

Centre for Health Information, Research and evaluation (CHIRAL), Swansea
University.

Part 1: Public Transport Overview

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Purpose and Summary of Document:

Report describing methodology, limitations and descriptive analyses of the indicative public transport travel times and availability within the Abertawe Bro Morgannwg University Health Board boundaries as outlined in the proposal agreed by Abertawe Bro Morgannwg University Health Board.

Background

In December 2011, the Together for Health document, produced by the Welsh Government said that the NHS in Wales is facing some tough challenges and should make sure all its services are “sustainable” and “comparable with the very best”. Initially, the outcomes from the South Wales and Changing for the Better programmes will be a series of high level options that ABMU will use to engage with the general public over the optimal service configuration for specialist services (South Wales outcomes) and the key principles for service redesign of all other local services (Changing for the Better outcomes).

As with any service re-design exercise, it is important to consider the implications on patients, visitors and staff. One of the most important considerations is whether the potential changes have an effect on people’s ability to access services by various modes of transport, e.g. car, public transport, etc.

The transport infrastructure in South Wales is going through a period of uncertainty with likely changes to the way Welsh Government funding is allocated to Local Authorities and Regional Transport Consortia. In addition, there is likely to be a reduction in the funding (Local Transport Grants) allocated to Local Authorities from April 2013. The likely effects of the funding reduction will be a rationalisation of local transport provision.

Abertawe Bro Morgannwg University Health Board (ABMU) has approached the Centre for Health Information, Research and evaluation (CHIRAL) at Swansea University to develop accessibility profiles to better understand the impacts of service reconfiguration from a public transport perspective. This document outlines the methodological approach developed by CHIRAL and provides a descriptive overview of the resulting outputs from the GIS models as defined in the project proposal.

Study Area

The study area, as defined by ABMU, is defined by the health board boundary which consists of three unitary authorities in South Wales; Neath Port Talbot, Swansea and Bridgend.

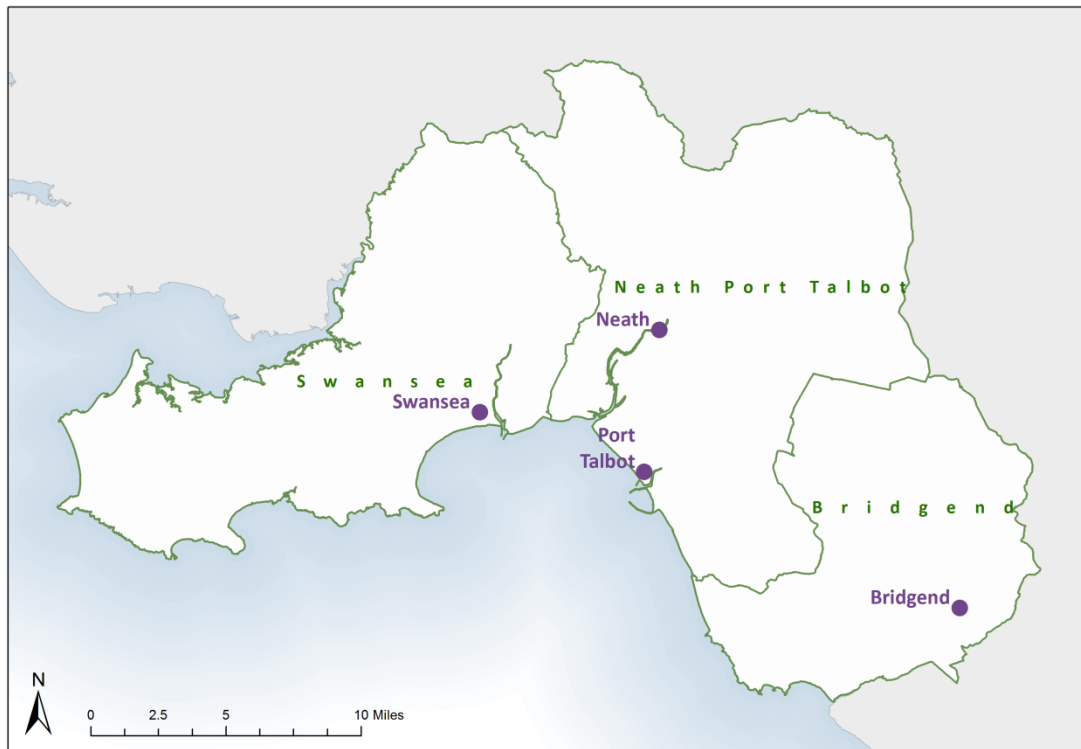


Figure 1: Study Area

Within the study area there are a number of public transport routes linking East, West, South and Mid Wales. Moreover, there are a number of local transport routes which link the communities within the study area. Figure 2 provides an overview of the currently operating bus routes within the ABMU boundary and illustrates bus services that originate or terminate at a bus stop within the study area. Table 1 summarises the Monday to Friday bus public transport network for each unitary authority within the study area. Each route is counted as distinct, unless it stops at the same stops and follows the same route.

Table 1: Bus Routes Summary

	Number of Distinct Bus Routes	Miles of Bus Routes	Number of Bus Stops
Swansea	558	411.5	2,037
Neath Port Talbot	360	313.11	2,118
Bridgend	212	213.8	1,148
Total	1,130	938.41	5,303

Bus Routes that Originate or Terminate within the ABMU boundary

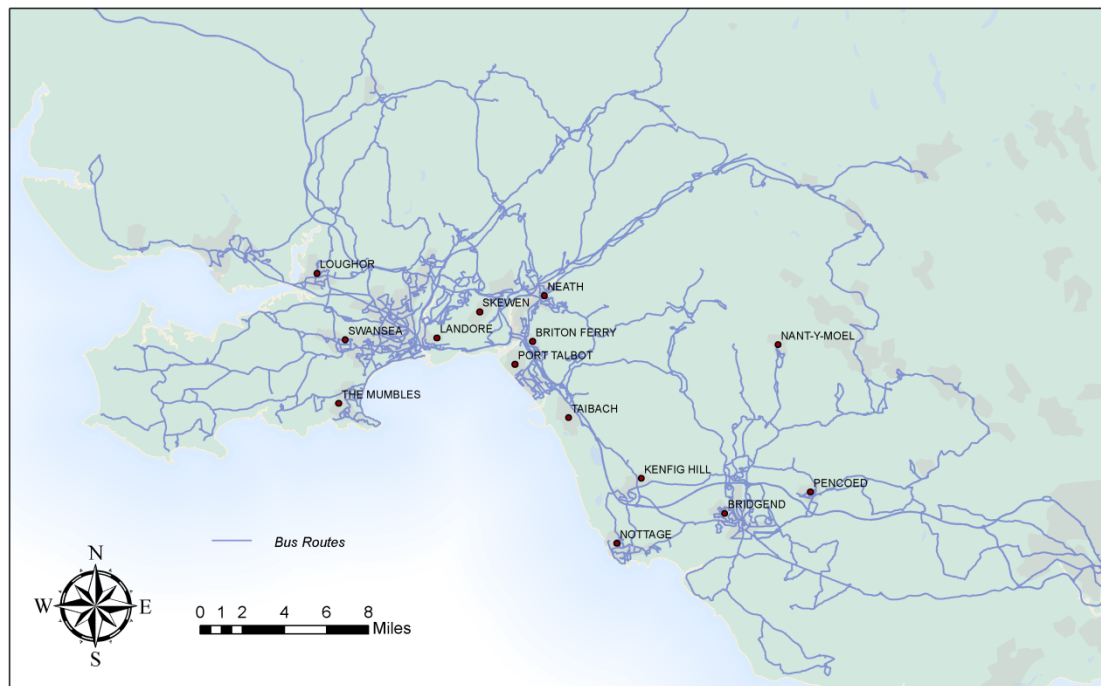


Figure 2: Study Area Bus Routes

Figure 3 provides an overview of the rail transport network and shows the location of the 18 rail stations within the study area.

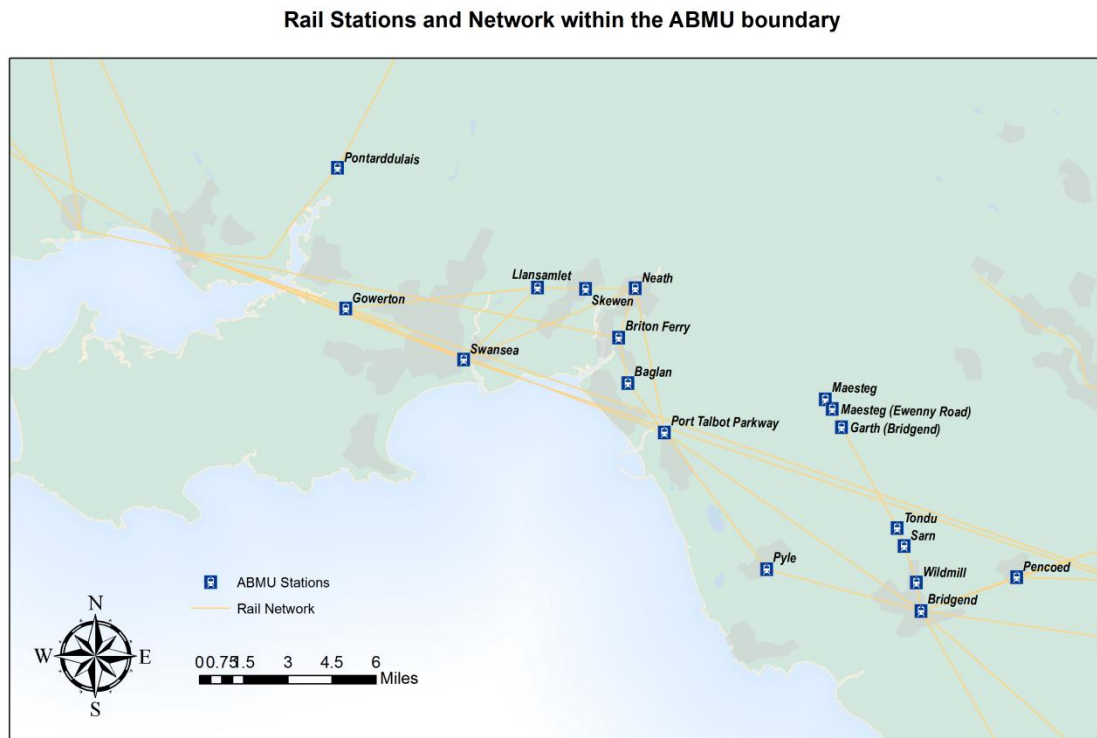


Figure 3: Study Area Stations and Rail Network

Methodology

Data Sources

To develop the GIS models four core datasets were used:

1. , Ordnance Survey Integrated Transport Network (ITN) Layer;
2. National Public Transport Access Node (NaPTAN), a database detailing bus stops and stations;
3. Association of Train Operating Companies Rail Timetable Data; and
4. Traveline National Dataset for Bus Routes.

The transport access nodes, rail and bus timetables are only available in a proprietary format and therefore required pre-processing and transferring into a relational database for use in the

GIS. Each database contained a set of tables detailing each journey made within the ABMU study area, along with stop locations and arrival and departure times for each stop.

The main road network dataset used was the Ordnance Survey's ITN layer, which is a geographic database describing every road in the UK in terms of location, type and direction. This dataset provided the GIS model with a reference network to estimate walking times and, given the bus data outlined previously, determine a bus route for each journey held within the bus route database.

Bus and Walking Network

The bus and walking network comprised 3 layers of data: two network layers (1) a road network and 2) bus routes) used to determine the direction of travel and travel cost (minutes) along each road or bus route, and 3) network junctions (bus stops) used to transfer from the road network to the bus network. The essential attribute to this network is the travel cost value; this determines how far a person can travel across the network within a given time. In this case the road network cost attribute was calculated at 3.5 mph to simulate the average walking speed of an adult. Therefore, for each section of road in the database the section length is used to calculate a travel cost in minutes with a walking speed of 3.5 mph.

A similar approach was used to generate the bus route travel cost. By comparing a number of bus journeys to the equivalent car drive times in the GIS an estimate of relative journey times based on road type and speed limits were made. For example, if a car can travel down a section of road between two bus stops at 30 mph, it has been estimated, using the bus timetabling information that a bus will travel along the same section of road at two-thirds of the speed (i.e. 20 mph). This estimation includes time incurred for stopping at bus stops for people to alight or disembark at the bus stop. Once this network data had been built, service area models were generated to estimate how far a person can travel within in set time period(s) from a facility. In this study 15, 30, 45 and 60 minute intervals were chosen as the break zones to generate service areas from each of the NHS facilities in the study area.

Rail Network

Due to dispersed nature and reduced numbers of train stations an alternative method was developed involving identifying the nearest (in terms of travel time) rail station to each NHS facility using the bus and walking network. Timetabling data was used to calculate journey times across the

rail network. By combining the average train travel time and the walking and bus times to the station a set of service areas were generated from each of the stations within the rail network that were accessible within 60 minutes of a facility. For example, for a journey from Morriston Hospital to the Bridgend area, the travel time from Morriston Hospital to Swansea Station and from Swansea Station to Bridgend Station resulted in 52 minute journey time. Given that we are looking at journey times with a maximum of one hour this leaves an 8 minutes travel zone surrounding Bridgend Station via the bus/walking network.

Two Step Floating Catchment Analysis Technique

The two step floating catchment (2SFCA) technique is a methodology originally developed to measure access to health care facilities which takes into account service availability (i.e. number of doctors or beds available at a given location per head of population) as well as travel time to the facility. This method has been adapted to measure accessibility to public transport by taking into account service availability (i.e. the number of bus or train services stopping at given stop) by head of population for the ABMU health board area. The method involves the following steps:

- Step 1. Using population centres (2011 Population weighted LSOA centroids) and service availability (the number of buses or trains stopping at a stop) within a specified distance of the population demand point (250m, 500m or 750m), create a service demand ratio for each public transport stop within the study area.
- Step 2. For each population demand point calculate bus stops located within the specified distances (250m, 500m or 750m) and sum the service demand ratio to realise the final 2SFCA score.

In addition to the base methodology, a distance decay calculation has also been included. This weights the 2SFCA scores so that bus or train stops that are closer to the population demand point are deemed more appealing than those which are further away. Therefore, access to a hospital via a bus stop that requires a long walking distance will be deemed less accessible, and in comparison a stop or station a short walk (e.g. less than 5 minutes) will be more appealing and therefore accessible.

The benefits of this method are that as well as modelling catchment areas for transport nodes, it also models choice of service available at population centre and transport availability by calculating the number of services stopping at each stop on a Monday to Friday basis. This results in population

centres with a higher frequency service being scored higher than those population centres which may have more stops closer, but an infrequent service.

Assumptions & Limitations

There are a number of assumptions that have been made when developing the GIS models, which have been made for the practical reasons surrounding times scales and computational power. Therefore the outputs from the GIS model **should be considered indicative as opposed to accurate outputs**, particularly when analysing travel-times. The assumptions made in the GIS model are as follows:

- Bus travel times have been calculated using average travel times based on **road type**. This has been estimated by comparing times taken to drive a bus route in a car as modelled in the GIS to the average time taken for a bus to complete the same route as defined in the bus timetables. As such the *time of day* that a journey is made are not catered for, along with extended *transfer wait times* between bus routes and between bus routes and rail journeys.
- Quantifying aspects of human nature are difficult – for example determining how long a person is prepared to leave (in terms of time) when transferring to another bus route or onto a train service will in reality affect their perceptions of how long a journey will take.
- Equally the average walking speed for an adult has been modelled at **3.5 mph** – this of course varies from person to person depending on age and physical mobility (e.g. mothers with push chairs, disabled passengers etc.). Therefore, the model assumes a “perfect” journey is being made with limited transfer waiting times and an individual possessing good mobility. This 3.5 mph could be recalculated for further studies as necessary.

Results

The outputs from part 1 of the project are delivered as a set of maps and accompanied by descriptive census 2011 statistics. The maps are split into three categories, bus travel isochrones (travel times), rail service areas and two step floating analysis catchment maps. These are included in Appendices 1, 2 and 3 respectively and are also included as separate map files. Each of the output categories are described in the following sections.

Bus and Walking Travel Time Maps

The bus travel time maps are made up of four bands of travel times 0-15 minutes, 15-30 minutes, 30-45 minutes, and 45-60 minutes. Each of these bands represents how far a person can travel through a combination of bus travel and walking from the given NHS facility, inversely these zones also represent how long it takes to travel to the specified NHS facility.

All of the maps are shaded using the same colour scheme (dark purple to light purple), by describing one the same principles will apply to the others. Taking the map that visualise the travel times to Gorseinon Hospital, the darkest shade of purple represents the shortest travel time zone (0-15 minute travel time). In this map this zone centres on the town of Gorseinon with most of the immediate surrounding villages also within this travel time. The next zone (15-30 minute travel time) extends all the way down to the south-east covering the majority of Swansea city centre and suburbs and extending west beyond Llanelli at the western edge of the ABMU boundary. This zone also extends several miles up the Amman Valley to the North of Gorseinon. The third zone (30-45 minute travel time) extends the service availability further, covering all of Swansea and a lot of the Gower peninsula. It also extends further east to the cover most of the Neath-Port Talbot Unitary Authority. The final zone and lightest shade of purple (45 -60 minute travel time) to the Bridgend in the east and the western edges of the Gower as well as the Neath Valley thus defining the furthest extent of the one hour travel time to/from Gorseinon Hospital.

The same zones and colours are applied to each of the maps found in appendix 1 for each of the NHS facilities in the study area. These maps aim to provide an estimate of travel times a person will incur when traveling to a particular facility located on the map. In total there are 14 bus and walking travel time maps which delineate travel times up to 60 minutes from an NHS facility.

Rail Travel Times

The rail travel time maps (Appendix 2) are defined differently to the bus travel time maps in the sense that separate zones are not defined. For the rail maps a 60 minute travel time is defined as the cut-off point for each of the facilities, that is, if a station cannot be reached within 60 minutes of a facility it is not included in the analysis. The maps show, for each facility, the travel time area by train, bus and walking travel within 60 minutes of a facility. Due to the linear nature of rail travel in the study area - mainline rail routes operate from east to west with far fewer and slower routes operating north to south - the results show a moving window which reflects this. Travel zones are dependent on the how long it takes to travel the closest station from a facility. This is illustrated in the Gorseinon Hospital travel map, with areas to the east of Pyle essentially inaccessible by rail within a 60 minute time period.

Census Stats

Using the 2011 small area census statistics it is possible to estimate how many people fall within each travel time zone for the bus, walking and rail travel using population weighted centroids. These centroid are weighted to represent where the majority of people reside within a census unit, in this case the lower super output area unit. The figures for the study are have been summarised in table 2. The general trend, from these statistics, is that the majority of the population have greater accessibility (in terms of travel time) when using rail transportation. There is one particular anomaly which should be noted which concerns the Ty Garngoch facility. This records a population count of 0 for the 0 – 15 minute zone, which on closer inspection of the data is as a result of the location of the population weighted centroid. There are a number of residential addresses within this zone; however the majority of the population within the LSOA's which surround this facility live outside this zone and therefore the centroid is positioned outside of the buffer zone.

Table 2: Census Statistics – Population Counts within Zones

	0-15 Minutes	15-30 Minutes	30-45 Minutes	45-60 Minutes	Total Bus/Walk within 60 Minutes	Rail Travel Within 60 minutes
Cefn Coed Hospital	126,649	177,530	64,197	138,591	506,967	512,438
Cimla Hospital	53,353	240,280	176,143	45,006	514,782	514,782
Coity Clinic	42,935	102,413	77,557	252,721	475,626	501,955
Gellinudd Hospital	8,586	117,542	228,545	139,036	493,709	510,585
Glanrhyd Hospital	47,042	116,960	93,642	242,831	500,475	514,782
Gorseinon Hospital	25,414	208,452	115,483	121,450	470,799	376,018
Maesteg Community Hospital	23,651	162,317	234,280	91,036	511,284	493,431
Morrison Hospital	10,740	250,488	91,776	137,218	490,222	439,633
Neath Port Talbot Hospital	21,980	132,410	306,717	50,177	511,284	510,585
Port Talbot Resource Centre	40,516	207,148	233,190	33,928	514,782	511,284
Princess of Wales Hospital	42,935	102,413	77,557	252,721	475,626	501,955
Singleton Hospital	116,071	175,380	72,638	142,878	506,967	514,782
Tonna Hospital	50,458	216,678	198,352	49,294	514,782	514,782
Ty Garngoch	0	201,523	132,861	107,853	442,237	354,021
Ystradgynlais Community Hospital	5,835	35,591	278,054	120,355	439,835	461,885

Two Step Floating Catchment Analysis

The two step floating catchment analysis results (Appendix 3) reflect the higher public transport availability in the more urbanised areas of Swansea, Bridgend, Neath and Port Talbot. The only area with a high accessibility score when the analysis is performed using a 250m access buffer (i.e. how far the algorithm searches for a bus stop from a population centre) is Swansea. The smaller towns of Bridgend, Maesteg and Neath also have moderate accessibility scores at 250m whilst the outlying towns and villages from these areas suffer from poor accessibility. This reflects the reduced number of services (available on a Monday to Friday basis) that are accessible from stops that are within 250m of population centres outside of major towns and city.

The maps that visualise the scores for 500m and 750m distances again reflect how the major towns and city are well served by public transport. However whereas, at 250m there was relatively poor accessibility outside of major urban areas, the situation is improved if you willing – or able – to travel a bit further to access the public transport network. The ability to travel further increases the choice of service available and therefore the number of services a person can access. This is

reflected in the 2SFCA scores seen at 500m and 750m, particularly in some areas to the north-west of Swansea city centre and the valleys to the north of Port Talbot and Bridgend.

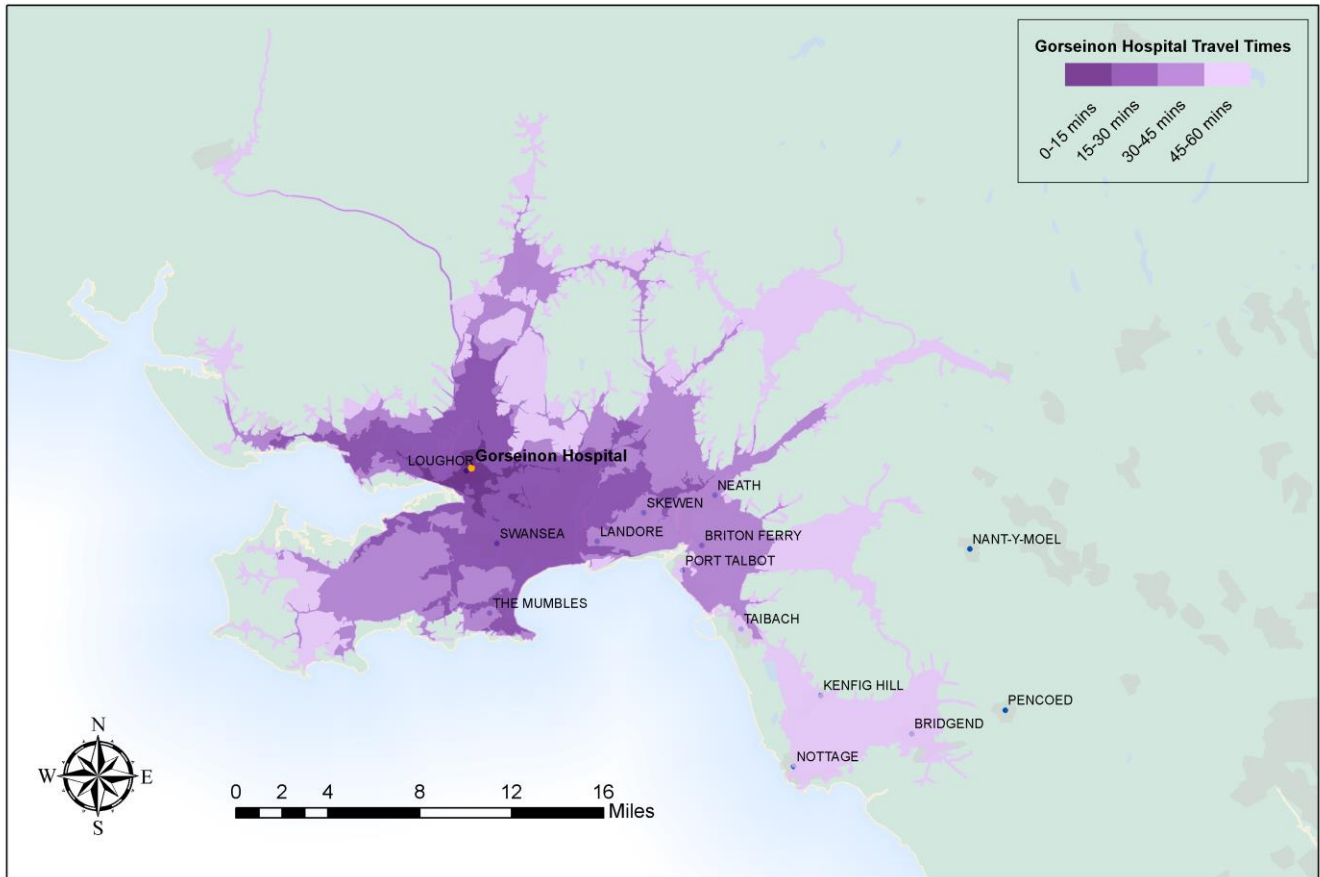
Summary

This report aims to provide a general overview on the current state of public transport availability in the ABMU study area. The models indicate that, generally, most populated areas within the ABMU area can reach an NHS facility via public transport within 60 minutes. However, service availability (the numbers of services running on a Monday – Friday basis) is much reduced outside of major towns, in particular due to the limited east-west nature of the train network. This leaves many areas to the north of ABMU study area poorly serviced by public transport, with relatively long travel times. Scenario specific analysis would enable a more detailed picture of likely public transport transportation issues to be developed – for example identifying a particular demographic such as the elderly or developing accessibility profiles for a particular facility or service.

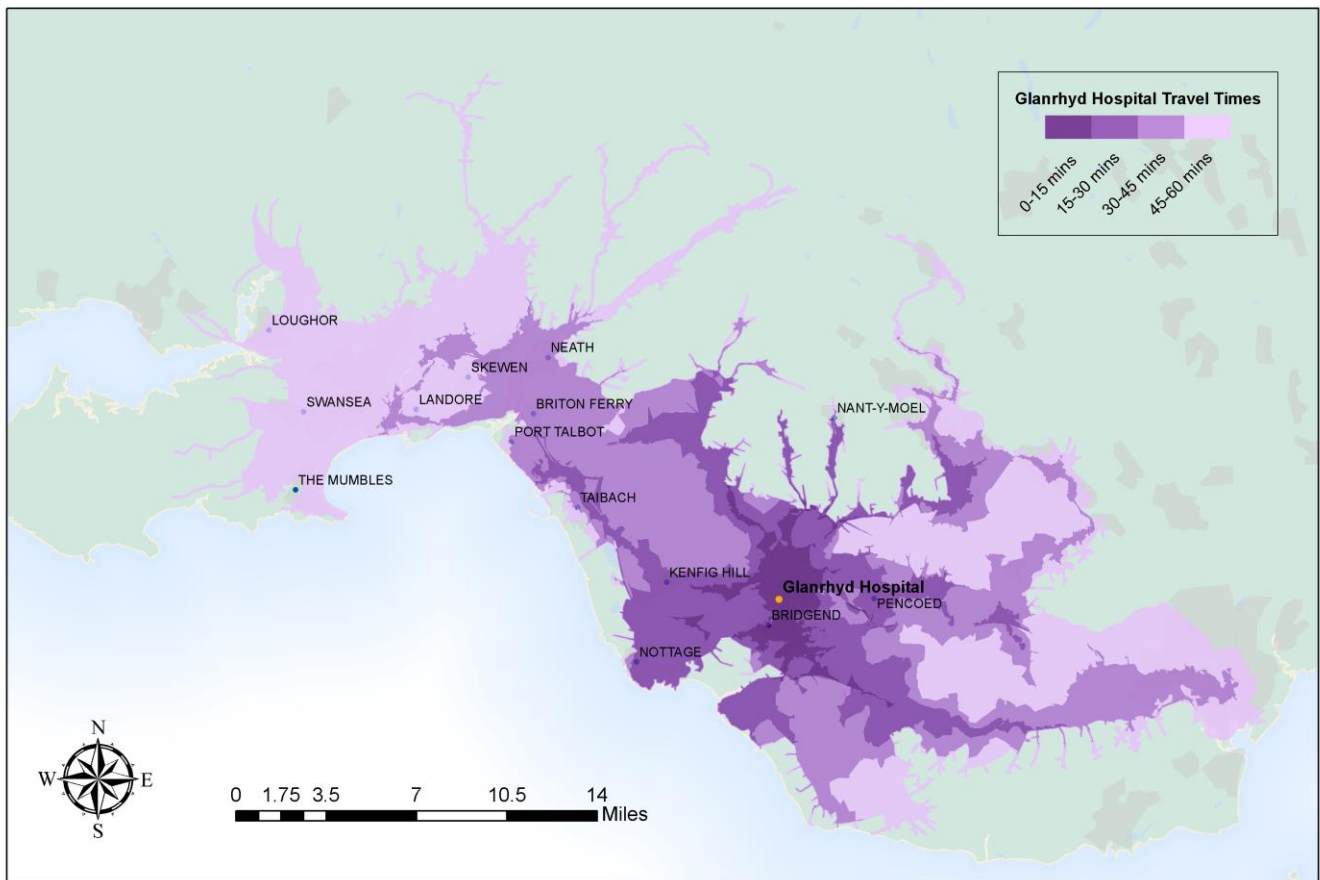
It should be noted that these models, although firmly based around scheduled timetables, can only provide an indicative overview of public transport provision. It cannot account for an individuals or group of individuals travel habits, and in particular how people perceive public transport provision. This should be considered when interpreting the model outputs.

Appendix 1: Bus and Walking Travel Times

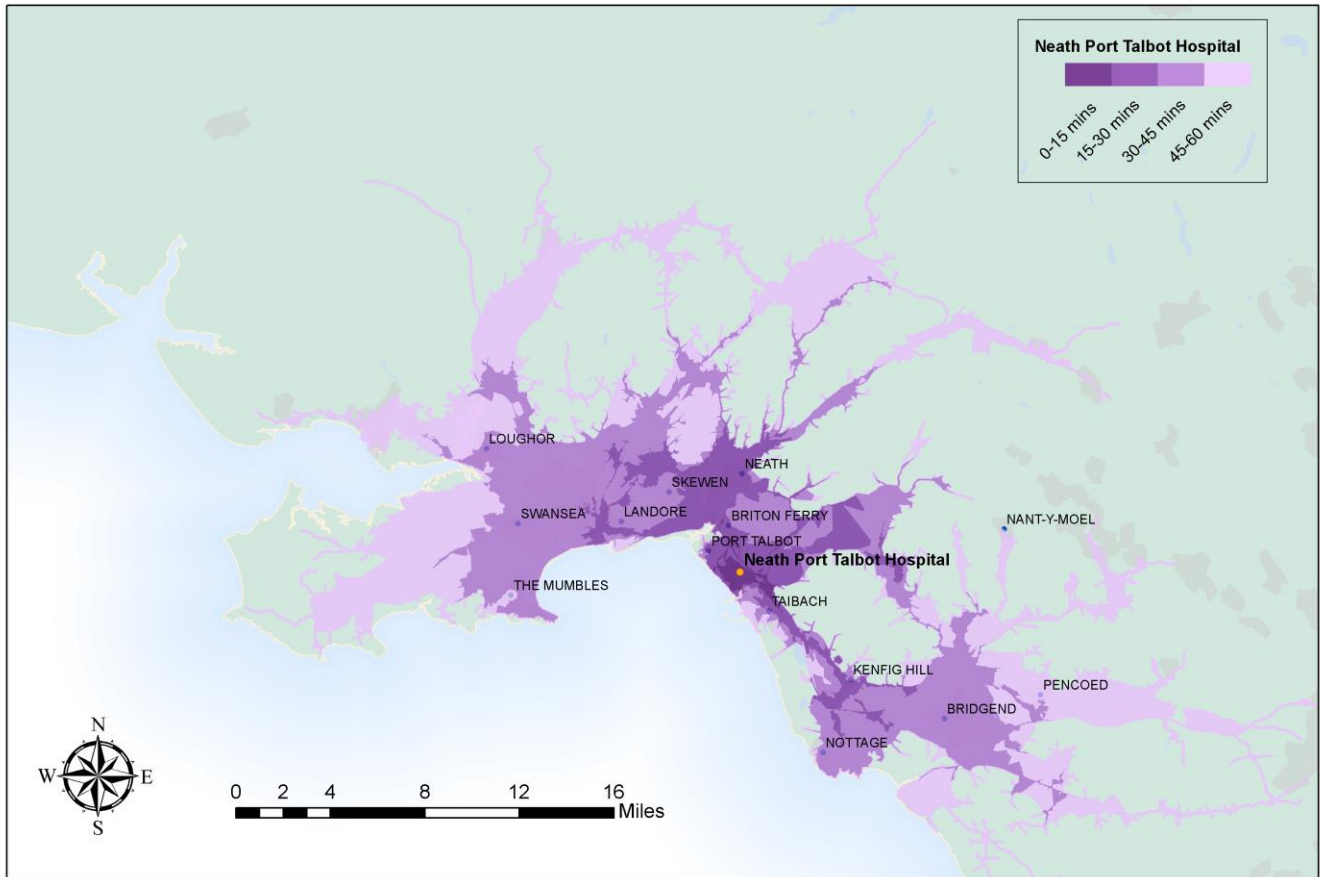
Public Transport Travel Times (Bus + Walk) - Gorseinon Hospital Travel Times



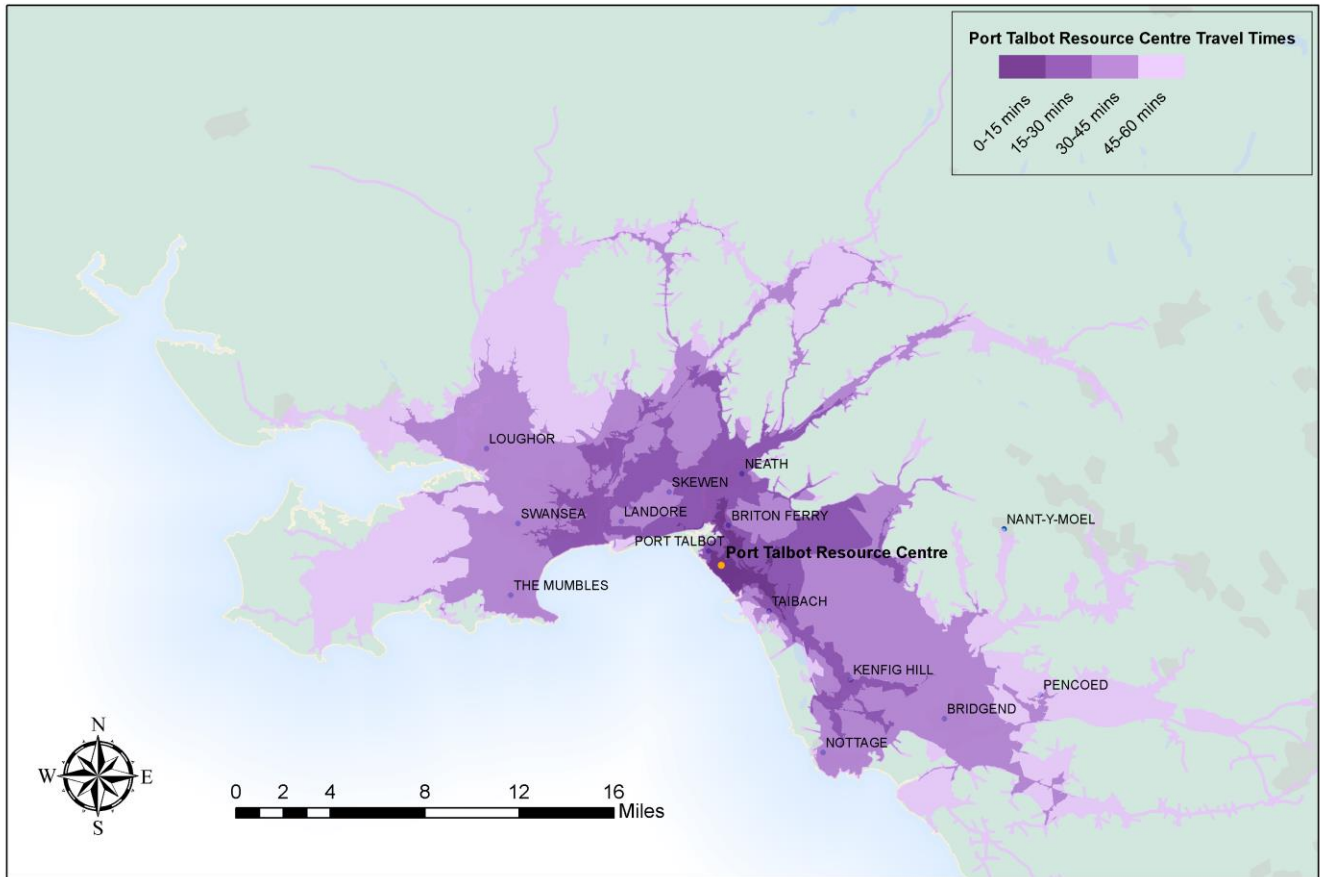
Public Transport Travel Times (Bus + Walk) - Glanrhyd Hospital



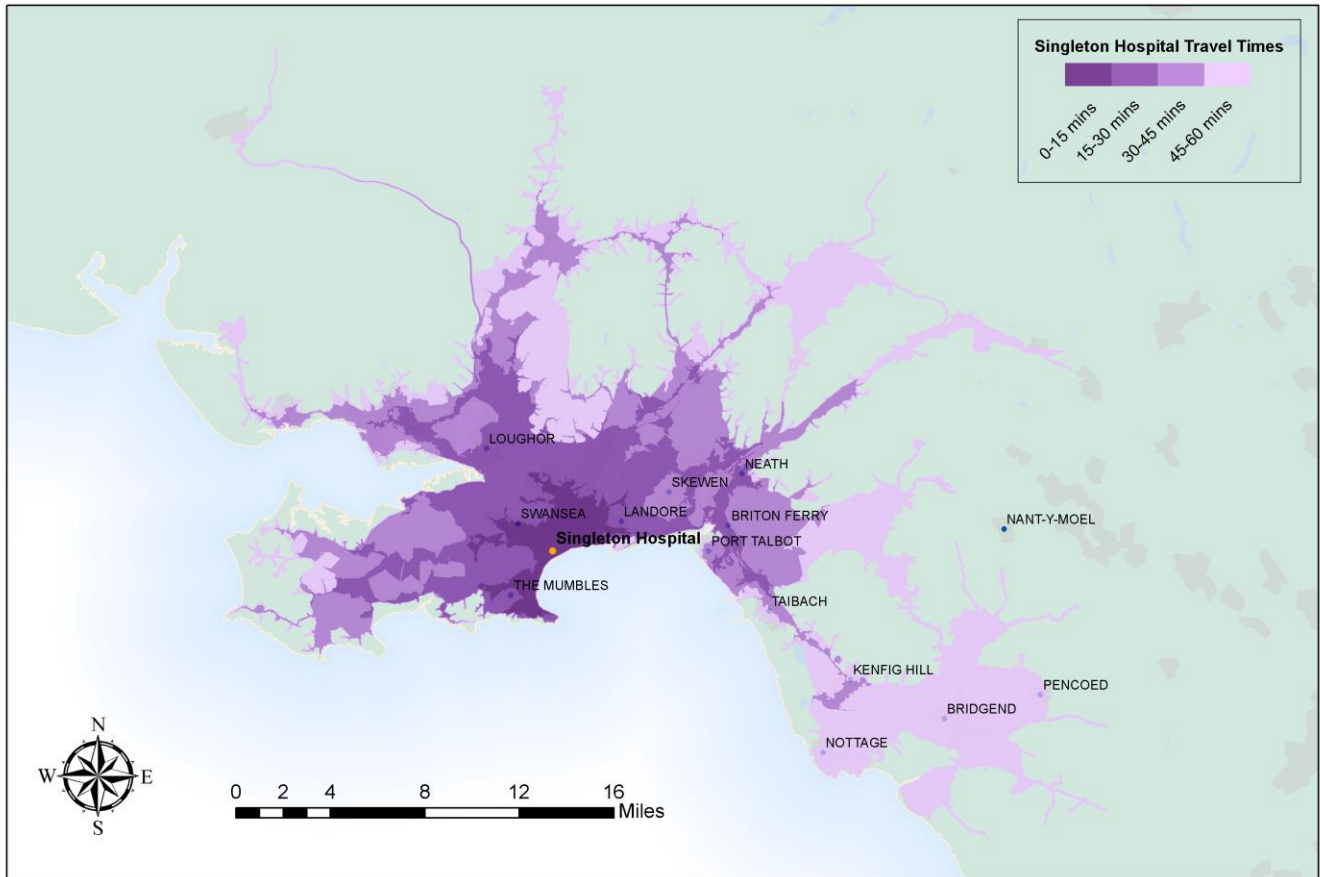
Public Transport Travel Times (Bus + Walk) - Neath Port Talbot Hospital



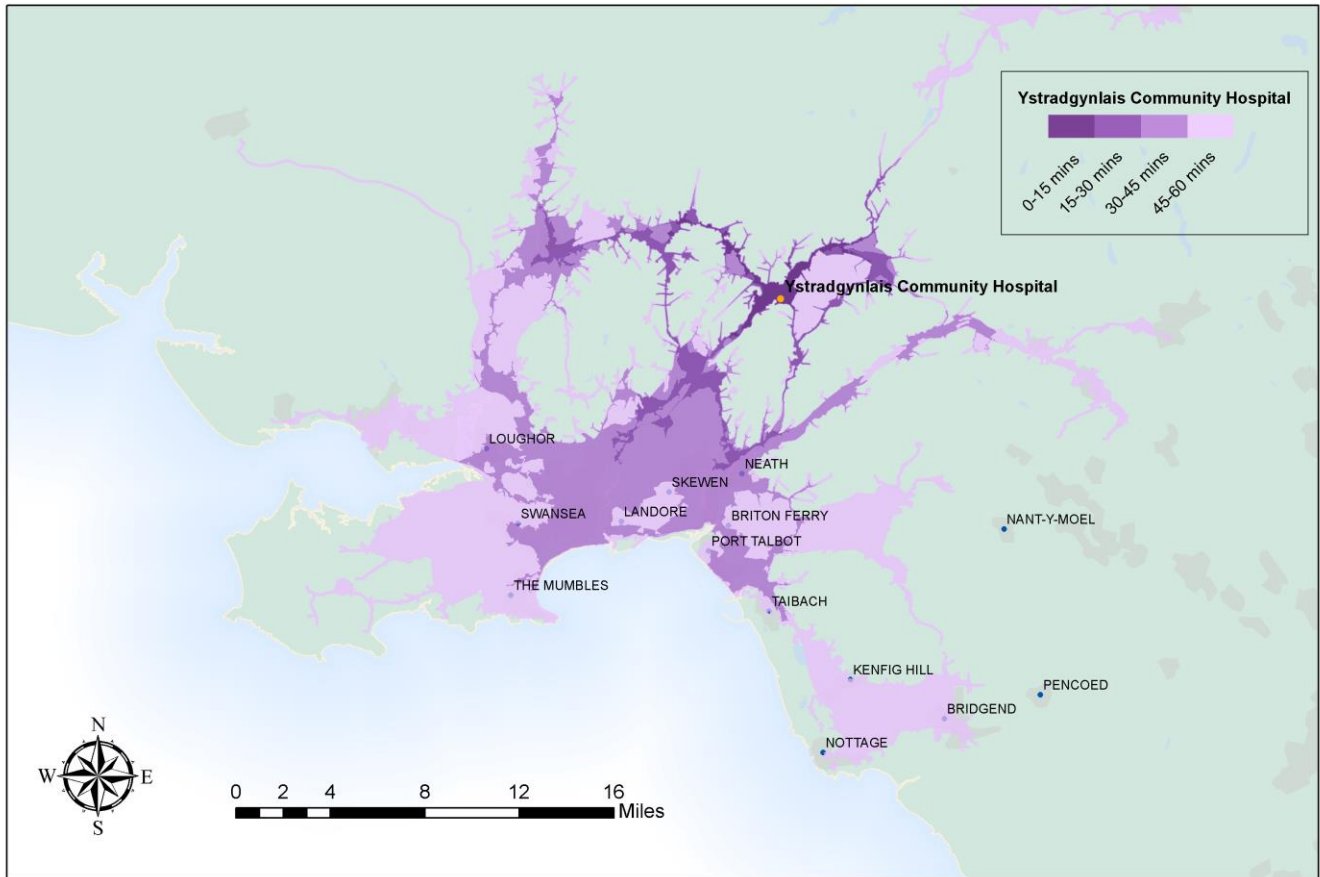
Public Transport Travel Times (Bus + Walk) - Port Talbot Resource Centre



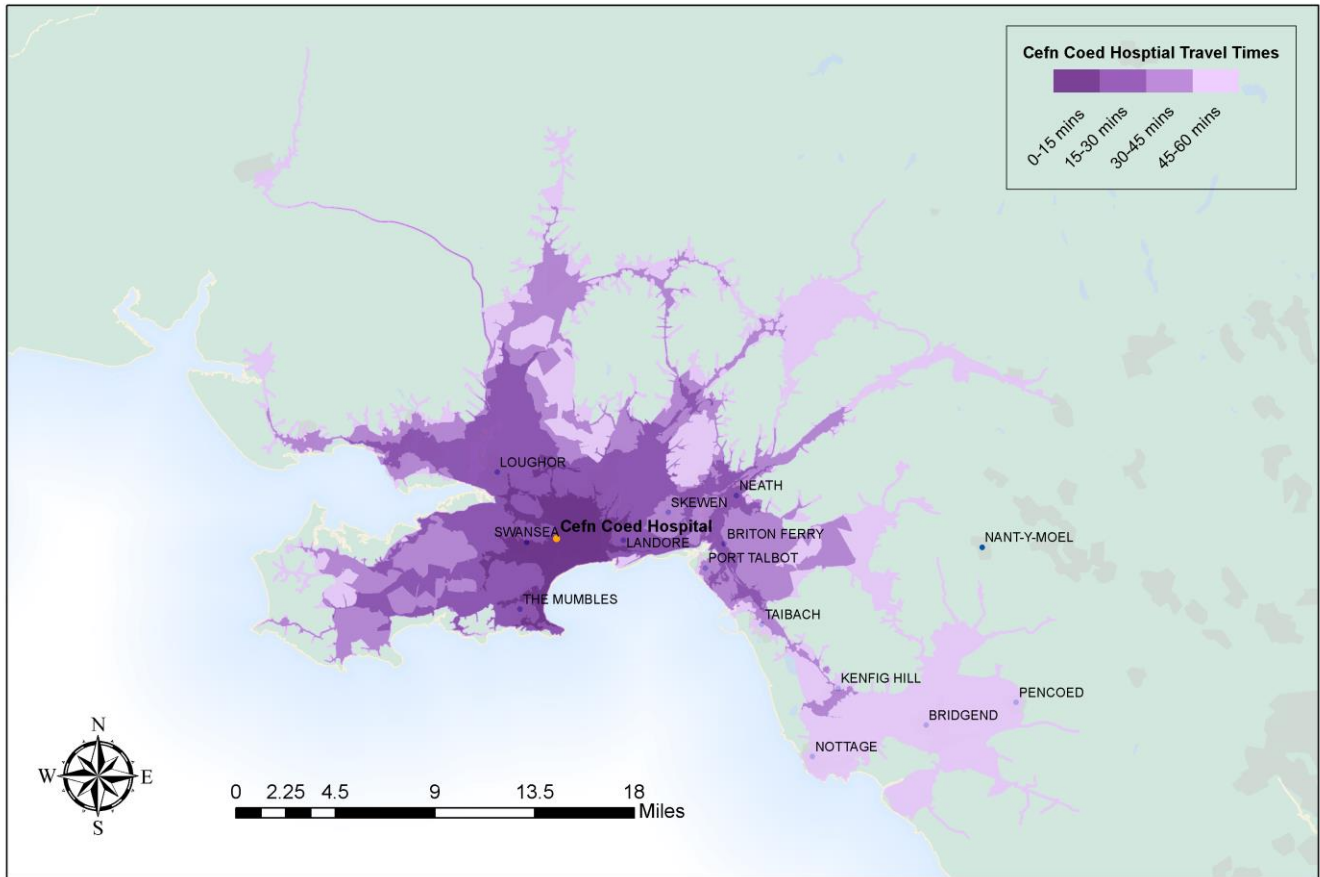
Public Transport Travel Times (Bus + Walk) - Singleton Hospital Travel Times



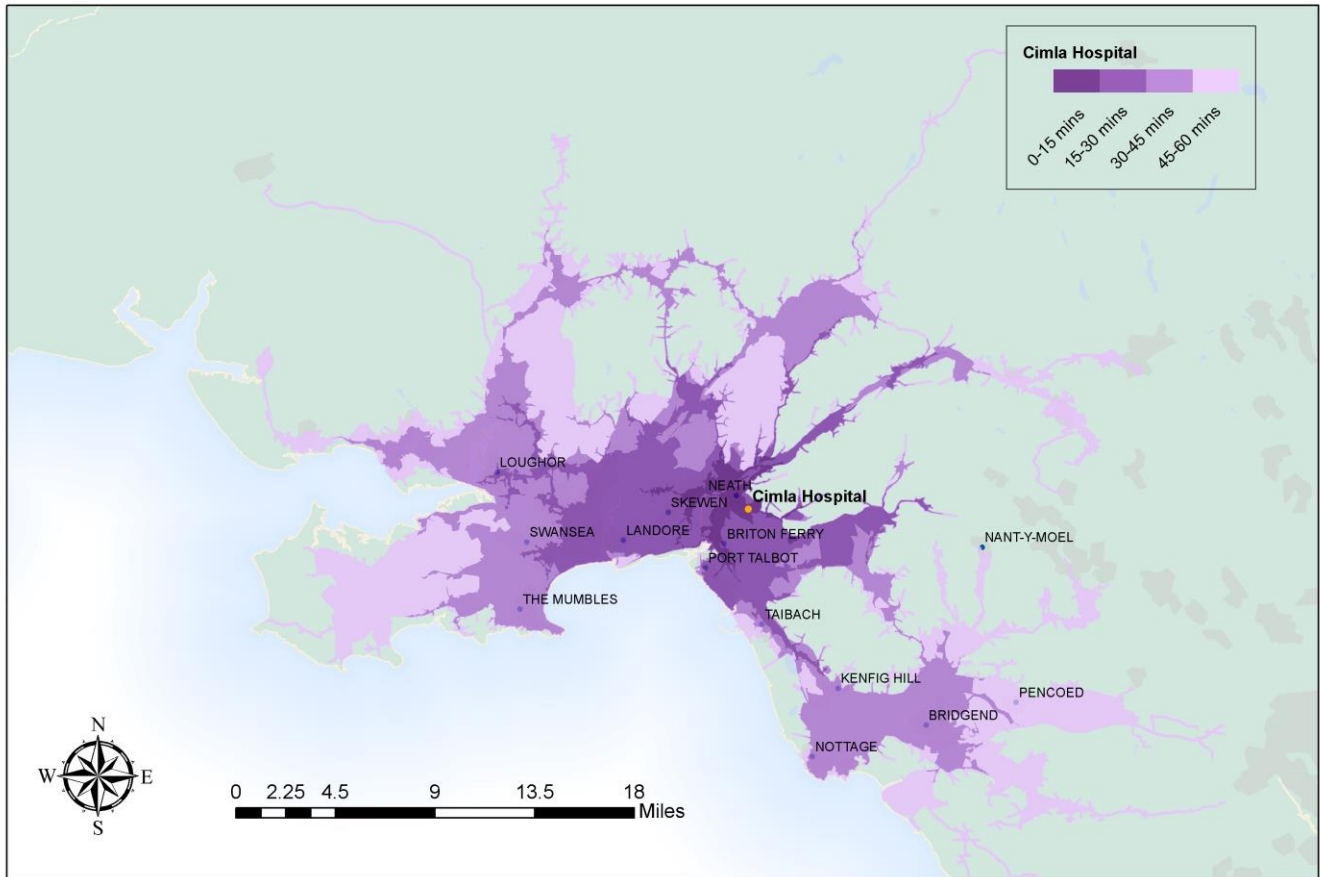
Public Transport Travel Times (Bus + Walk) - Ystradgynlais Community Hospital



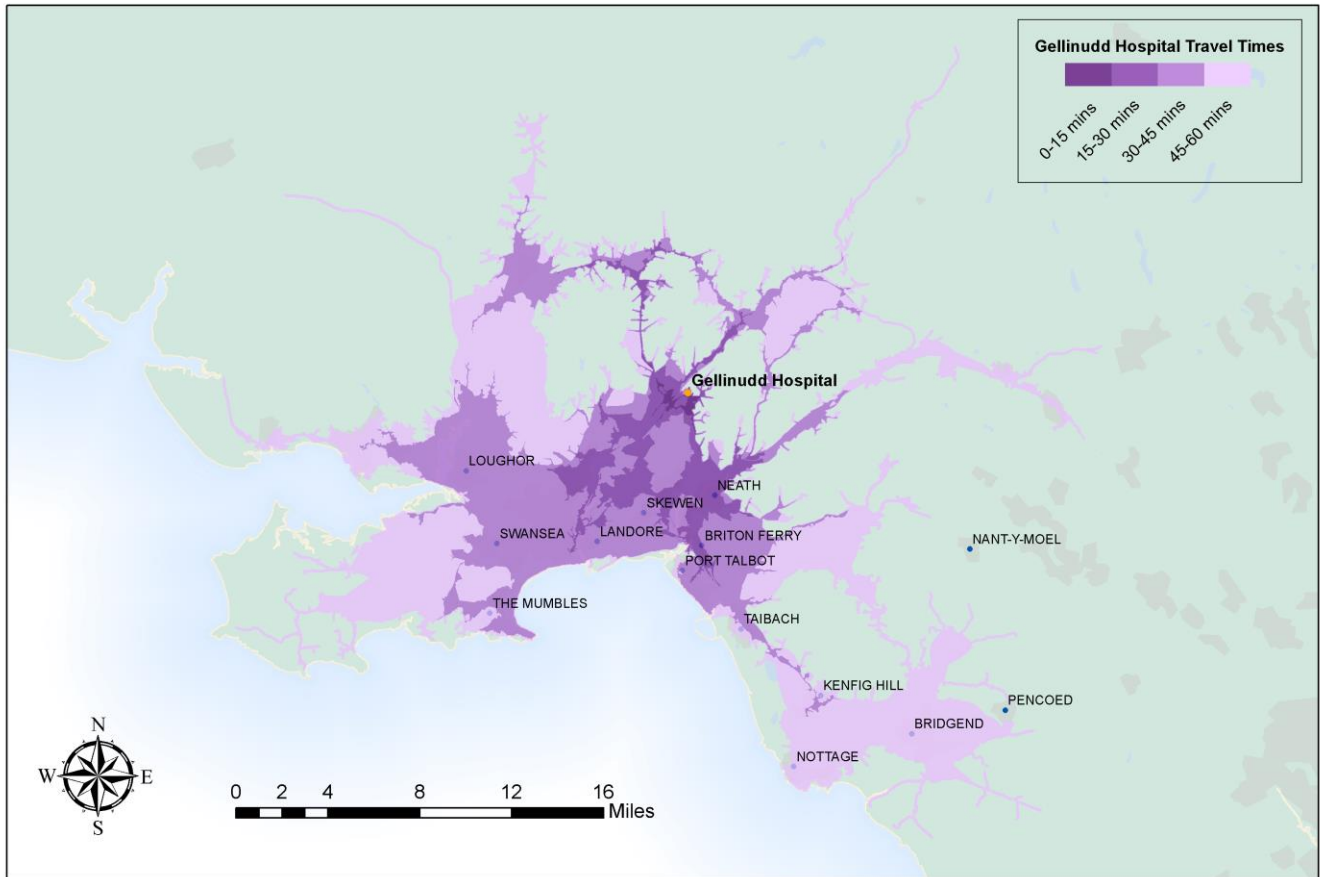
Public Transport Travel Times (Bus + Walk) - Cefn Coed Hospital



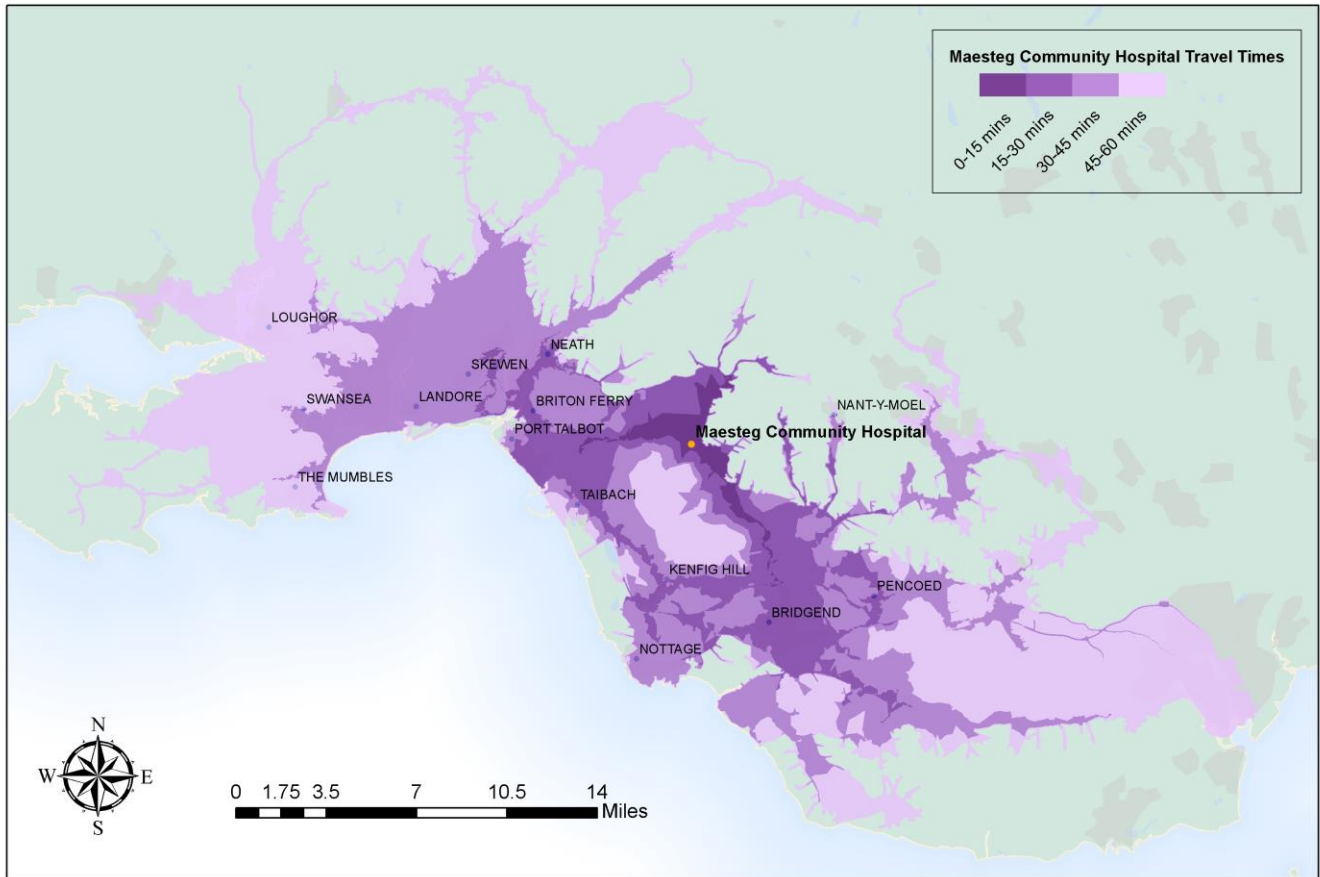
Public Transport Travel Times (Bus + Walk) - Cimla Hospital



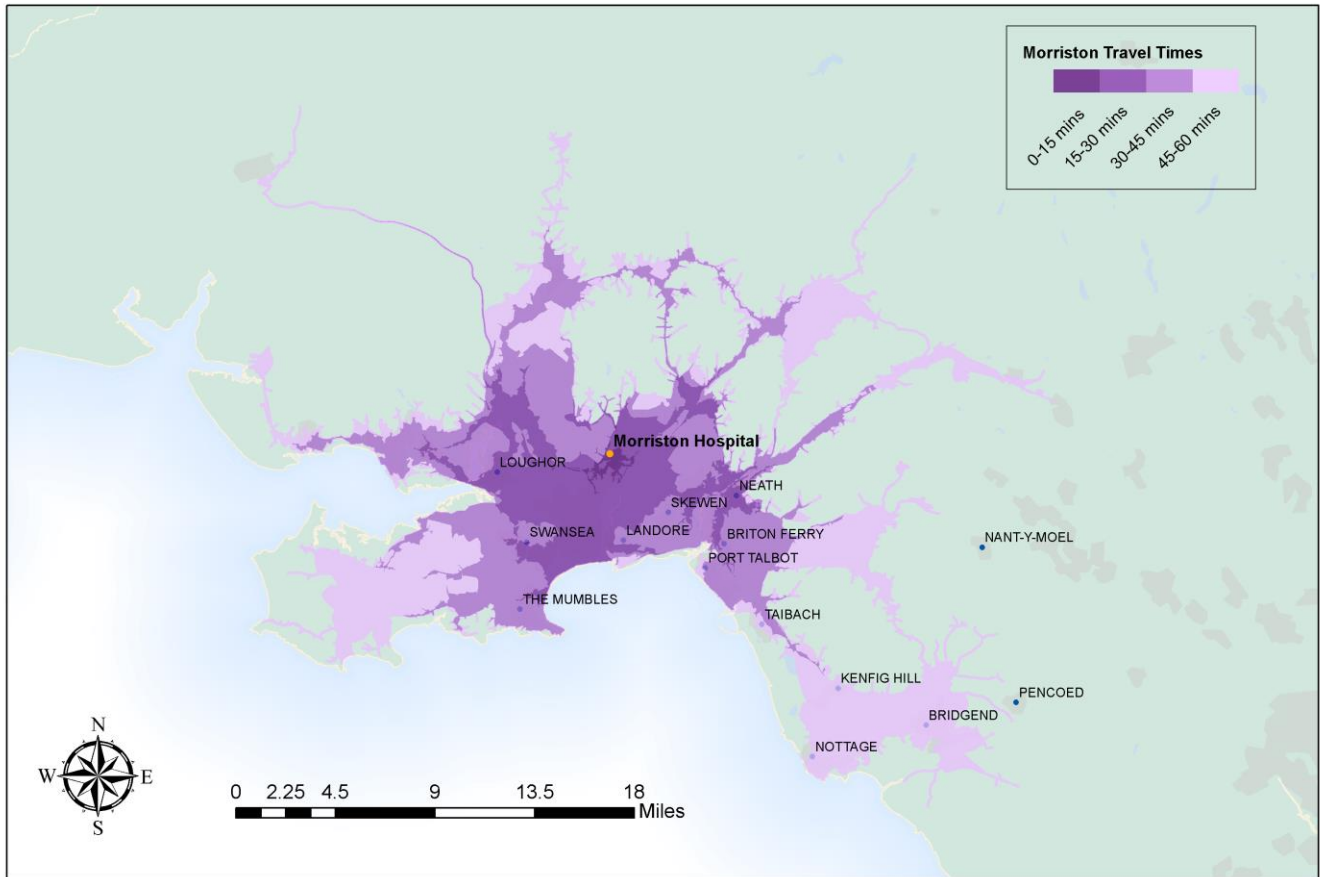
Public Transport Travel Times (Bus + Walk) - Gellinudd Hospital Travel Times



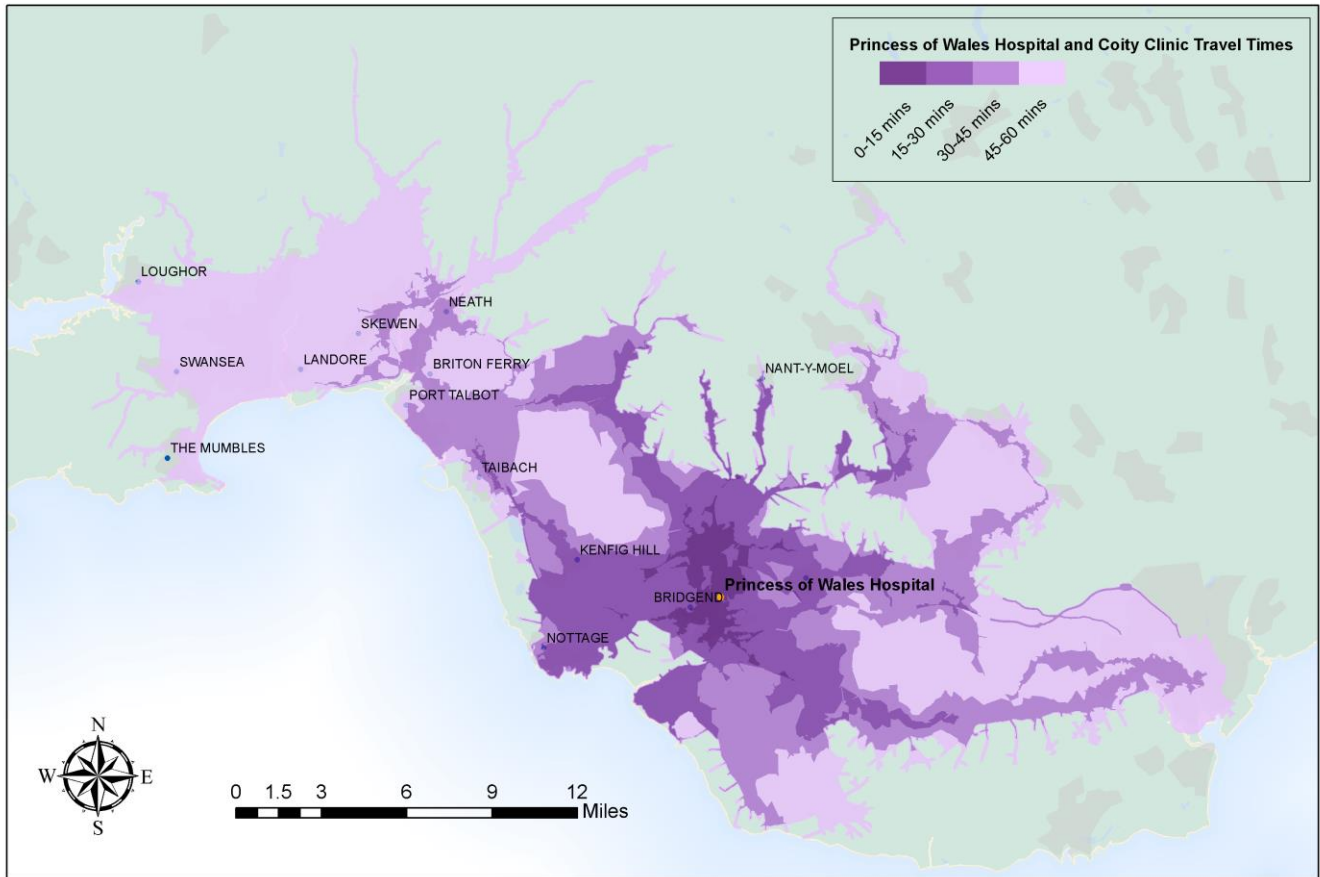
Public Transport Travel Times (Bus + Walk) - Maesteg Community Hospital



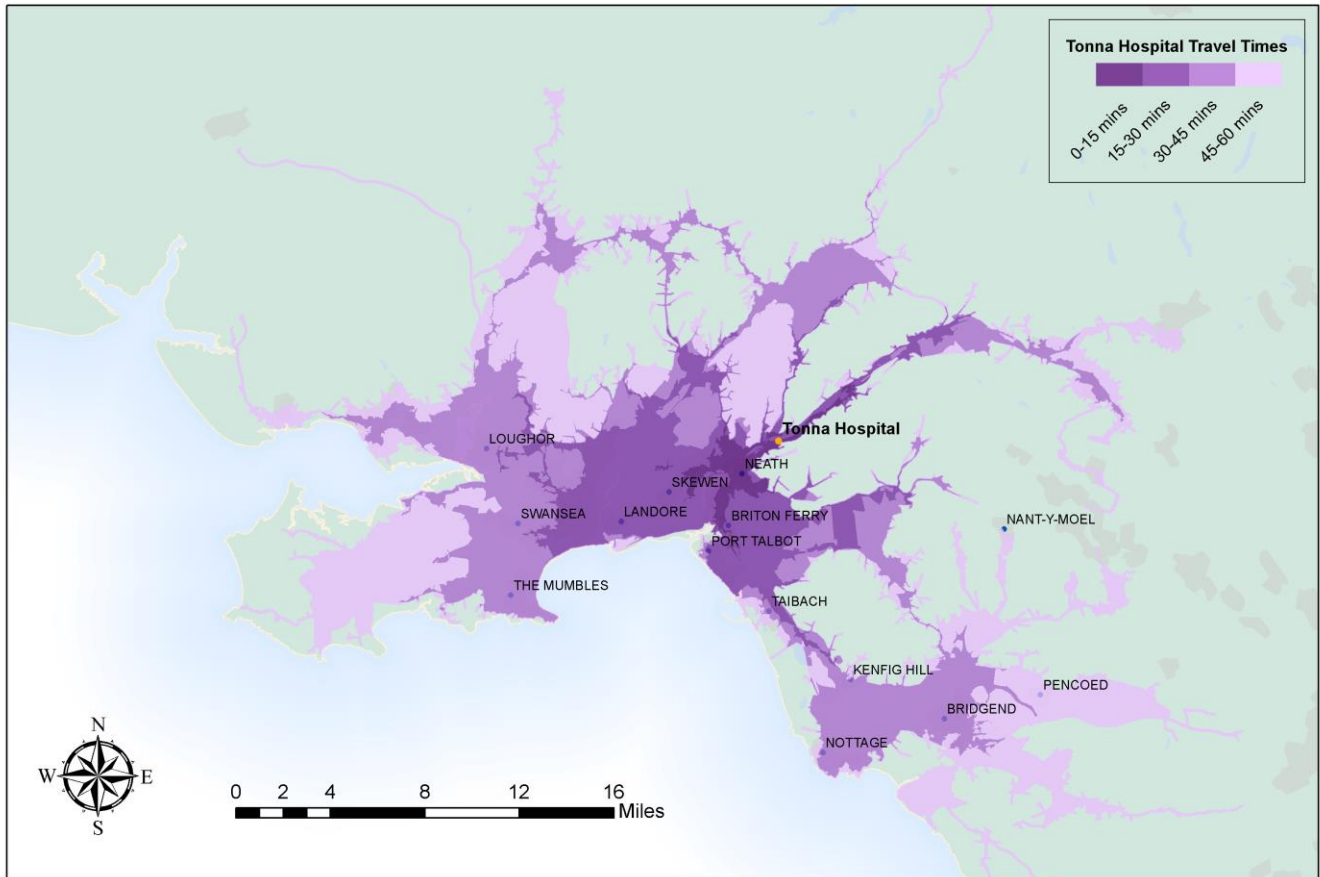
Public Transport Travel Times (Bus + Walk) - Morriston Hospital



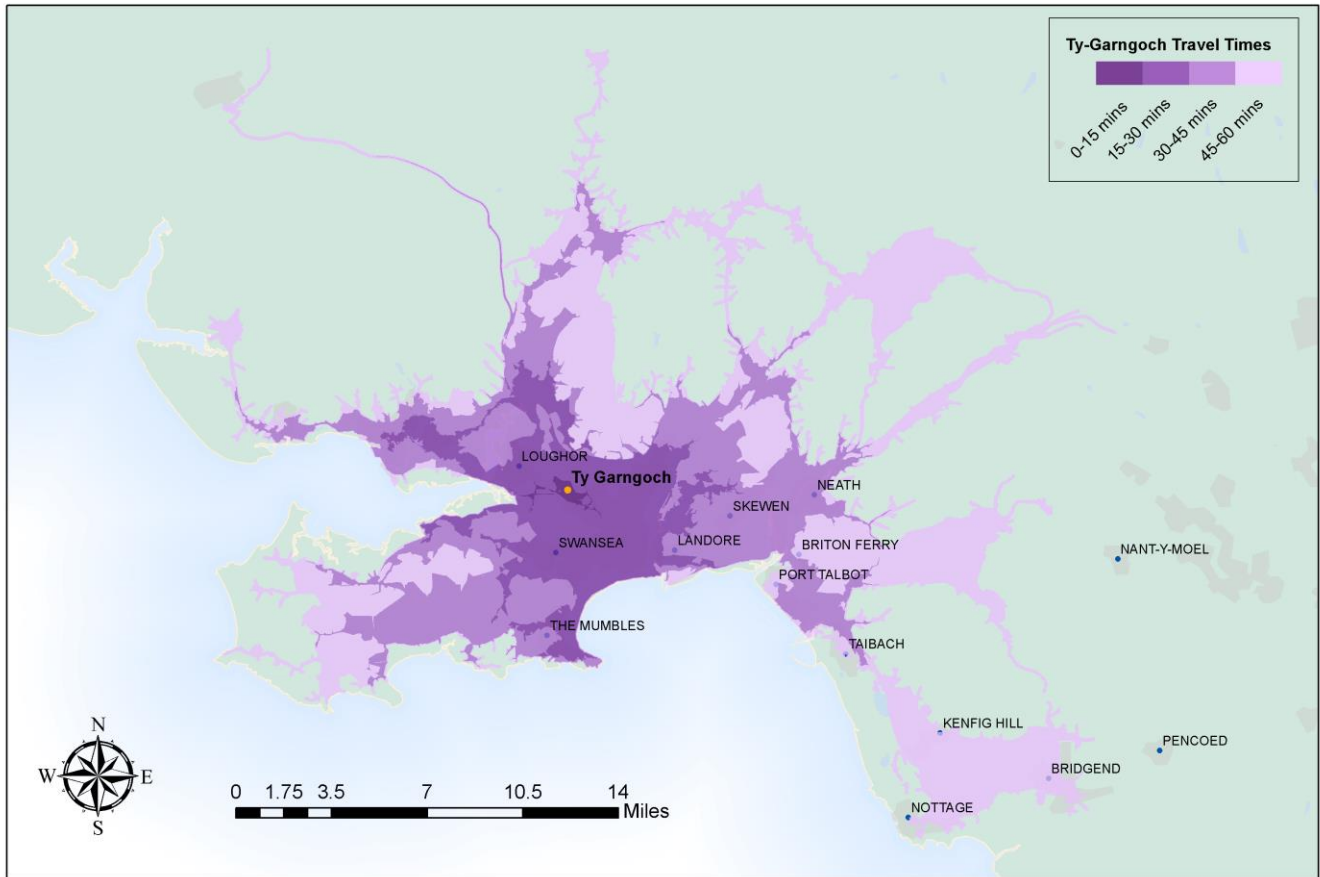
Public Transport Travel Times (Bus + Walk) - Princess of Wales Hospital and Coity Clinic



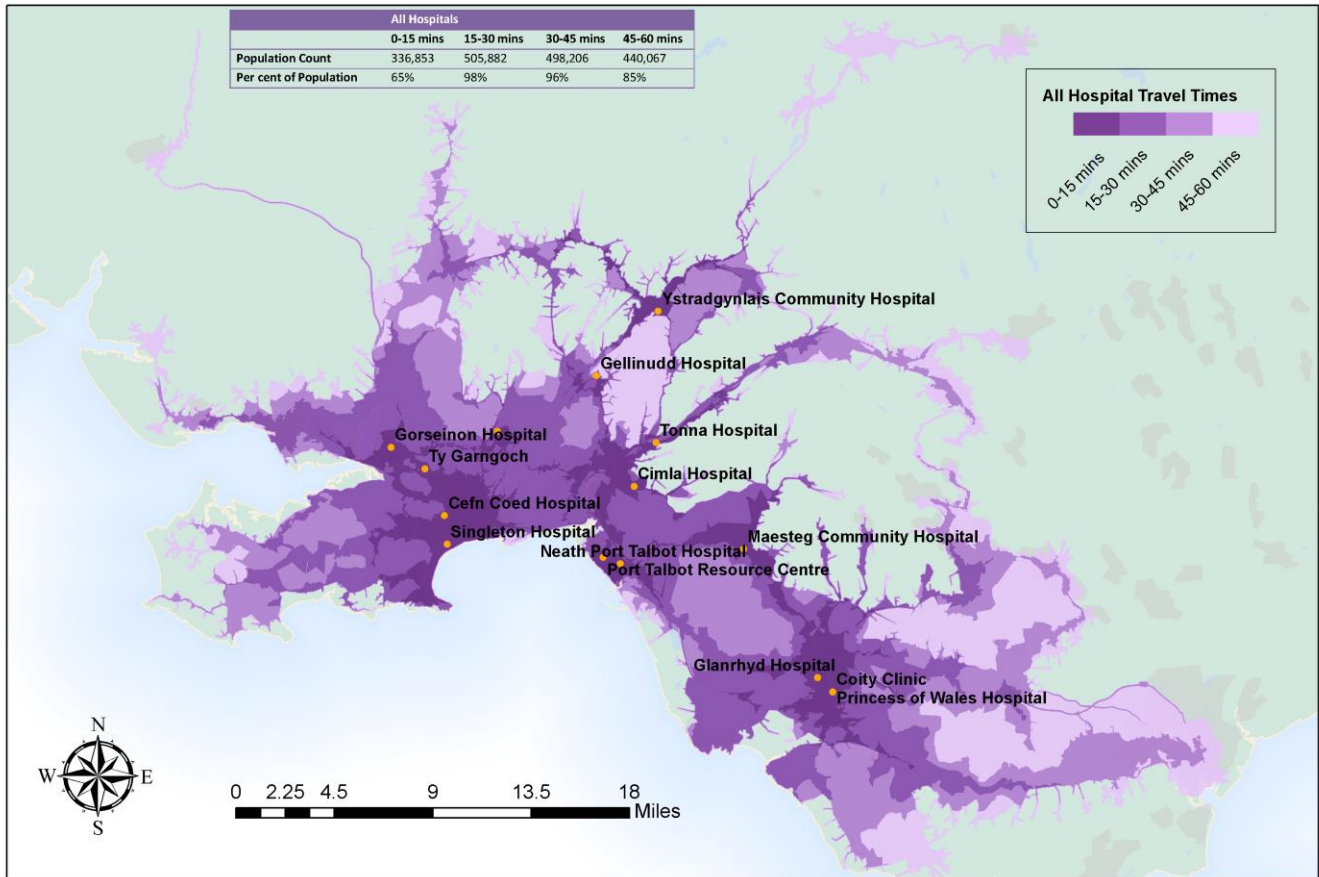
Public Transport Travel Times (Bus + Walk) - Tonna Hospital



Public Transport Travel Times (Bus + Walk) - Ty-Garngoch Travel Times

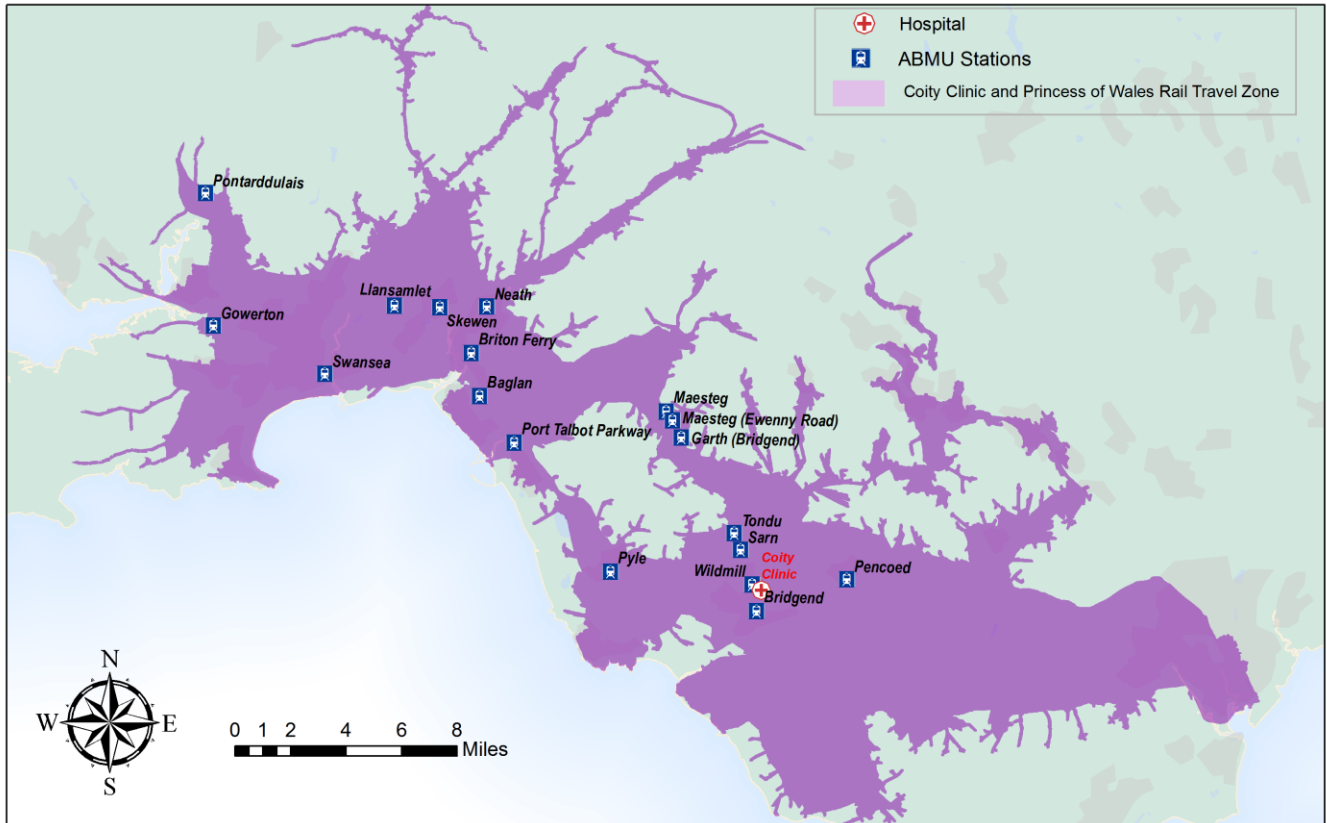


Public Transport Travel Times (Bus + Walk) - All Facilities

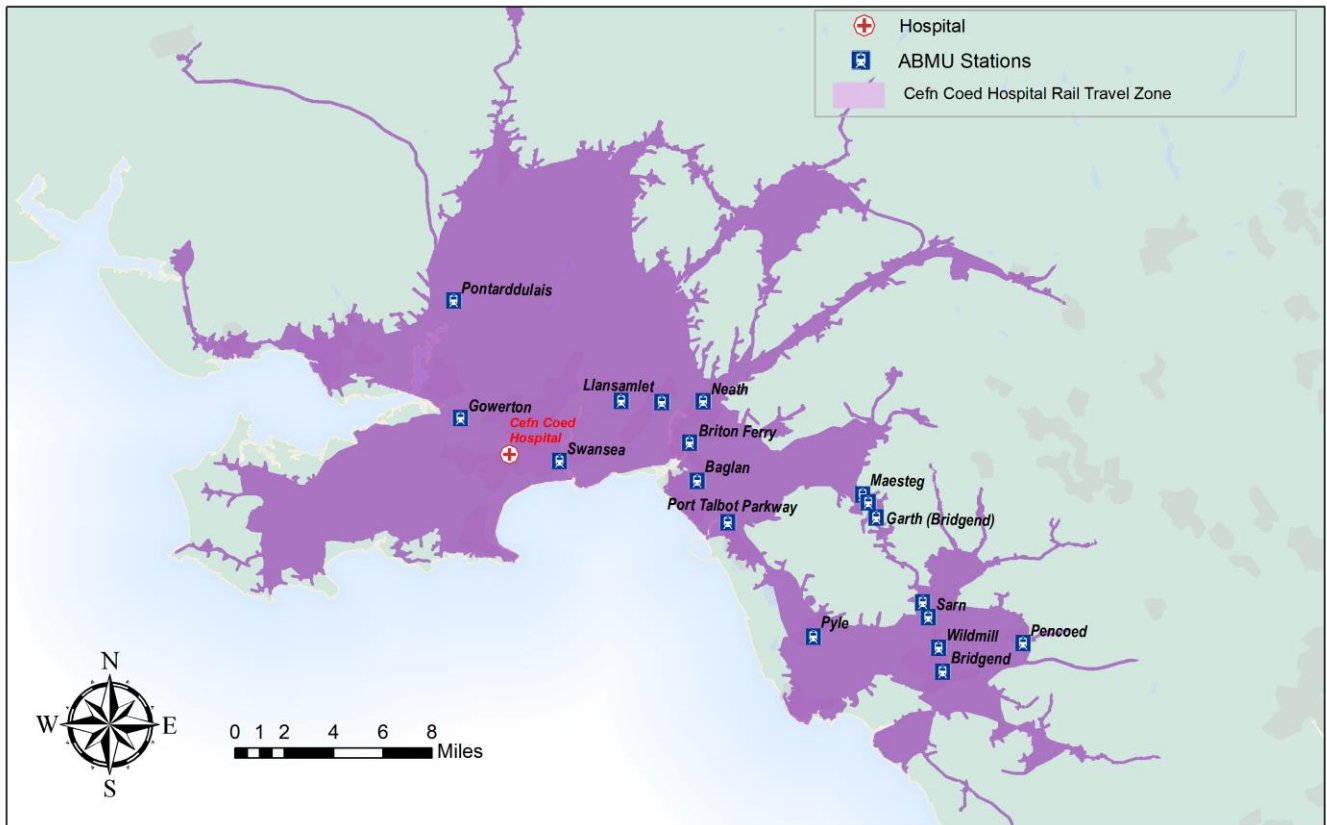


Appendix 2: Rail Travel Zones

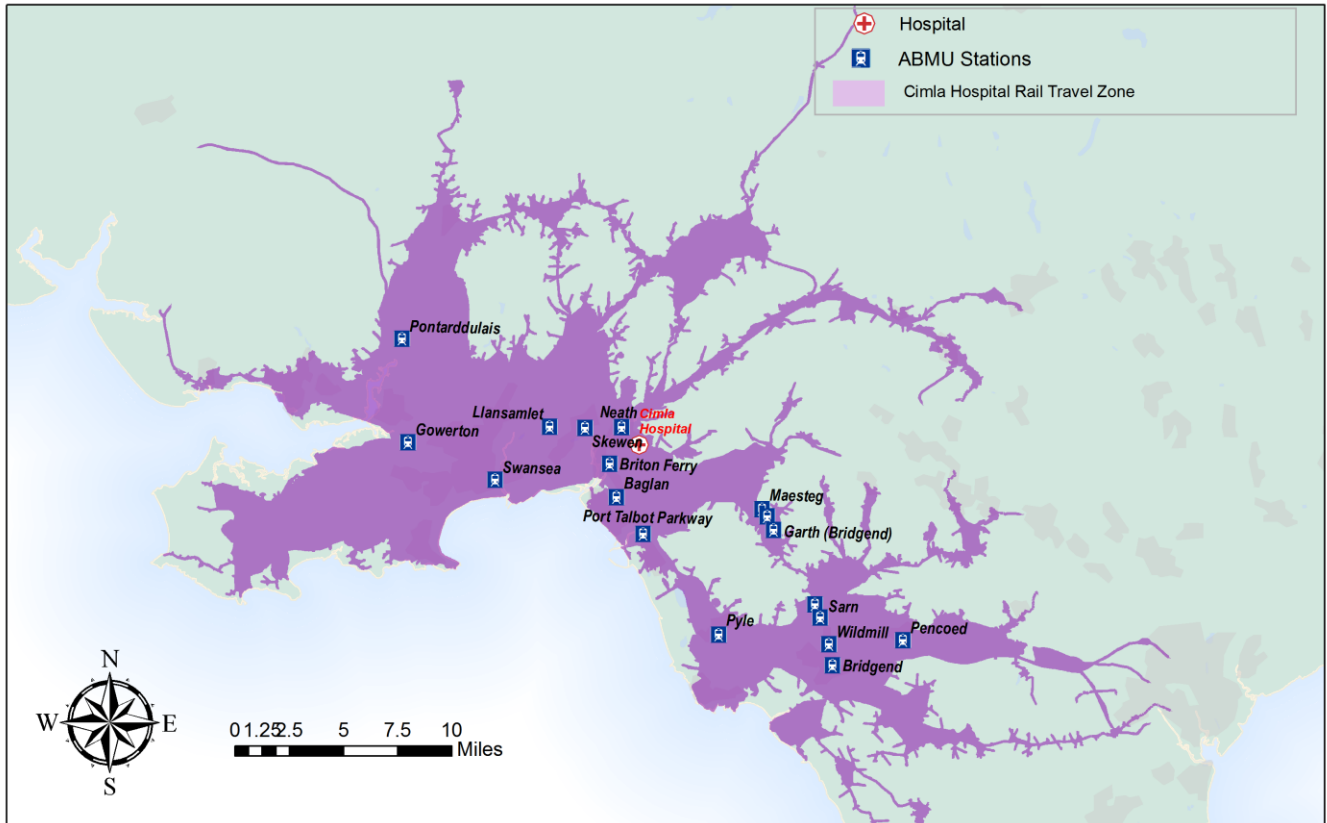
Coity Clinic and Princess of Wales Rail Travel Zone



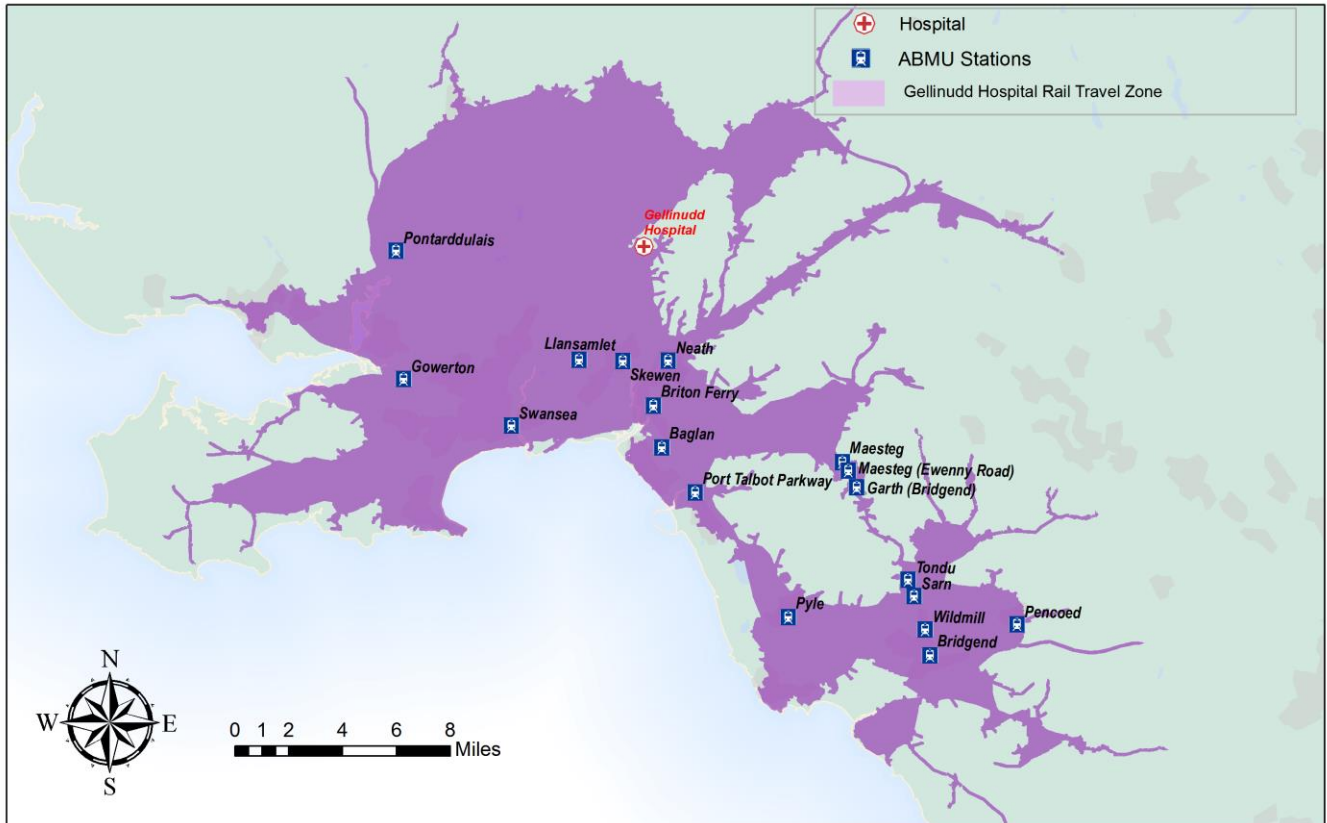
Cefn Coed Hospital Rail Travel Zone



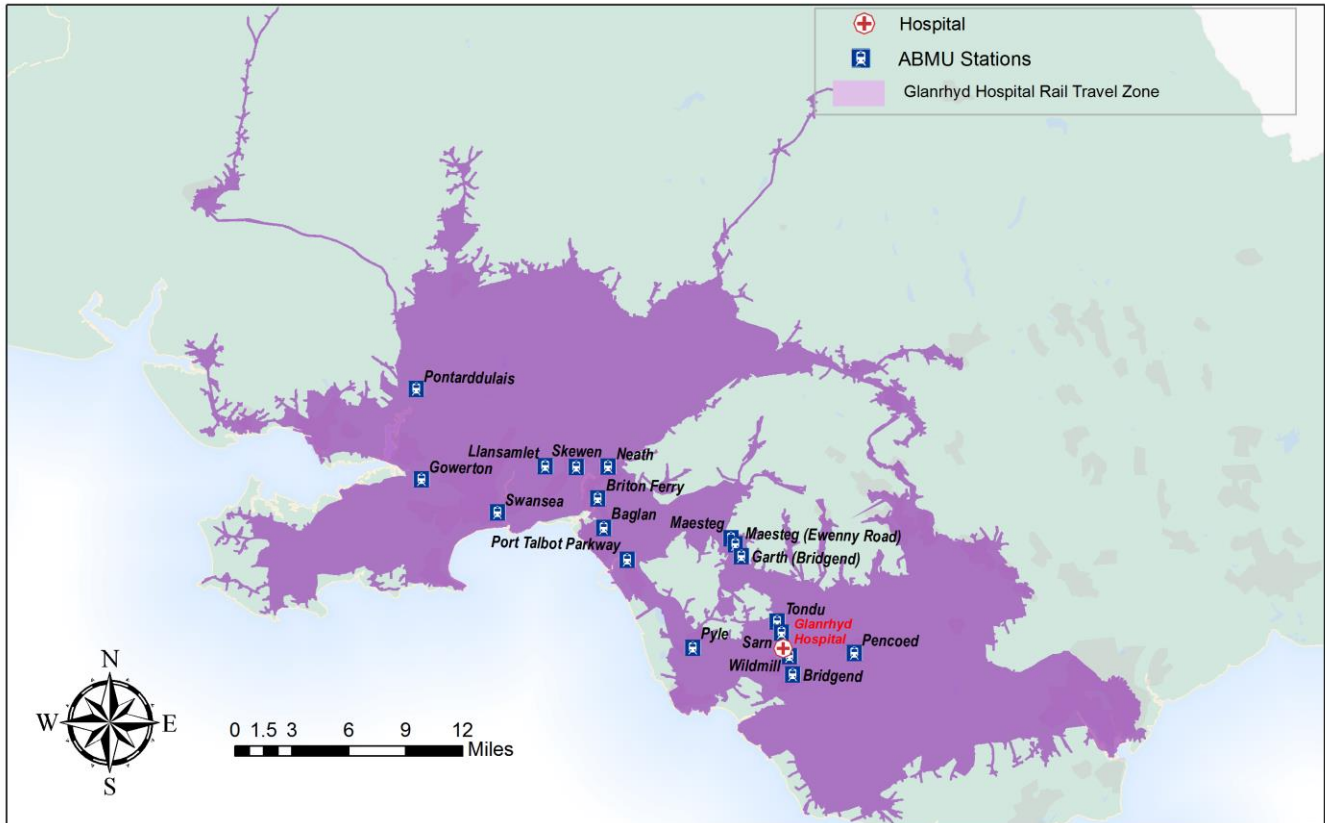
Cimla Hospital Rail Travel Zone



Gellinudd Hospital Rail Travel Zone



Glanrhyd Hospital Rail Travel Zone

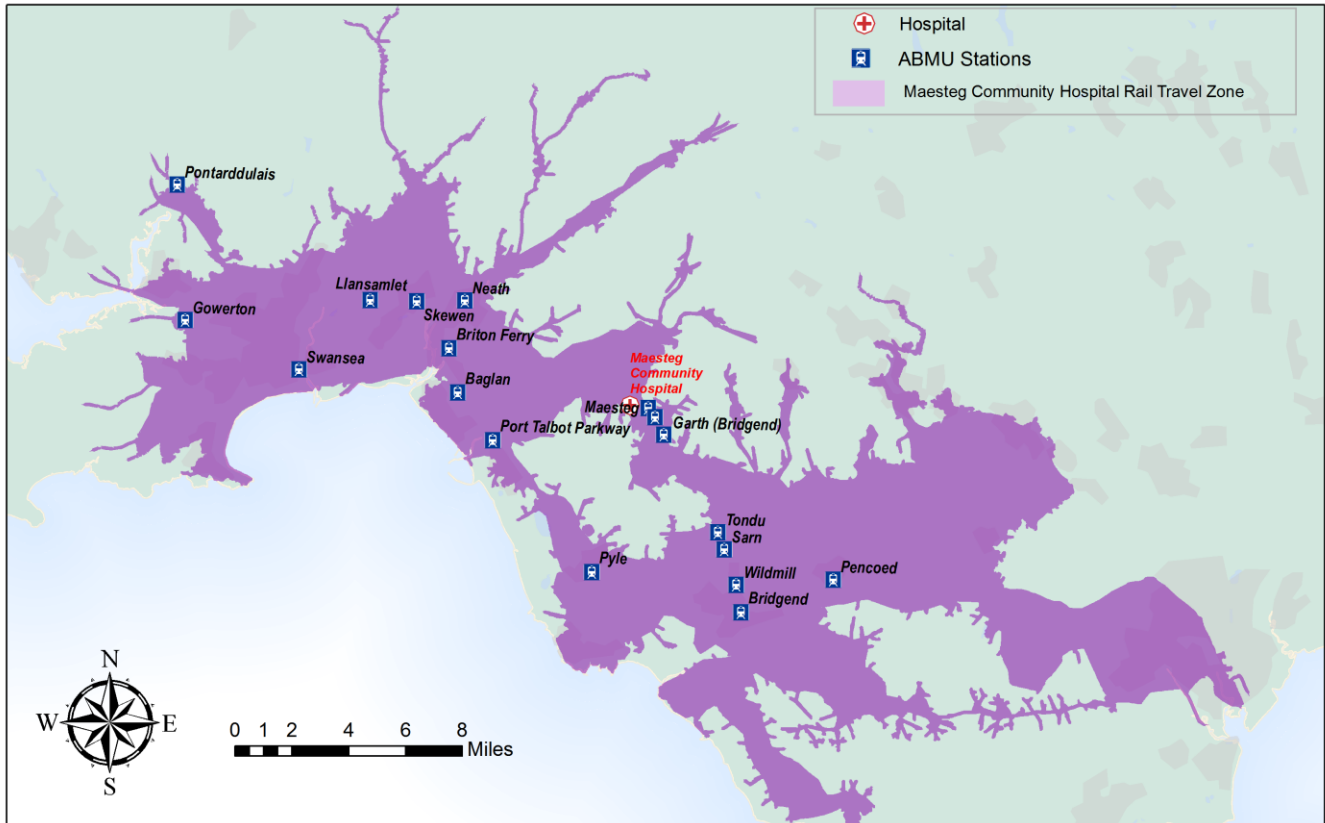


ABMU Changing for the Better: Public Transport

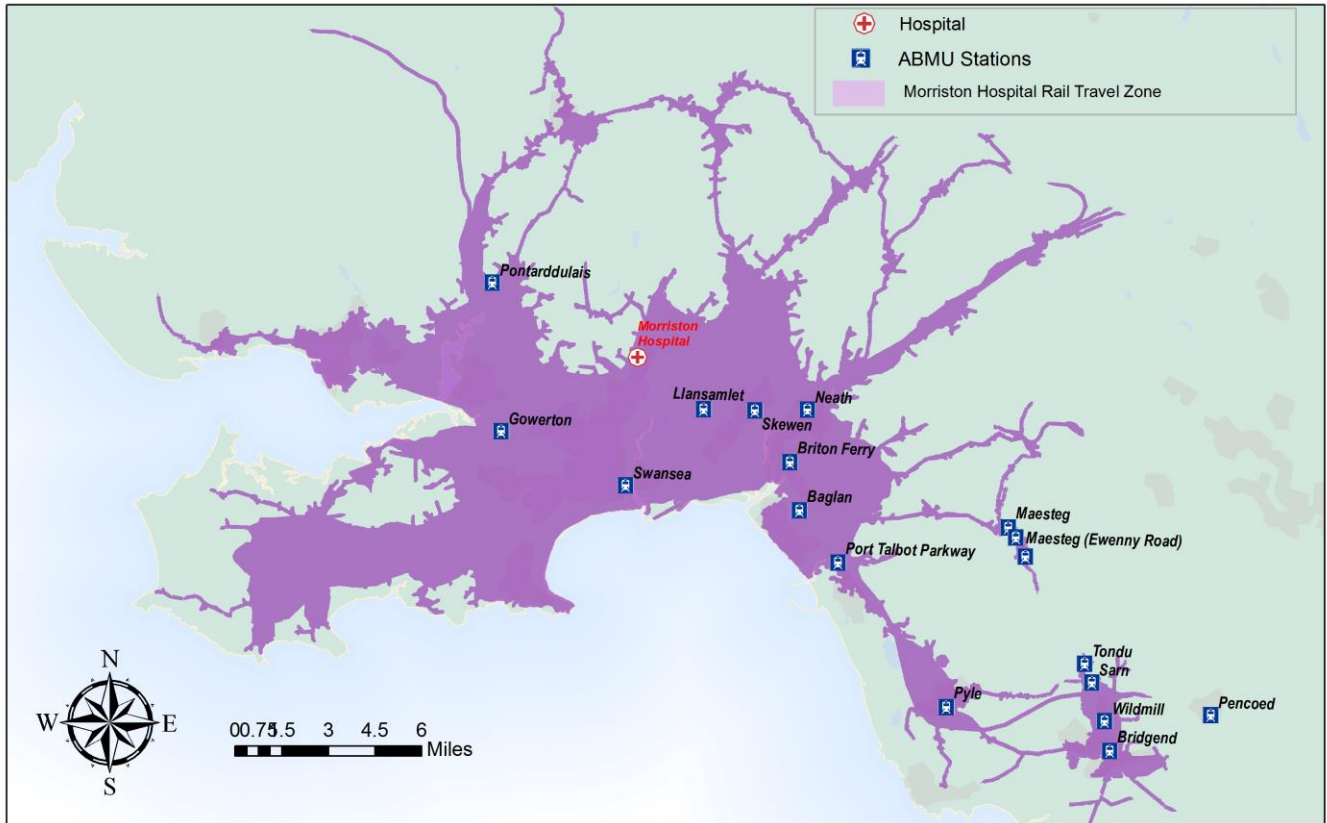
Gorseinon Hospital Rail Travel Zone



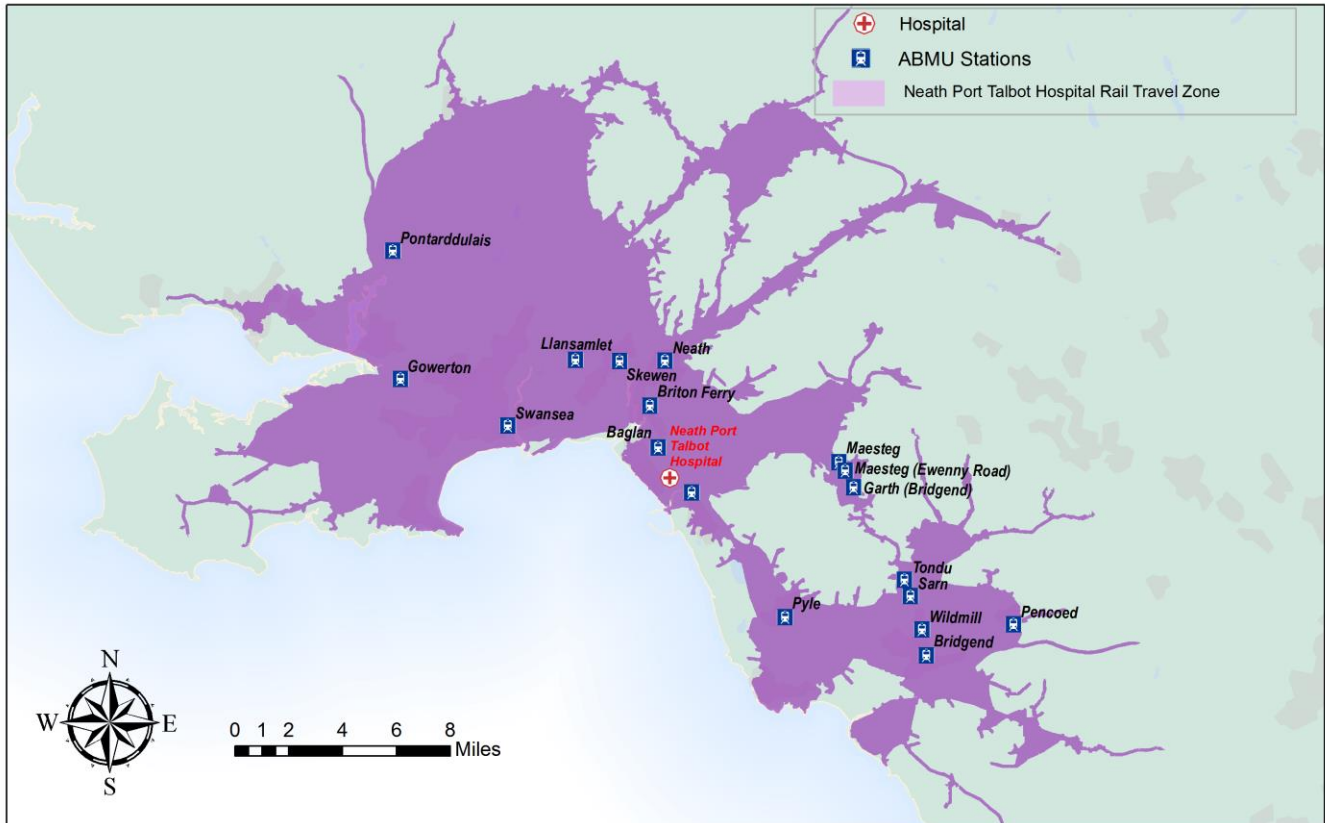
Maesteg Community Hospital Rail Travel Zone



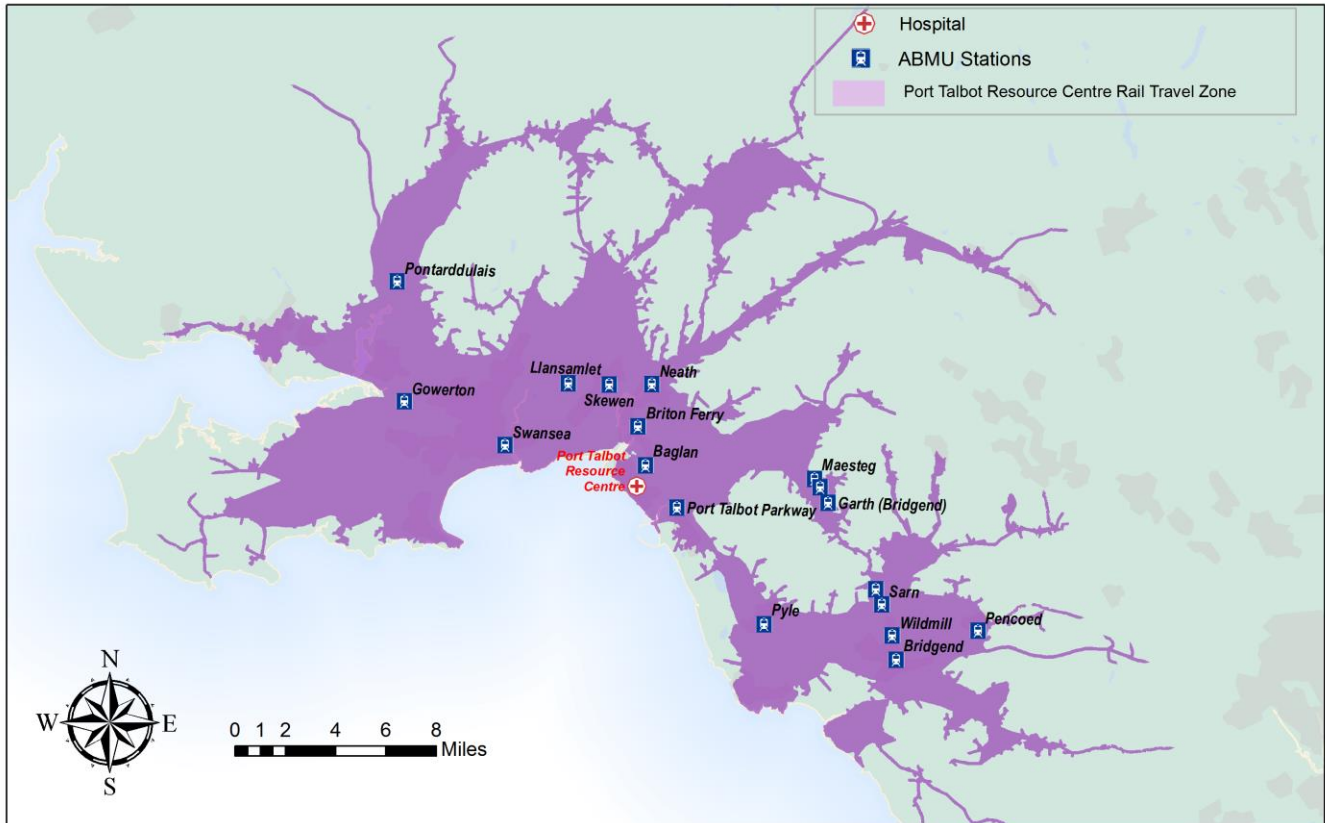
Morrison Hospital Rail Travel Zone



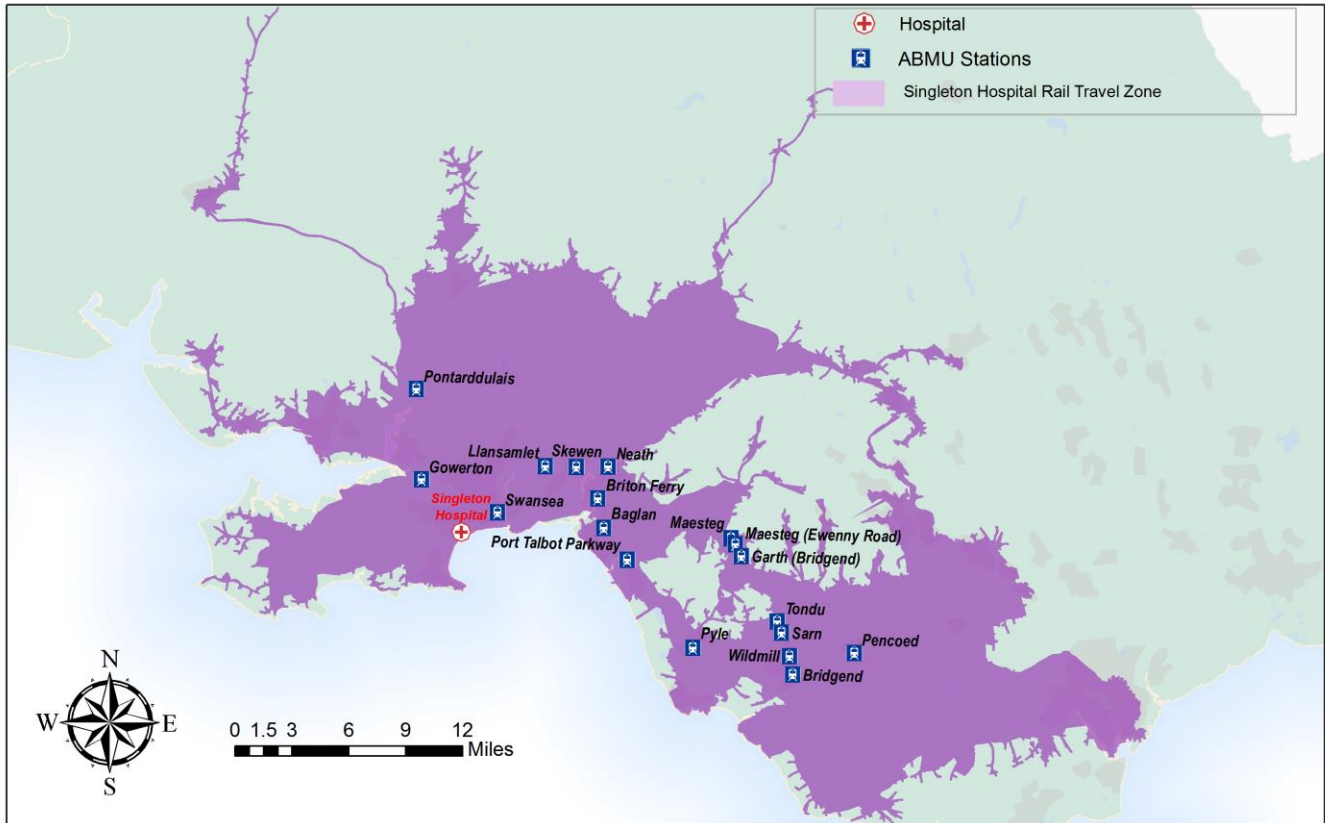
Neath Port Talbot Hospital Rail Travel Zone



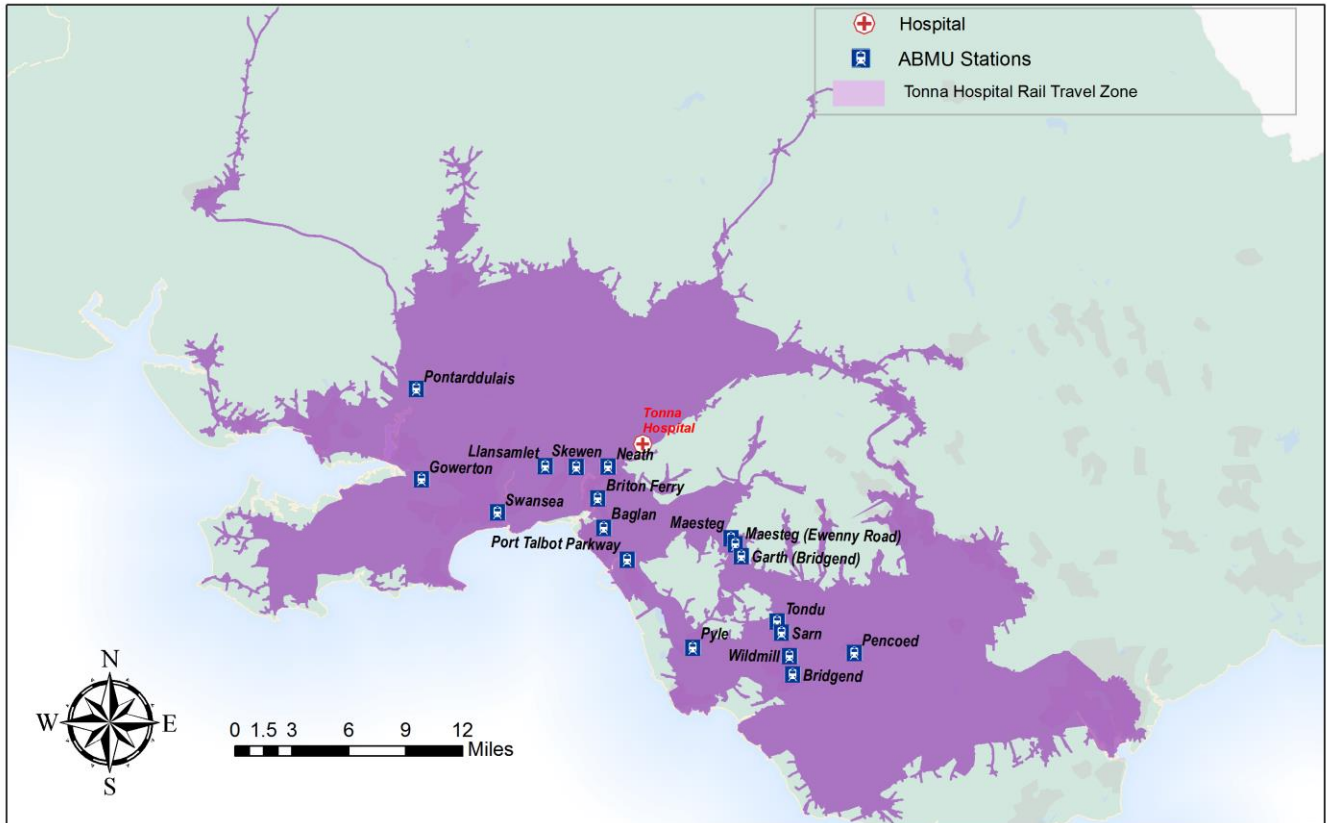
Port Talbot Resource Centre Rail Travel Zone



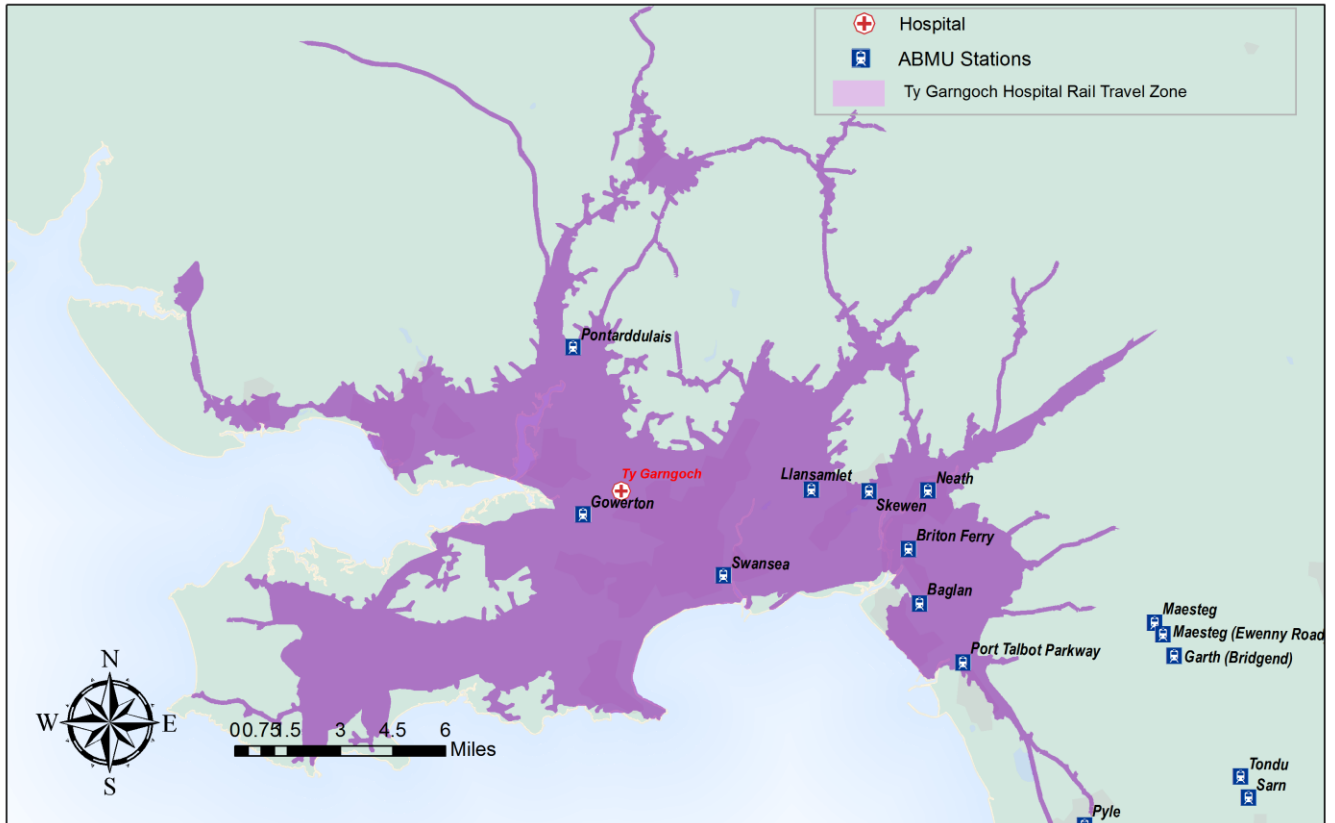
Singleton Hospital Rail Travel Zone



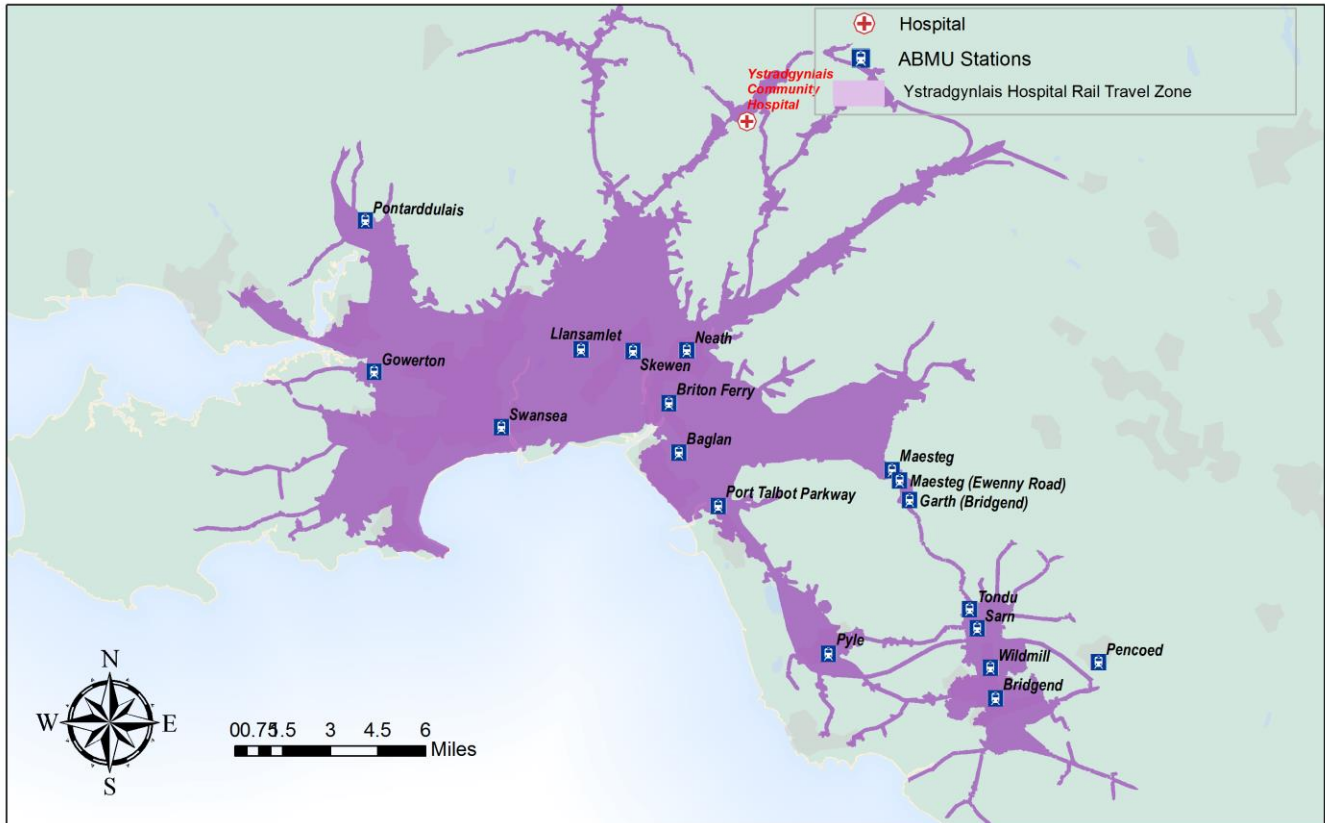
Tonna Hospital Rail Travel Zone



Ty Garngoch Hospital Rail Travel Zone



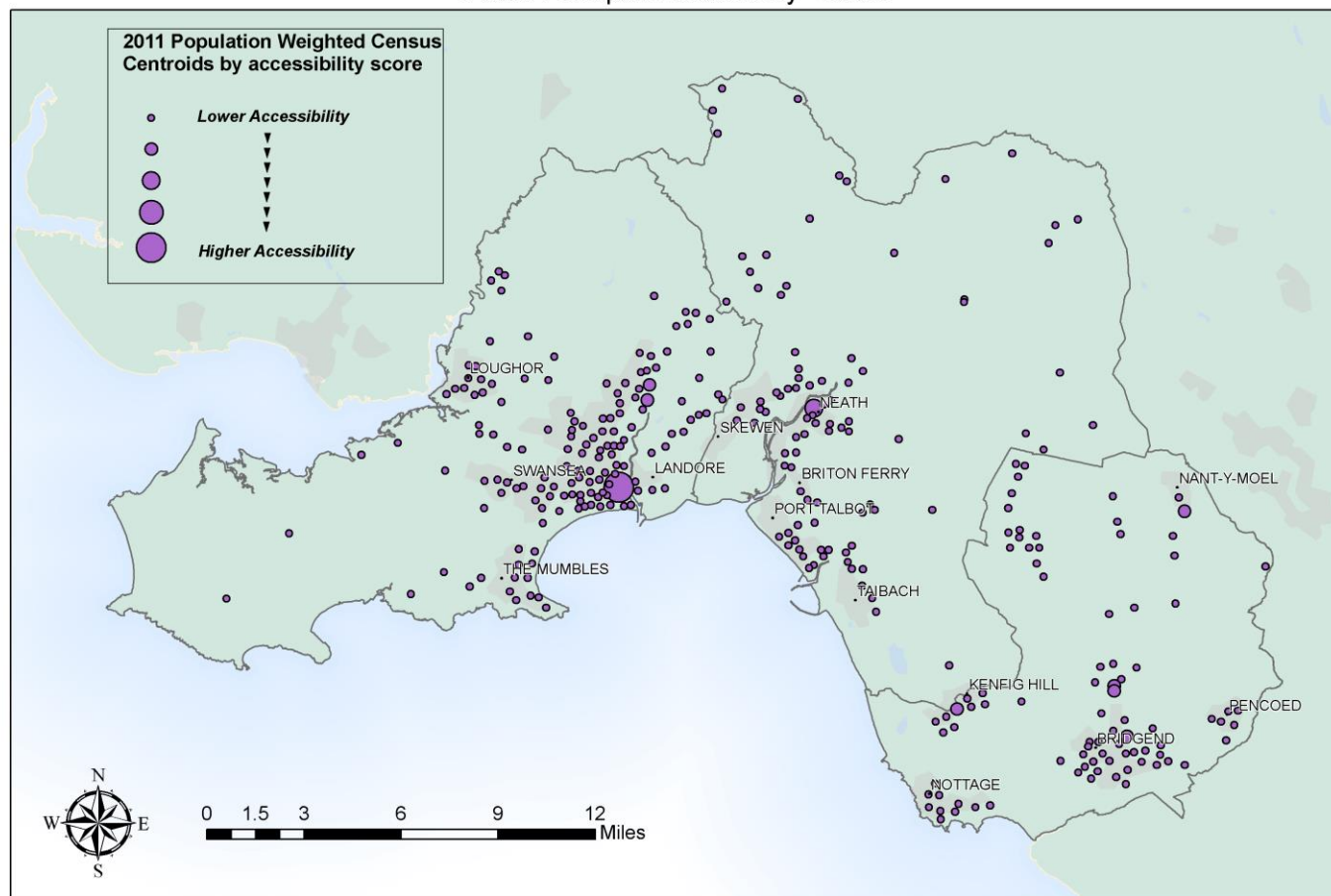
Ystradgynlais Hospital Rail Travel Zone



Appendix 3: Two Step Floating Catchment Analysis Results

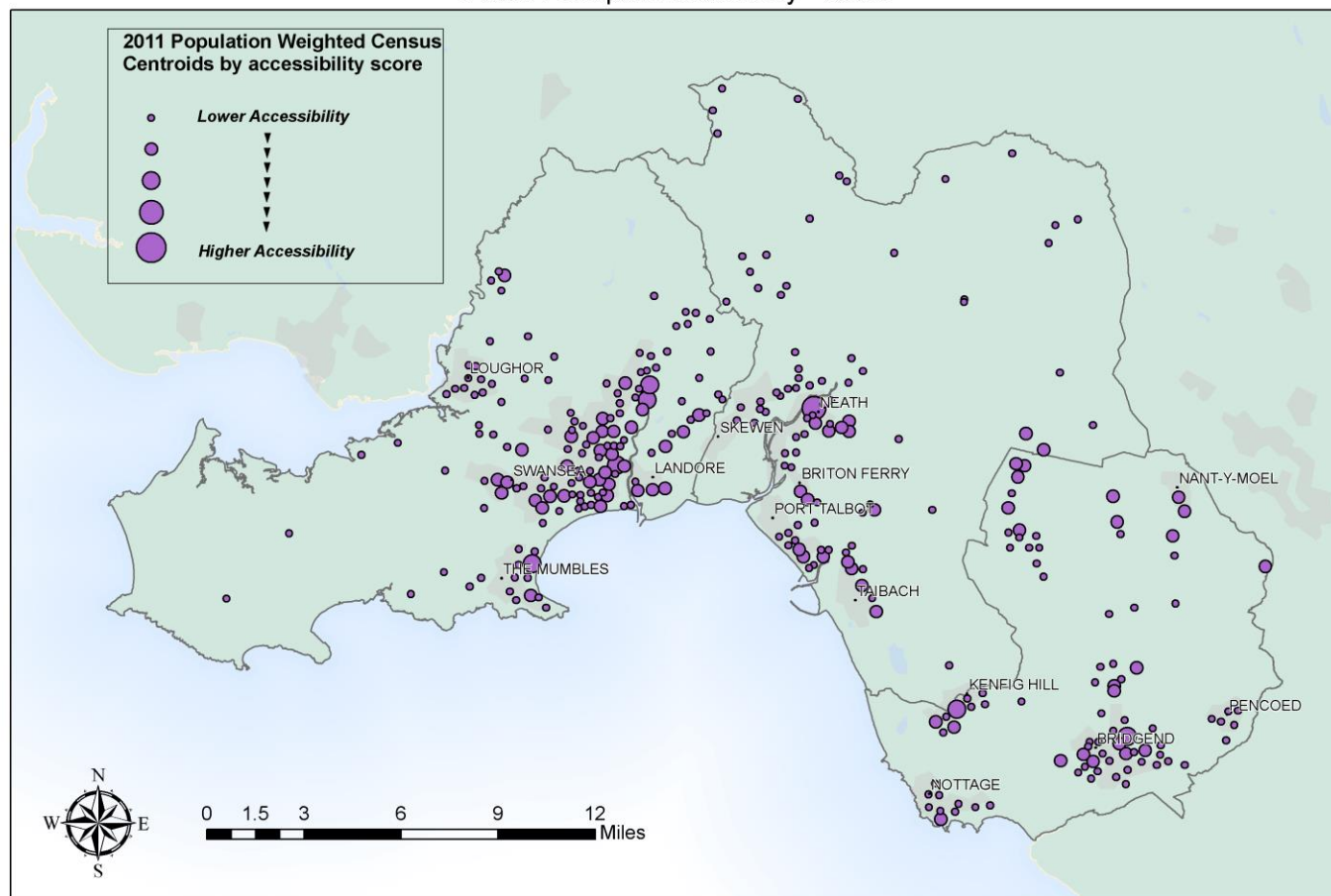
ABMU Changing for the Better: Public Transport

Public Transport Accessibility - 250m



ABMU Changing for the Better: Public Transport

Public Transport Accessibility - 500m



Public Transport Accessibility - 750m

