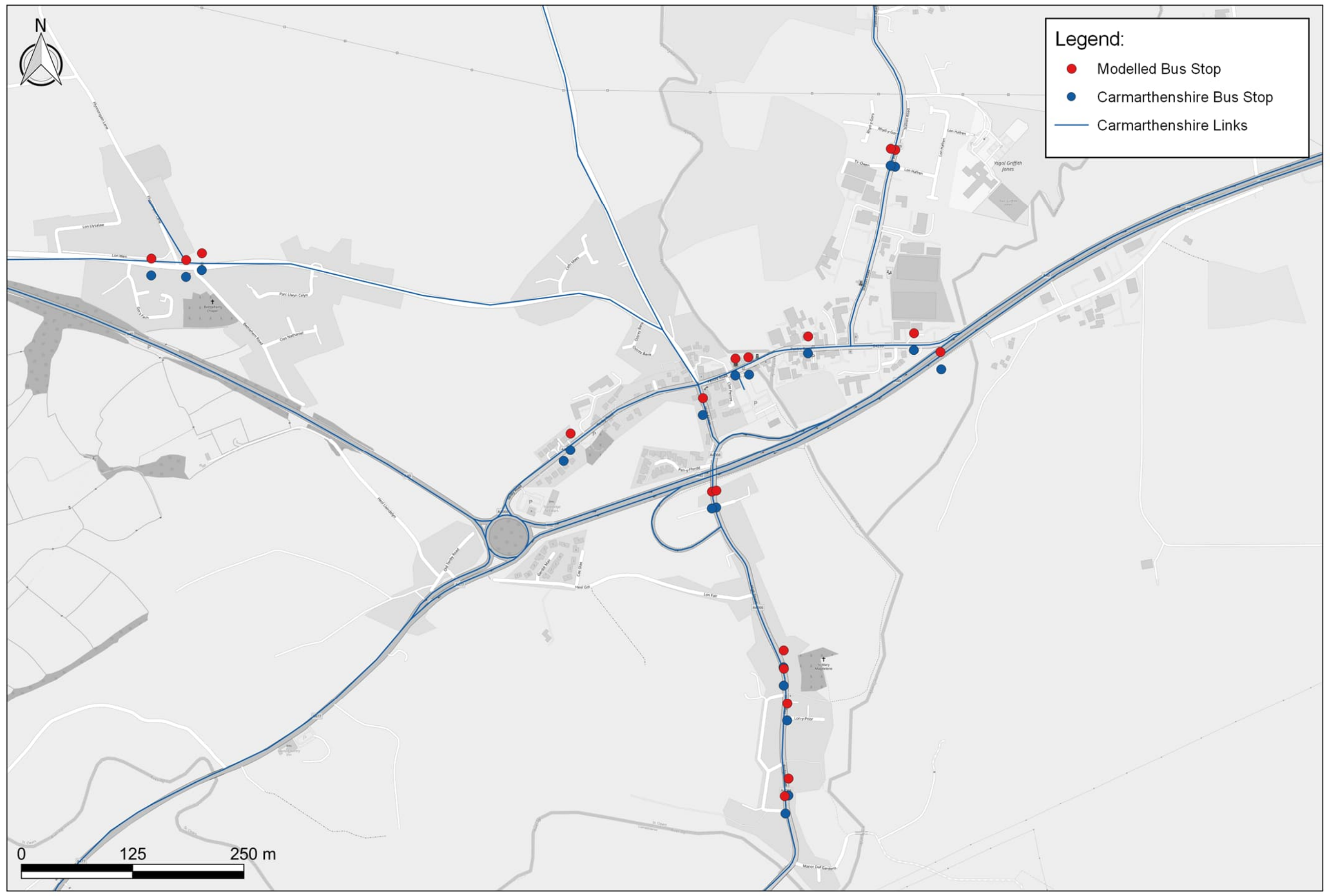

Figure 15 - A comparison of St Clears public transport stops from the model and NapTAN

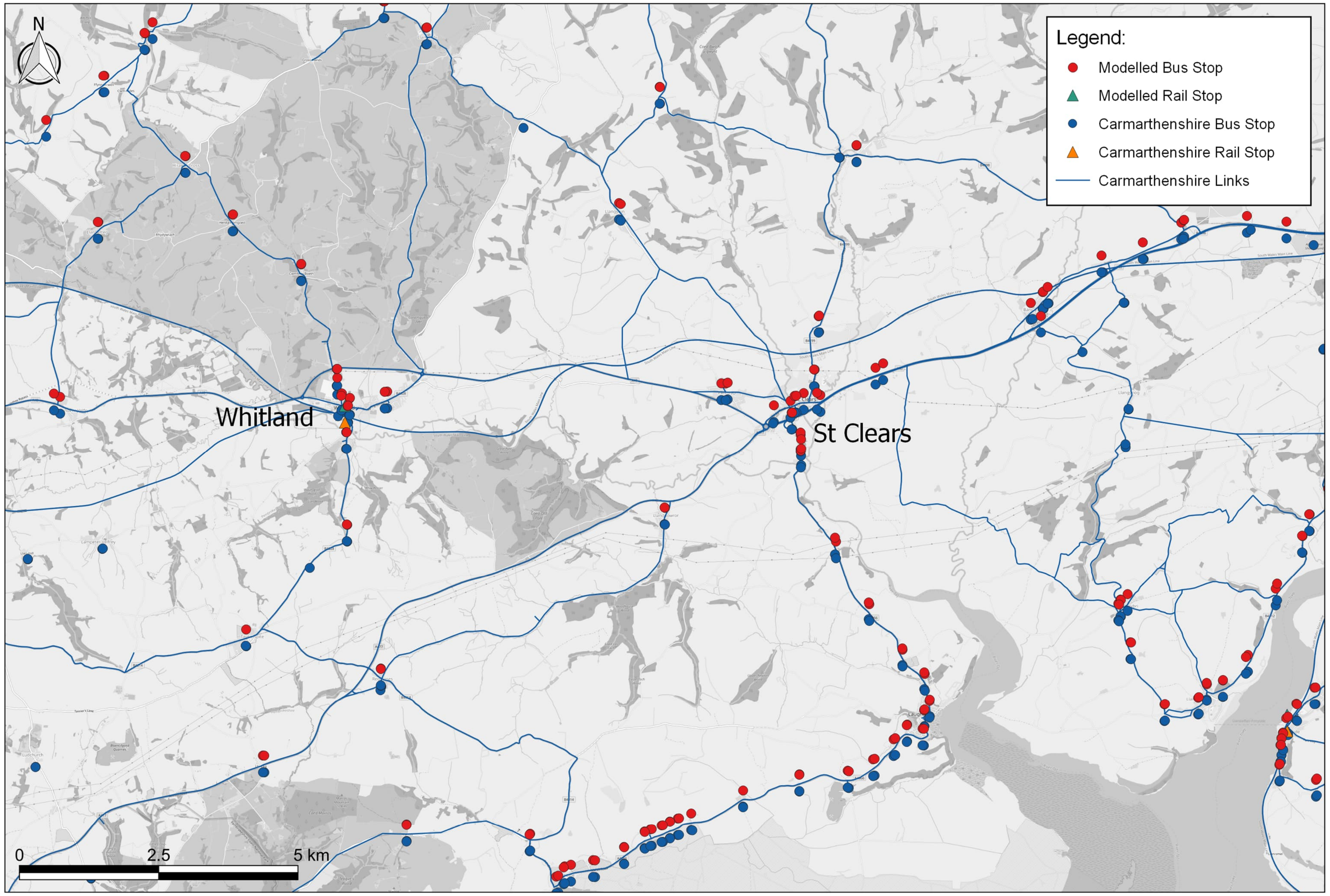

Figure 16 - A comparrison of the area surrounding Whitland and St Clears public transport stops from the model and NapTAN

Figure 14, Figure 15 and Figure 16 show that most bus and all current rail stops are accurately represented in the model. Bus stops have been omitted only where the corresponding network is not in the model and only for stops that are remote from Whitland and St Clears. No changes to the number of the bus stops in the model is proposed. Whitland rail station is the only rail station in the area of focus.

The review of public transport routes in the model has been limited to those which pass through the AoF. There are opportunities for transfers onto these services from other services outside the AoF, which have not been reviewed. But the number of passengers making these transfers is likely to be small and therefore it was not considered to be proportionate to undertake a wider review (and update) of the model.

The bus routes in the AoF are based on the 2019 timetable, and there are currently five different bus services that operate in Whitland and St Clears, which are: 221, 222, 223, 224 and 322. Bus routes have been reviewed and are considered to be accurate when compared to current (2023) bus routeing. Departure times, and the stops served, do not exactly align with current timetables. There are 53 train services that stop at Whitland and, whilst these have the correct stopping patterns, most have different departure and arrival times when compared to 2023 timetable.

It is not proposed to make any updates to the base year public transport timetables in the model. It is considered disproportionate to do so, given the likely small mode share of public transport in the AoF. Similarly, incorporating 2023 timetable data into a small sub-area of the PTAM would introduce a risk that connectivity across the wider model would be impacted as updated arrival and departure times would not align with unchanged timings on services operating outside of the AoF.

It is noted that the planned St Clear Railway station is not represented in the current base and forecast model networks. Re-opening of this new station is due in 2024[5]. The planned station and accompanying services will need to be coded into the forecast networks as part of this study. The updated rail services timetables will likely be required for updating the forecast models although assumptions can be made using existing services if this data is not available.

Public Transport Model Calibration/Validation

The criteria used to assess the public transport links and screenlines individually is summarised below in Table 11.

[5] https://tfw.wales/projects/metro/swansea-bay-metro/work-early-development

Table 11 - Public Transport count validation criteria

Criteria	Description of criteria	Acceptability Guideline
Individual Screenlines	Modelled flows should be within 15% of counts	All or nearly all screenlines (interpreted as > 85%)
Individual Links	Modelled flows should be within 25% of counts, except where observed hourly flows are particularly low (less than 150 passengers per hour). TAG does not prescribe criteria for passenger flows under 150 per hour.	> 85% of links

PUBLIC TRANSPORT SCREENLINES

A review of screenlines in the area of focus was undertaken. The only screenline located within the area was the Whitland rail screenline, as shown in Figure 17. The screenline shown crosses two rail lines: the Pembroke and Tenby line, and the South Wales Main Line. These fork apart just west of Whitland with one heading northwest and the other southwest.

The comparison of observed and modelled screenline passenger flows are shown in Figure 12. To pass TAG criteria the individual screenlines need a percentage difference of less than 15%. The eastbound screenline only does not pass in any of the periods but, the westbound screenline passes in the IP and PM periods but fails in the AM peak with a very high percentage difference of 182%.

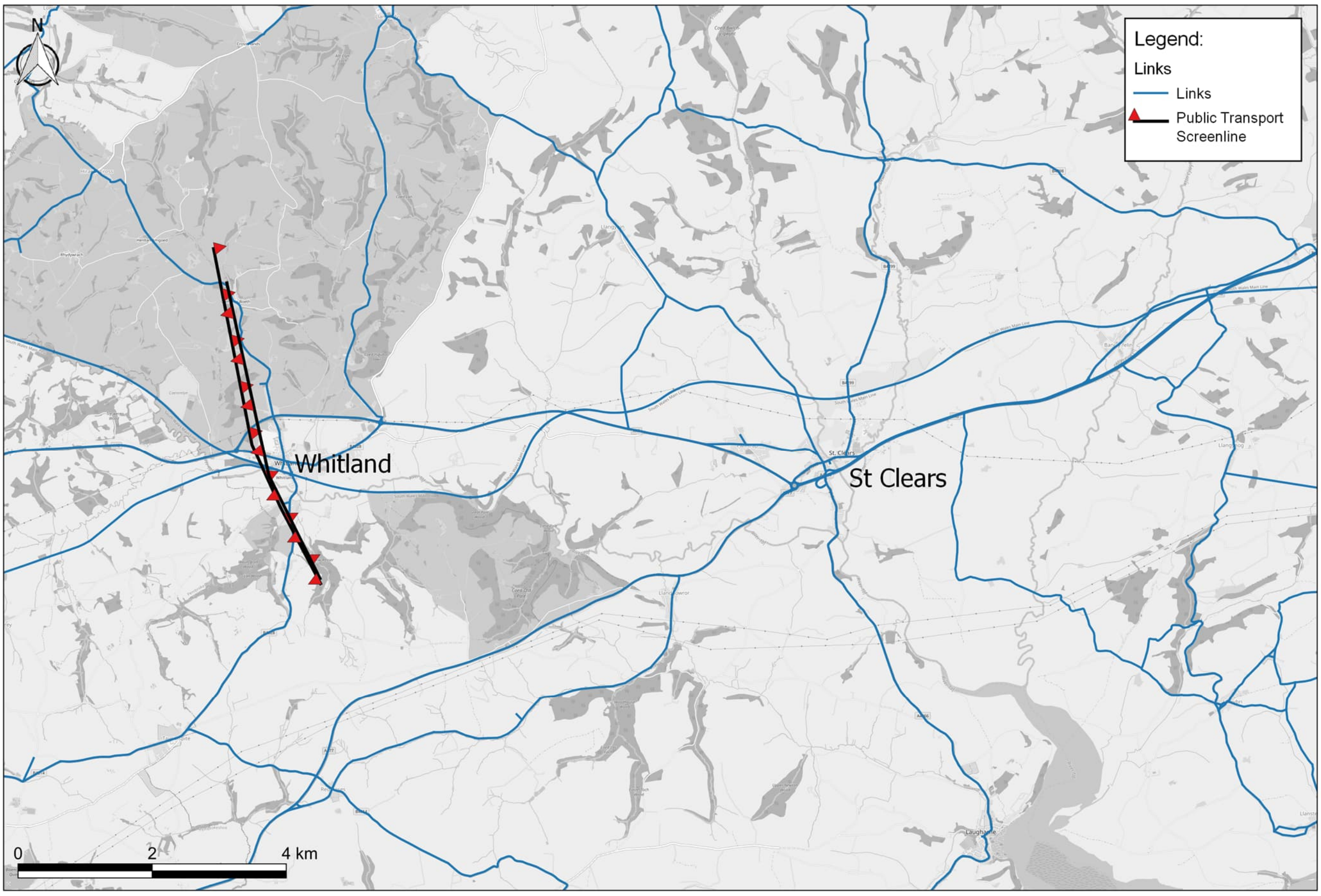

Figure 17 - Whitland Screenline in the PT Model

Table 12 – Carmarthenshire screenlines

Name	AM				IP				PM			
	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH	Obs	Mod	% Diff	GEH
Rail Screenline CMR EB	171	268	57%	6.5	157	209	33%	3.8	153	180	18%	2.1
Rail Screenline CMR WB	60	169	182%	10.2	166	179	8%	1.0	159	152	-4%	0.6

PUBLIC TRANSPORT LINK FLOWS

Table 13 shows the observed and modelled counts for the rail links from Whitland station. The observed values are all lower than 150 and as such TAG provides no threshold for acceptability. Percentage and absolute differences between modelled and observed passenger flows are nonetheless shown in Table 13. Overall, there is a mixture of percentage and absolute differences percentage differences which are sometimes large. However only two GEH values are above 5. Given that there is no acceptability threshold defined by TAG, these differences are simply noted and no corrective action is proposed.

Table 13 – Observed and modelled counts along the links around Whitland station

Link Name	Link No	Observed	Modelled	Diff	%	GEH
AM						
Narbeth to Whitland	6458	75	73	-2	-3%	0.2
Whitland To Narbeth	6458	31	55	24	44%	3.7
Clunderwen to Whitland	6462	96	195	99	51%	8.2
Whitland To Clunderwen	6462	29	114	85	75%	10.1
IP						
Narbeth to Whitland	6458	56	56	0	0%	0.0
Whitland To Narbeth	6458	54	66	12	18%	1.5
Clunderwen to Whitland	6462	101	153	52	34%	4.6
Whitland To Clunderwen	6462	112	113	1	1%	0.1
PM						
Narbeth to Whitland	6458	68	66	-2	-3%	0.2
Whitland To Narbeth	6458	71	56	-15	-27%	1.9
Clunderwen to Whitland	6462	85	114	29	25%	2.9
Whitland To Clunderwen	6462	88	96	8	8%	0.8

There is some variability between the observed and the modelled data with some having quite small differences and others having very large differences.

PUBLIC TRANSPORT BOARDING AND ALIGHTING

Boarding and alighting data at Whitland rail station has been used in the SWMWTM development. There was no calibration or validation data for bus passengers in the area of focus.

The passengers boarding and alighting at Whitland station are presented in Table 14 below. The values presented do not meet the TAG criteria for comparison, stated in Table 11. While the percentage differences are large, generally exceeding 25% however the low GEH values demonstrate that the absolute differences are small.

Table 14 –Summary of the boarding and alighting at Whitland station in all periods.

Period	Boarding					Alighting				
	Obs	Mod	Diff	%	GEH	Obs	Mod	Diff	%	GEH
AM	24	37	13	35%	2.4	23	34	11	33%	2.1
IP	39	28	-11	-38%	1.9	21	26	5	19%	1.0
PM	16	23	7	32%	1.7	14	18	4	25%	1.1

The review of the PT model clearly shows that there is good representation of the public transport network within the AoF with only minor amendments required to bring it in line with current public transport provision. The review has only yielded a partial picture of the model's ability to recreate current conditions, but where comparisons between modelled and observed flows have been made the model performance is generally acceptable and no further updates are considered necessary.

RECOMMENDATIONS

Across both highway and PT assignment models, SWMWTM is a good representation of the transport network with the AoF in 2019 (the model base year). Some modest network enhancements are proposed to address inaccuracies in the highway model and to bring both models closer to representing the transport network in 2023.

Model calibration and validation has generally been shown to be acceptable (where available), but it is noted that the available data only facilitates a partial picture of the model's ability to represent current conditions.

It is therefore considered that SWMWTM is a robust tool assess the following:

- Local and strategic growth within the AoF
- Routing for trips generated by the proposed site (subject to an appropriate distribution being supplied and realistic trip generation)
- Approximate mode split for proposed site

However, careful consideration should be taken when attempting to extract the following from the model

- Turning movements for base year and in future
- Detailed network performance at the local junction level