Limerick Shannon Metropolitan Area Transport Strategy

Rail Assessment & Cost Benefit Analysis

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1. Introduction

1.1 Background

The draft Limerick Shannon Metropolitan Area Transport Strategy (LSMATS) was published in September 2020 and sets out the proposed framework for transport investment for the metropolitan area for the next 20 years. The draft strategy aligns with the over-arching vision and objectives of the National Planning Framework (NPF) and Regional Spatial and Economic Strategy (RSES) and will provide a framework for the planning and delivery of transport infrastructure and services in the LSMA over the next two decades. A key principal of the strategy's vision is to "provide a high level of public transport connectivity to key destinations and within high demand corridors."

Objectives for rail are set out within the draft LSMATS include the following:

- Improving InterCity services, particularly between Dublin, Limerick Junction and Cork
- Dual tracking of Limerick Colbert to Limerick Junction is proposed to improve journey times and increased frequency
- Rail based park and ride with new station at Ballysimon
- Promote consolidation of development around stations
- Colbert rail and bus station redevelopment including improved connectivity to the city centre for walking, cycling and by bus
- Investigate the potential for rail freight including reinstating the line between Limerick and Foynes
- Progress the electrification of the rail network

During the optioneering stage of the draft strategy further improvements were assessed including new train stations within Limerick City, dual tracking of rail lines between Limerick Colbert, Limerick Junction, Nenagh, and Ennis, a new rail line spur to Shannon Town and Shannon Airport and new stations at existing urban settlements along each line including Garryowen, Corbally, Moyross, Cratloe, Bunratty, Castleconnell. Ballysimon, Pallas and Oola. The assessment highlighted that the proposed land use growth and distribution established for the 2040 NPF growth forecasts did not support the provision of significant rail improvements. A lack of Transit Oriented Development around stations and uncompetitive journey times against bus-based proposals resulted in low patronage and, with the exception of the objectives listed above, the rail options considered were not brought forward into the draft strategy for appraisal.

Following the publication of the draft LSMATS a public consultation exercise was completed. As part of this consultation process Iarnród Éireann (IE) made a submission outlining potential additional improvements to the rail network within the region including inter-urban, freight and sub-urban rail improvements that could form part of the strategy.

Iarnród Éireann proposed that the benefits of rail improvements should be considered over a longer time frame that that of the draft strategy due to the timescales involved in implementing changes to infrastructure. They also outlined support for the redevelopment of Limerick Colbert station into a multimodal transport hub in collaboration with the NTA, Bus Éireann and Limerick City and County Council.

1.2 Report Purpose & Scope

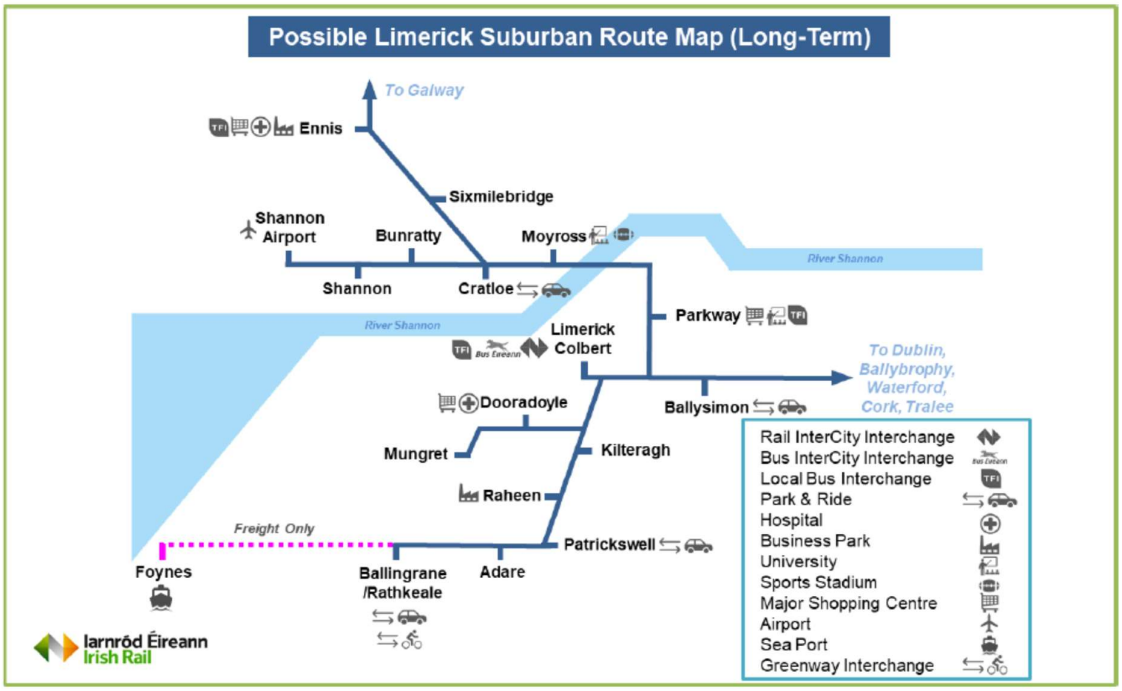
The main focus of this report is the assessment of additional rail options tested as part of the strategy in response to both the Iarnród Éireann submission and the 2020 programme for Government which outlined the prioritisation of rail projects in Limerick as well as the other regional cities.

In their submission, Iarnród Éireann outlines proposals for a new north-south commuter service within the LSMA. This includes the following:

- Re-opening the Foynes Branch to Adare and / or Mungret with possible new stations (Dooradoyle, Mungret, Kilteragh, Raheen, Patrickswell and Adare) and the Foynes curve included;
- Potential turnback and/or passing loop at either Sixmilebridge or Cratloe to increase capacity;
- 3 possible new stations on the line to Ennis / Galway.

Figure 1.1 below shows Iarnród Éireann's long-term vision rail map included within their submission.

Figure 1.1 – Iarnród Éireann Proposed future rail map



The above along with other enhancements, including those set out in the draft LSMATS, have been used to inform the development of potential options and enhancements to the rail line for testing. The main elements included in the assessment based on the proposals included in the submission are:

- Improvements to existing assets;
  - Increased frequency on existing services;
  - Additional stations at Ballysimon, Parkway, Corbally, Moyross, Cratloe and Newport Road;
  - Dual track between Limerick Junction and Limerick Colbert;

- Re-instate previous rail lines;
  - Mungret Line, with stations at Mungret and Dooradoyle;
  - Foynes Line with stations at Adare, Patrickswell, Raheen, Kilteragh, with freight connection beyond to Foynes;
- New rail spur to Shannon Airport;
  - Branching from proposed Cratloe station, with new stations at Bunratty, Shannon Town, Shannon Free Zone and Shannon Airport.

An assessment of different levels of rail network interventions have been tested using a combination of the above improvement measures.

1.3 Report Structure

This report provides an overview of the work completed to assess the different rail improvement options and includes the following chapters:

- **Section 2 Option Development & Costing:** provides an outline of the options tested and the costs of each option.
- **Section 3 Modelling & Land Use Assumption:** sets out the modelling assumptions and forecast land use.
- **Section 4 Model Performance Results:** outlines the performance of each line based on modelled outputs.
- **Section 5 Cost Benefit Analysis:** summaries the cost benefits analysis undertaken and the results.
- **Section 6 Summary:** provides a general summary of this report.

2. Option Development & Costing

2.1 Introduction

The rail options tested are detailed in this chapter. In total 4 options were tested as set out below:

- Option 1 – Existing network with new stations & increased frequencies on existing lines;
- Option 2 – Option 1 with addition of a new line to Shannon;
- Option 3 – Option 2 with addition of new lines to Adare & Mungret;
- Option 4 - Option 3 with dual track elements to improve journey times and reliability.

Each of the options is described in more detail in Section 2.2-2.5 with a full summary provided in Section 2.6. As outlined, an iterative approach to the option assessment was taken, starting with a limited selection of rail improvements and then increasing the accessibility, capacity and frequency of the rail network with each subsequent iteration. This was to help understand the feasibility and viability of the different elements of the proposed network enhancements.

It should be noted that the freight section of rail from Adare to Foynes is not included within the modelling as only passenger services are modelled within the NTA's Regional Modelling System (RMS). More information on the RMS can be found in Section 3 of this report and on the NTA's website at https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/.

2.2 Rail Timetabling

Significant work was undertaken as part of option development to determine the required infrastructure needed to enable an increase in the frequency of services along each line in the proposed rail networks and at each station, particularly with regard to capacity at Colbert Station. This assessment also considered the achievable journey times with and without dual tracking and with and without new stations. The assessment of the options concluded that:

- It is possible to operate services at 20 or 30 minutes headways with both dual and single track options towards Ennis, Shannon, Adare and Mungret.
- Additional passing loops would be required on the route towards Ennis, Adare and Mungret to operate either 20 or 30 minute headway services whilst retaining sections of single line
- Operation of services to both Mungret and Adare upon a single track configuration at a 20 or 30 minute frequency would place significant pressure upon Platform 4 at Limerick Colbert
- Operation of services to Mungret & Adare would either require the reinstatement of the Foynes curve or investment in reversal facilities at Limerick Check, the latter incurring journey time penalties.
- Operation of services to both Ennis and Shannon Airport at either a 20 or 30 minute frequency upon a single track configuration would require significant upgrades to the existing infrastructure, with multiple passing loops required.

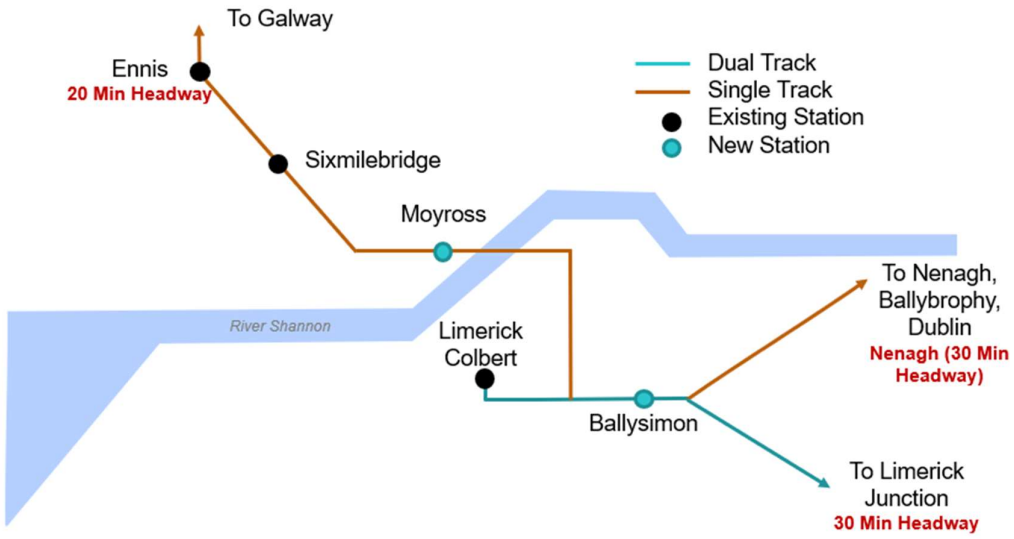
More detail on the timetabling work undertaken can be found in the technote within Appendix A.

2.3 Option 1 – Existing network with new stations

The first option included only enhancements on the existing rail lines. The section of track from Limerick Colbert to Limerick Junction was modelled as dual track with an additional station at Ballysimon, as per the draft strategy. The other lines, Ennis and Ballybrophy, remain as single track and with an additional station at Moyross with this station also serving as a passing loop for services to and from Ennis.

The frequency of service was modelled as every 20 minutes to Ennis and every 30 minutes to Ballybrophy and Limerick Junction. Figure 2.1 shows the rail network for Option 1.

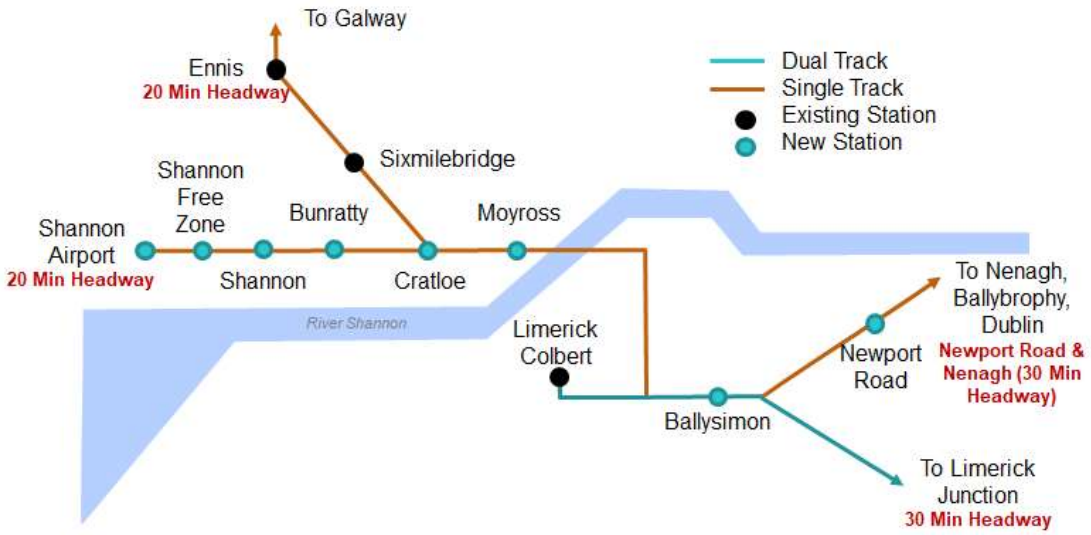
Figure 2.1 – Option 1 Proposed Rail Network



2.4 Option 2 – Shannon Line

Option 2 included further, more extensive improvements to the rail network with the inclusion of the Shannon Rail line as well as a new station at Newport Road on the Ballybrophy line. The Ballysimon station with Park and Ride site is included as per Option 1. The frequencies of the Limerick Junction, Ballybrophy and Ennis in remained as per Option 1 with 20 minutes services modelled from Shannon Airport resulting in a combined frequency of 10 minutes from Cratloe to Limerick Colbert. Figure 2.2 below shows the Option 2 rail network modelled.

Figure 2.2 – Option 2 Proposed Rail Network

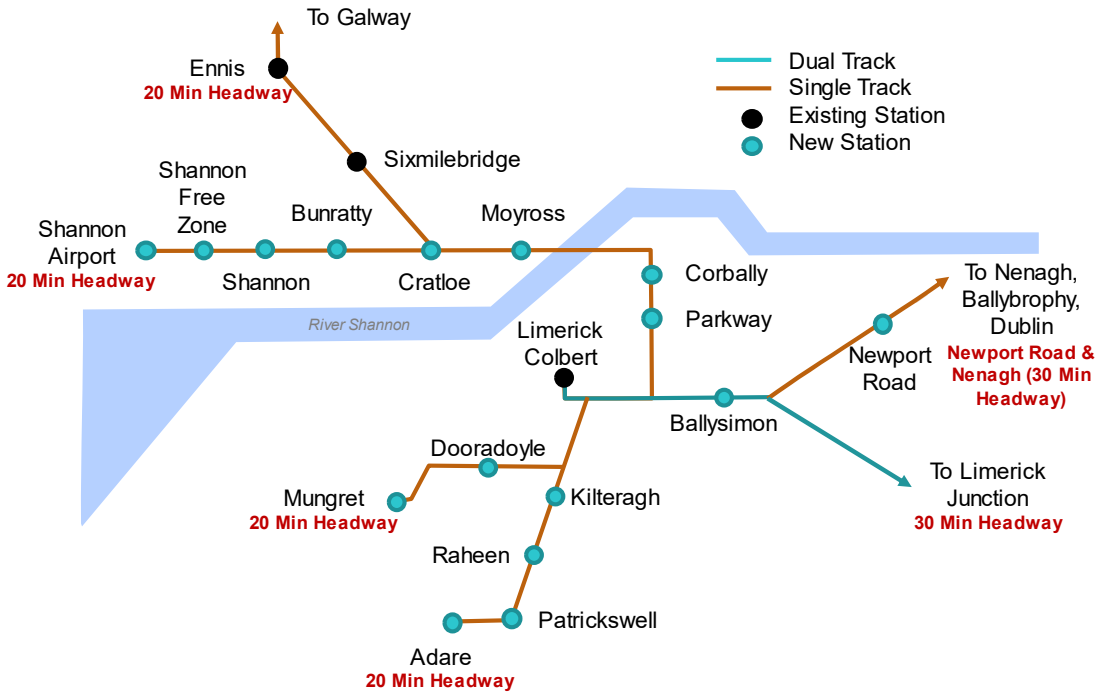


2.5 Option 3 – Full network with single track and passing loops

Option 3 includes the new branch lines to Mungret and Adare in addition to Shannon. It also includes dual track on the Limerick Colbert to Limerick Junction track section as per Options 1 and 2. All other lines remain as single track. Though the single track option has significantly lower cost than dual tracking, journey times are slower and the journey time reliability is reduced. To operate trains with a 20 minute headway on the single track lines, a number of passing loops are required. More detail on the passing loop locations and how these locations were generated can be found in the timetabling note contained with Appendix A.

Figure 2.3 shows the proposed rail network for Option 3.

Figure 2.3 – Option 3 Proposed Rail Network



2.6 Option 4 – Full network with dual track

This option is effectively a Do Maximum scenario including significant levels of improvements across the network. The option includes all of the proposed new rail lines and stations as well journey time improvements on existing rail lines.

In this option all the rail lines in the LSMA are dual tracked including existing lines to Limerick Junction, Ennis and Ballybrophy and the new or reopened lines to Shannon Airport, Mungret and Adare. The dual tracking results in approximately a 10% journey time saving reflecting reduced delays resulting from passing loops. Removing the requirement for passing loops will also improve journey time reliability and allow for increased frequencies if required in the future.

There are also new rail stations on the existing rail line at:

- Moyross;
- Corbally;
- Parkway;
- Ballysimon; and
- Newport Road.

On the new Shannon rail branch line there are stations at:

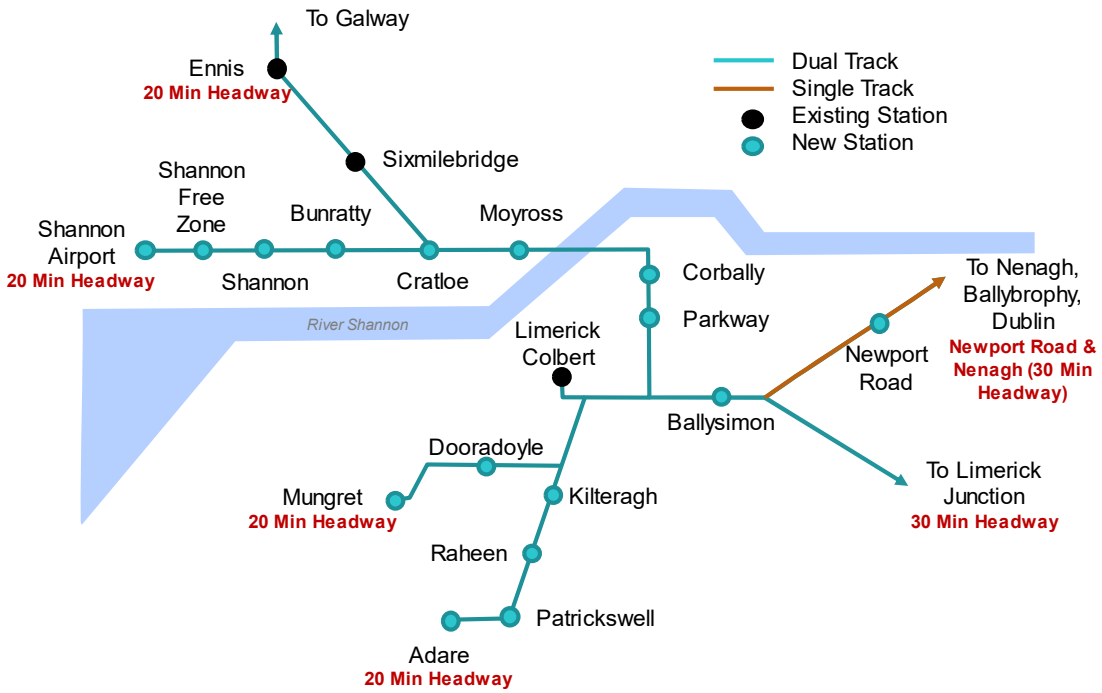
- Shannon Airport;
- Shannon Free Zone;
- Shannon Town; and
- Cratloe

The new Mungret line also includes a station at Dooradoyle, while the new Adare line includes stations at:

- Kilteragh;
- Raheen; and
- Patrickswell.

Figure 2.4 shows the proposed rail network modelled in Option 4.

Figure 2.4 – Option 4 Proposed Rail Network



2.7 Option Costing

A cost estimate was required for each of the options being tested for the Cost Benefit Analysis of the options. This section provides a brief summary of how the costs were developed. The full costings report with further detail on the methodology and assumptions can be found in Appendix B.

A desktop study was completed in order to determine the likely costs of each element of the proposed rail improvements. This involved the use of aerial maps, historical mapping and local knowledge of the area. The costs estimates were developed only for the purposes of this high-level cost benefit analysis. A more detailed study would be required to refine the estimates made here for further stages of appraisal.

As is standard practice a risk allowance of 66% has been applied to the 'Base Cost' to generate the 'P80' value. This is the value that will be used in the cost benefit analysis although the costings were also produced with risk allowances of 53% and 76% as well.

As well as producing the total costs for each of the options tested, the branch lines were costed individually, allowing a comparison of cost and demand to be made on a line by line basis.

The full costings report is included as Appendix B of this report and provides more detail of both the process of calculating the costs and the elements included and excluded in the costings.

The estimated costs for each of the options are outline in Table 1 below.

Table 1 – Cost estimates by Option

Option	Base Costs plus Contractor's Fees (€ BN)	Risk Allowance Added	Capital Cost (€ BN)
Option 1	0.32	Low (P50) – 53%	0.49
	0.32	Mid (P80) – 66%	0.53
	0.32	High (P90) – 76%	0.56
Option 2	0.86	Low (P50) – 53%	1.32
	0.86	Mid (P80) – 66%	1.43
	0.86	High (P90) – 76%	1.51
Option 3	1.12	Low (P50) – 53%	1.72
	1.12	Mid (P80) – 66%	1.87
	1.12	High (P90) – 76%	1.98
Option 4	1.81	Low (P50) – 53%	2.77
	1.81	Mid (P80) – 66%	3.00
	1.81	High (P90) – 76%	3.19

2.8 Option Summary

Table 2 on the following page provides a summary of the infrastructural improvements and costing for each option modelled.

Table 2 – Rail Options – Included Improvements

Rail Schemes	Description	Option 1	Option 2	Option 3	Option 4
Single or Dual track	Existing Intercity - Limerick Junction to Limerick Colbert (30 minute headway)	Dual	Dual	Dual	Dual
	Existing Suburban - Limerick Colbert to Ennis	Single	Single	Single	Dual
	New Spur Suburban - Cratloe to Shannon	X	Single	Single	Dual
	New Spur Suburban - Limerick Colbert to Adare	X	X	Single	Dual
	New Spur Suburban - Limerick Colbert to Mungret	X	X	Single	Dual
With / without curve	New Line Limerick Colbert to Foynes	N/A	N/A	With	With
New Stations - Existing line	Ballysimon	✓	✓	✓	✓
	Parkway	X	X	✓	✓
	Corbally	X	X	✓	✓
	Moyross	✓	✓	✓	✓
	Cratloe	X	✓	✓	✓
	Newport Road	X	✓	✓	✓
New Stations - New Line	Bunratty	X	✓	✓	✓
	Shannon	X	✓	✓	✓
	Shannon Free Zone (Industrial Estate)	X	✓	✓	✓
	Shannon Airport	X	✓	✓	✓
	Dooradoyle	X	X	✓	✓
	Mungret	X	X	✓	✓
	Kilteragh	X	X	✓	✓
	Raheen	X	X	✓	✓
	Patrickswell	X	X	✓	✓
	Adare	X	X	✓	✓

3. Modelling and Land Use Assumptions

3.1 Introduction

This chapter provides a summary of the assumptions underpinning the modelling of the different options to be tested. It also includes detail of the land use assumptions for both of the forecast years.

The modelling work was completed using the updated NTA Mid-West Regional Model (MWRM) version 3. This model has a 2016 base year and improved calibration compared to the previous version 2 model. It should be noted that the initial draft LSMATS was tested using the version 2 model, as this was completed prior to the release of version 3. However, the final strategy has been modelled using version 3 and a summary of the difference between the model version scan be found in Section X of the LSMATS modelling report.

3.2 Model Forecast Years

Two forecast years have been modelled for the medium and long-term demand. It should be noted that the original draft strategy modelled one forecast year. However, a second year has been modelled for the assessment of the rail options in response to points raised in IE submission and to allow for distribution of additional population within the catchment of the proposed rail network. The two forecast modelled years are 2040 & 2070.

3.3 Do Minimum Model

Since the proposed rail improvements are expected to build on the improvements included in the draft LSMATS, it is important that the Do Minimum reflects this. This means that the impacts of the proposed rail enhancements can be isolated for assessment. Hence, the Do Minimum used for the modelling work is the draft LSMATS strategy run, updated for the V3 model.

3.4 Land Use Assumptions 2040

The land use for 2040 forecast year is the same as the land use that was used in the draft LSMATS modelling work. The 2040 Planning Datasheet for the LSMATS was produced by the NTA, in conjunction with Limerick City and County Council (LCCC) and Clare County Council. The forecasts are in line with the National Planning Framework and Regional Spatial and Economic Strategies projections for the LSMA.

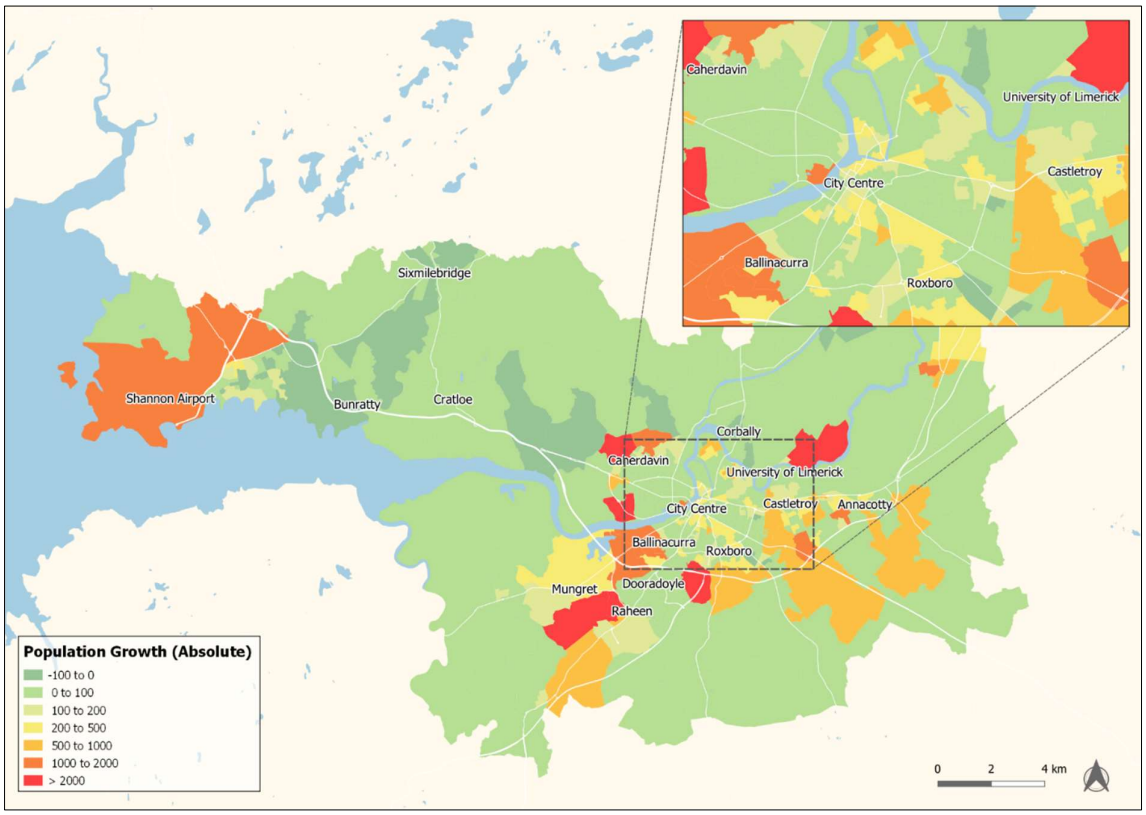
The Planning Datasheet includes primarily includes changes to population, employment and education. The 2016 and 2040 totals and growth for these 3 demographics are shown below in Table 3.

Table 3 – 2040 Land use Assumption Summary

Demographic	2016	2040	2016 to 2040 Growth	
Population	132,420	206,444	74,024	56%
Employment	57,010	83,680	26,670	47%
Education	37,911	55,171	17,260	46%

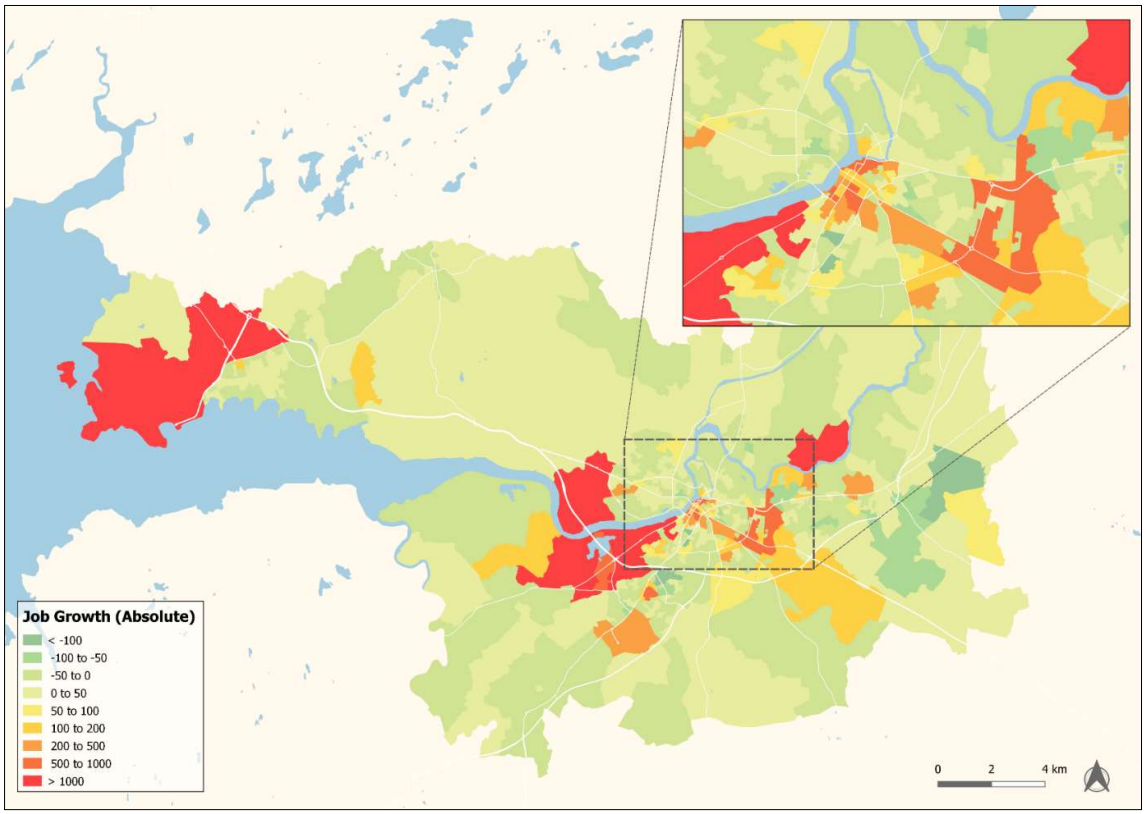
The absolute growth in population by Small Area is mapped in Figure 3.1. Significant increases in population are forecast for the proposed South Clare Economic SDZ, Mungret/Raheen area and Moyross amongst others.

Figure 3.1 – Population Growth 2016 to 2040



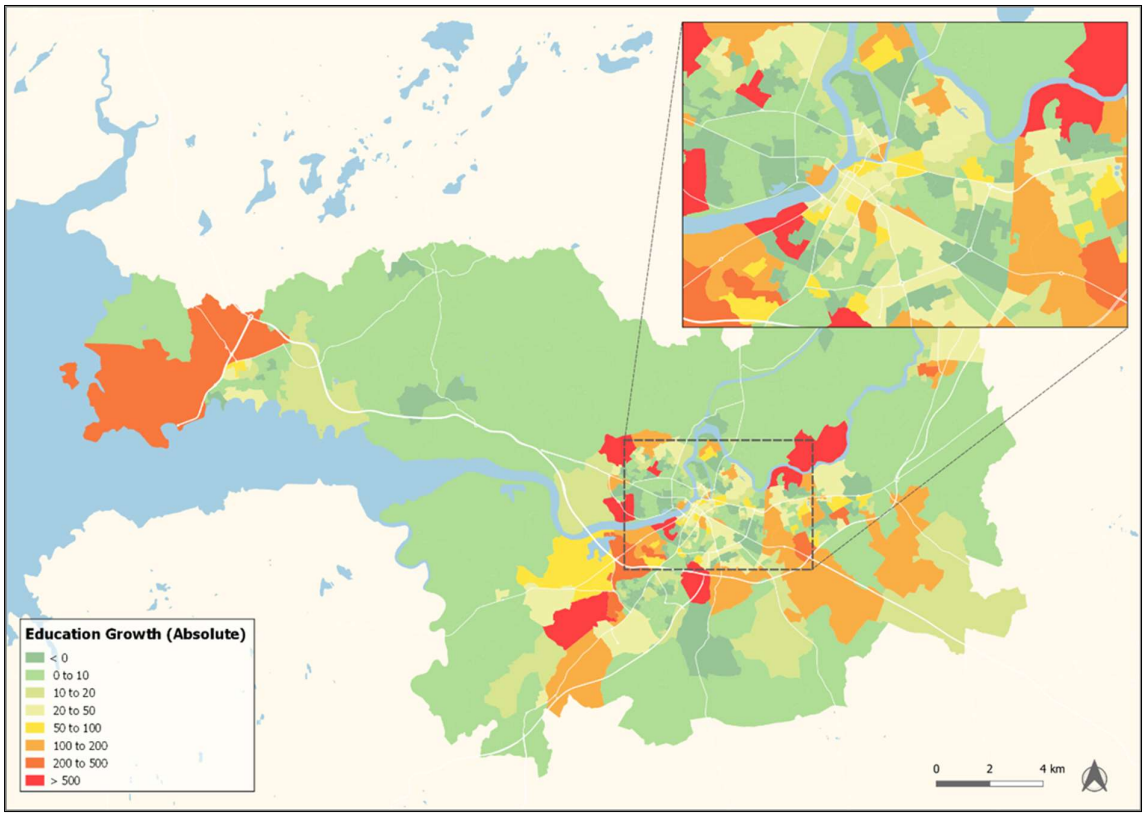
In terms of employment growth, the areas with the highest level of additional employment by 2040 include Ballinacurra (which includes Limerick Docklands), the City Centre, Mungret, Shannon and the proposed South Clare Economic SDZ.. Figure 3.2 shows the areas of employment growth.

Figure 3.2 – Job Growth 2016 to 2040



The final element of the land use included in the Planning Datasheet is education, as with the population and jobs growth the education growth is focused around the Limerick Suburbs and areas of significant population increase such as Mungret and the proposed South Clare Economic SDZ. Figure 3.3 shows the location of education growth.

Figure 3.3 – Education Growth 2016 to 2040



More details of the land use assumptions for 2040 are included in the within the LSMATS modelling report.

3.5 Land Use Assumptions 2070

3.5.1 Population, Employment & Education Growth

There is currently no agreed growth plan for a 2070 forecast year. For the purposes of this study, it was assumed that growth within the LSMA population would continue at the same per annum growth as assumed between 2016-2040. Employment and Education land uses were also factored up by the per annum same rate as assumed between 2016-2040. Table 4 summarises the land use for 2070 and the assumed grow from 2040.

Table 4 – 2070 Land use Assumption Summary

Demographic	2016	2040	2016-2040 Growth	Per Annum	2040-70 Growth		2070 Total
Population	132,420	206,863	74,443	3,102	93,054	45.0%	299,917
Employment	57,010	83,680	26,670	1,111	33,338	39.8%	117,018
Education	37,911	55,171	17,260	719	21,575	39.1%	76,746

The majority of the population growth was then distributed within a 1km catchment of the existing and proposed rail stations. Population for each station was then distributed based on the availability of greenfield/brownfield sites, existing population distribution or area depending on the station location. The proportion of growth included within each station's catchment was agreed with the NTA and is shown in Table 5.

A proportion of the growth was distributed to Ennis and Clarecastle which though just outside the LSMA will benefit significantly from the improved rail network and contribute to the overall demand and viability of the network. Shannon Airport & Free Zone, as non-residential area received no population growth. Education and employment were distributed as per the 2040 planning sheet.

This exercise was completed for the sole purpose of this modelling assessment and to ensure that the forecast land use was orientated around rail. Should further, more refined assessment of the rail options be undertaken these assumptions should reviewed in line with regional and national policy.

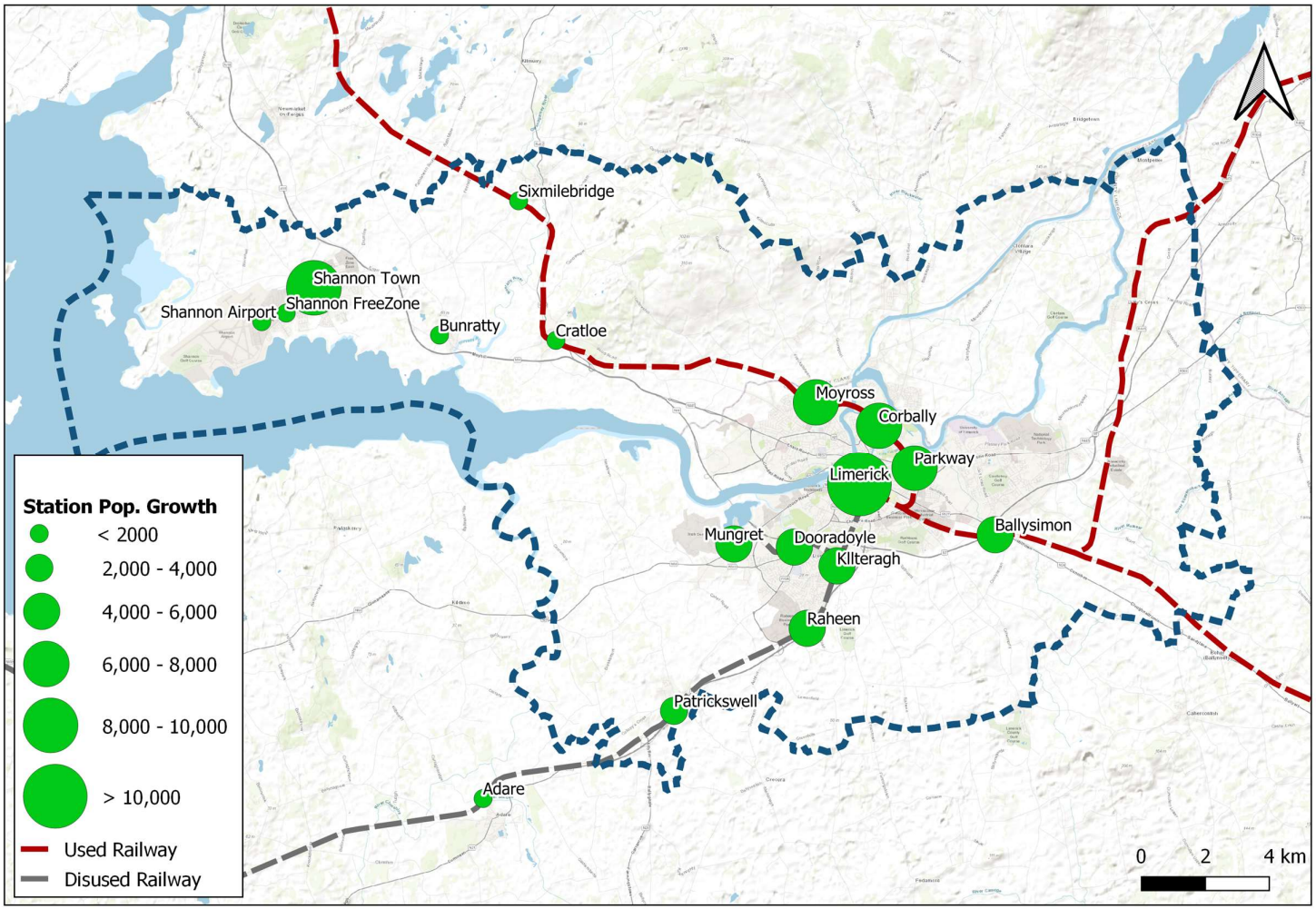
Table 5 - 2070 Land use – additional population within 1km of stations

Distribution of 2070 Growth	Proportion	Population Growth
Colbert	12.5%	11,632
Parkway	7.5%	6,979
Corbally	7.5%	6,979
Moyross	7.5%	6,979
Cratloe	2.0%	1,861
Bunratty	2.0%	1,861
Shannon Town	10.0%	9,305
Shannon Freezone	0.0%	-
Shannon Airport	0.0%	-
Sixmilebridge	2.0%	1,861
Ennis	10.0%	9,305
Clarecastle	2.5%	2,326
Ballysimon	5.0%	4,653
Tiperary Town	2.0%	1,861
Dooradoyle	5.0%	4,653
Mungret Village	5.0%	4,653
Kilteragh	5.0%	4,653
Raheen	5.0%	4,653
Patrickswell	2.5%	2,326
Adare	2.0%	1,861
Remainder LSMA (as per 2040 Distribution)	5.0%	4,653
Total	**100.0%**	**93,054**

The growth around stations is also depicted in the map in Figure 3.4. The level of growth is greatest around Limerick Colbert station in the City Centre. As the origin or destination of the new rail services, any population living close to the station would benefit from a much-improved rail service with new destinations and improved frequency of service on existing rail lines.

Ennis and Shannon Town as the two other main centres have the next highest levels of growth, followed by the stations within the Limerick suburban area on the rail line to Ennis or Shannon airport (Parkway, Corbally and Moyross). The remainder is distributed between the other stations with the lower levels of growth assumed in the more rural stations.

Figure 3.4 – 2070 Land Use Assumptions – Growth around rail stations



3.5.2 Special Zones

Growth for 'special' zones within the model, Shannon Airport and Foynes Port was provided up until 2050 from the NTA's National Demand Forecasting Model. This per annum growth from 2049-2050 was then assumed to continue up to 2070. This results in a 1.3% and 1.7% per annum growth from 2050-2070 for the Airport and Port respectively.

4. Model Results

4.1 Introduction

This chapter outlines the modelling results from all of the options tested in terms of performance of the network. This includes the following metrics:

- **Max Volume** – Highest hourly passenger demand along individual lines at a single point;
- **Proposed service capacity** – The proposed service capacity if defined as 85% of crush capacity with the spare capacity being the proposed service capacity less than passenger demand;
- **Line flows** – Hourly Passenger Demand across all sections of the network;
- **Station Demand** - Boardings and Alightings at individual stations.

The results included in this section are for the AM peak hour and represent the hourly peak demand. The capacity totals also reflect an hourly capacity – i.e. the new services have a headway of 20 minutes so the capacity of one service is multiplied by three trains per hour. The capacity of the trains is based on set values used with the RMS for both seated and crush capacity for different PT service types.

4.2 Option 1 Results

Option 1 is primarily the existing rail network and services with increased frequencies and two new stations Moyross, serving the Ennis line, and Ballysimon, on the Ballybrophy & Limerick Junction lines. The line to Limerick is also assumed to be dual tracked with single track retained on the rest of the network.

4.2.1 Option 1 Max Volume & Capacity

The maximum passenger volumes along each of the existing lines is shown in Figure 4.1 & Figure 4.2 for 2040 & 2070 respectively. As shown, in 2040 the maximum volume across all services is on the Ballybrophy line followed by the Limerick Junction line. All services operate with significant levels of spare capacity with no service reaching seated or proposed service capacity in 2040.

By 2070, demand on all lines has increased significantly, particularly on the Ennis line which is now the busiest service. All lines nearly reach or exceed the seated capacity with the Ballybrophy lines reaching 87% of proposed service capacity. The full boardings and alighting graphs for each year and lines showing the volumes along whole line in each direction can be found with Appendix C.

Figure 4.1 – Option 1 – 2040 AM Peak Max Volume & Spare Capacity

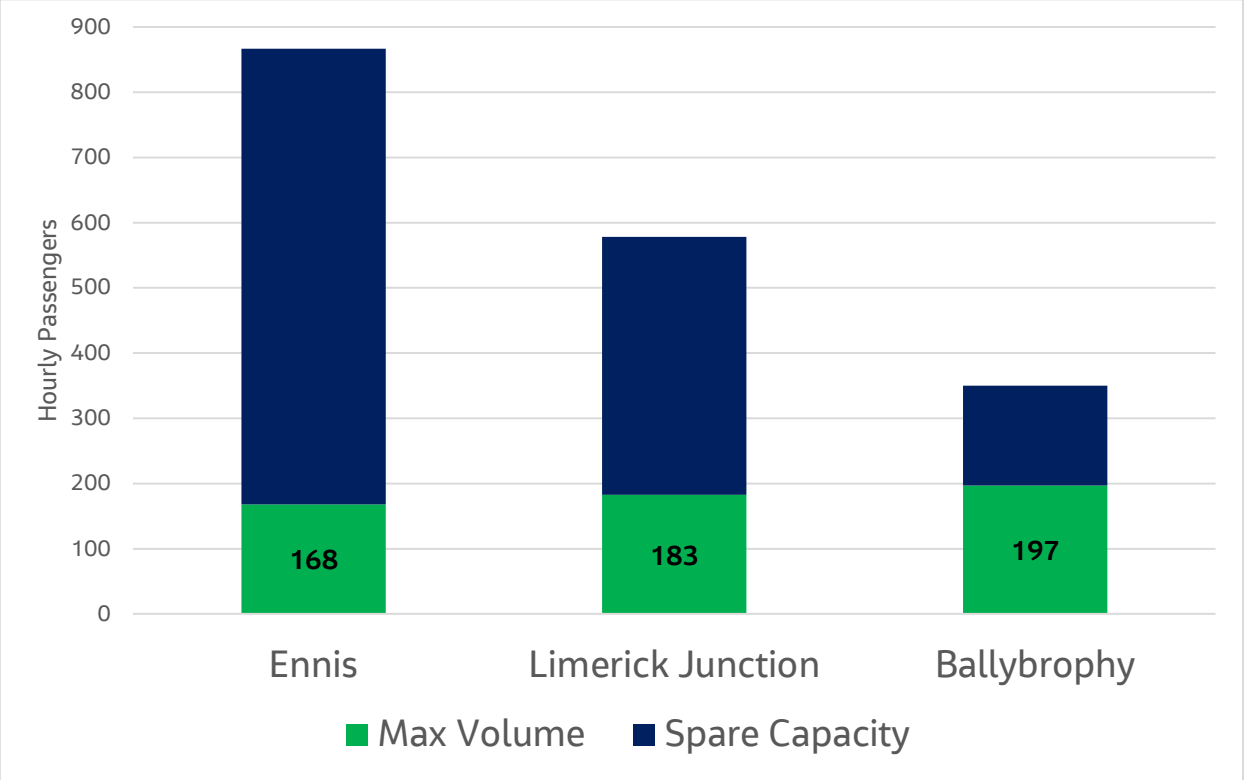
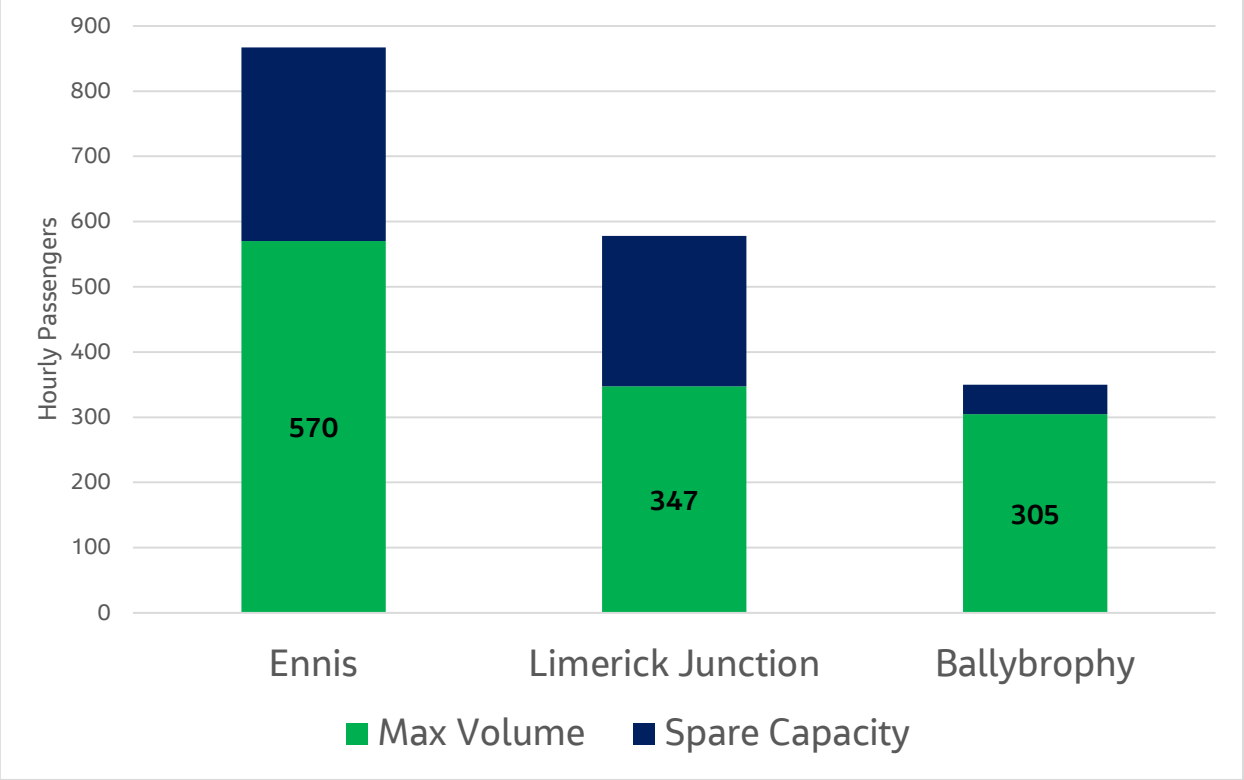


Figure 4.2 – Option 1 – 2070 AM Peak Max Volume & Spare Capacity



4.2.2 Option 1 Line Flows

Line flow maps showing the AM peak passengers volumes cross the network are shown in Figures 4.3 & 4.4 for 2040 and 2070 respectively. In 2040, the busiest section of the network is inbound from Ballysimon to Colbert with passenger volumes of 269. The busiest section of the Ennis line is between Sixmilebridge and Moyross with 168 passengers.

In 2070, passengers flows have increased substantially across the network particularly on the Ennis line with passengers numbers reaching 570. Though there is a less of an increase proportional on the other two lines the maximum volumes across the network is still between Ballysimon and Colbert.

Figure 4.3 Option 1 – 2040 Line Flows

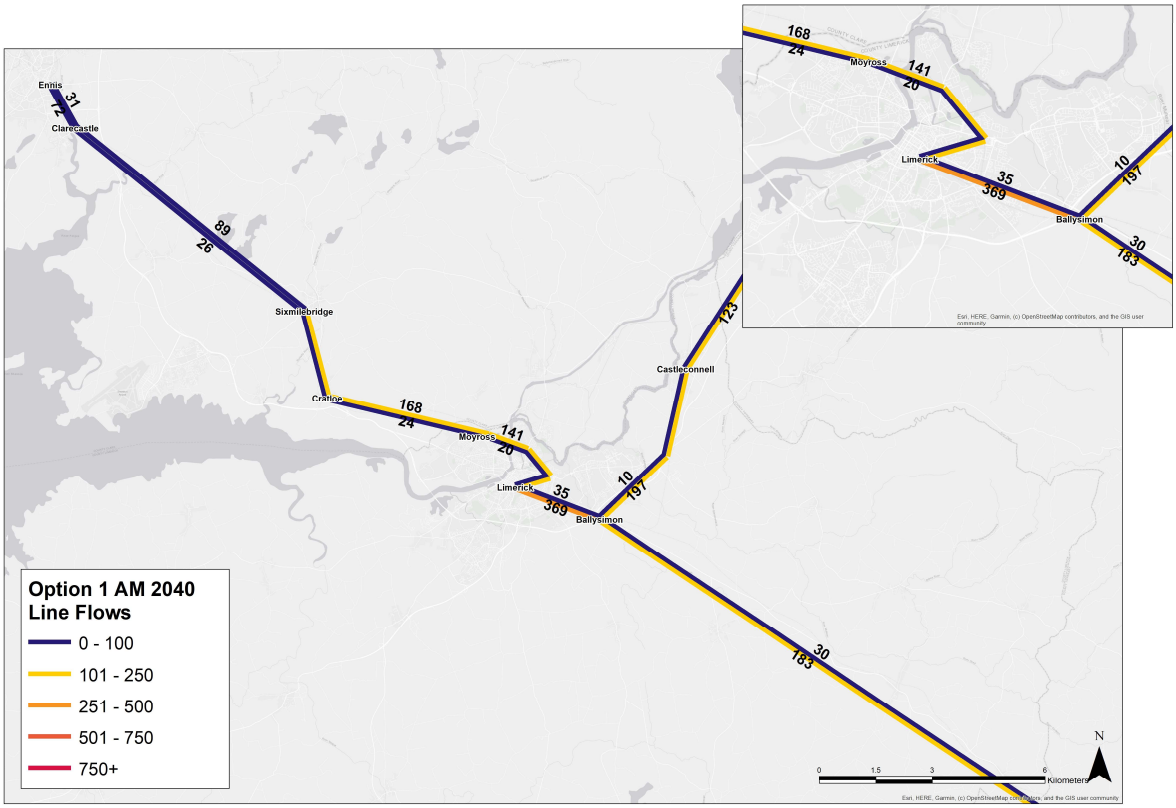
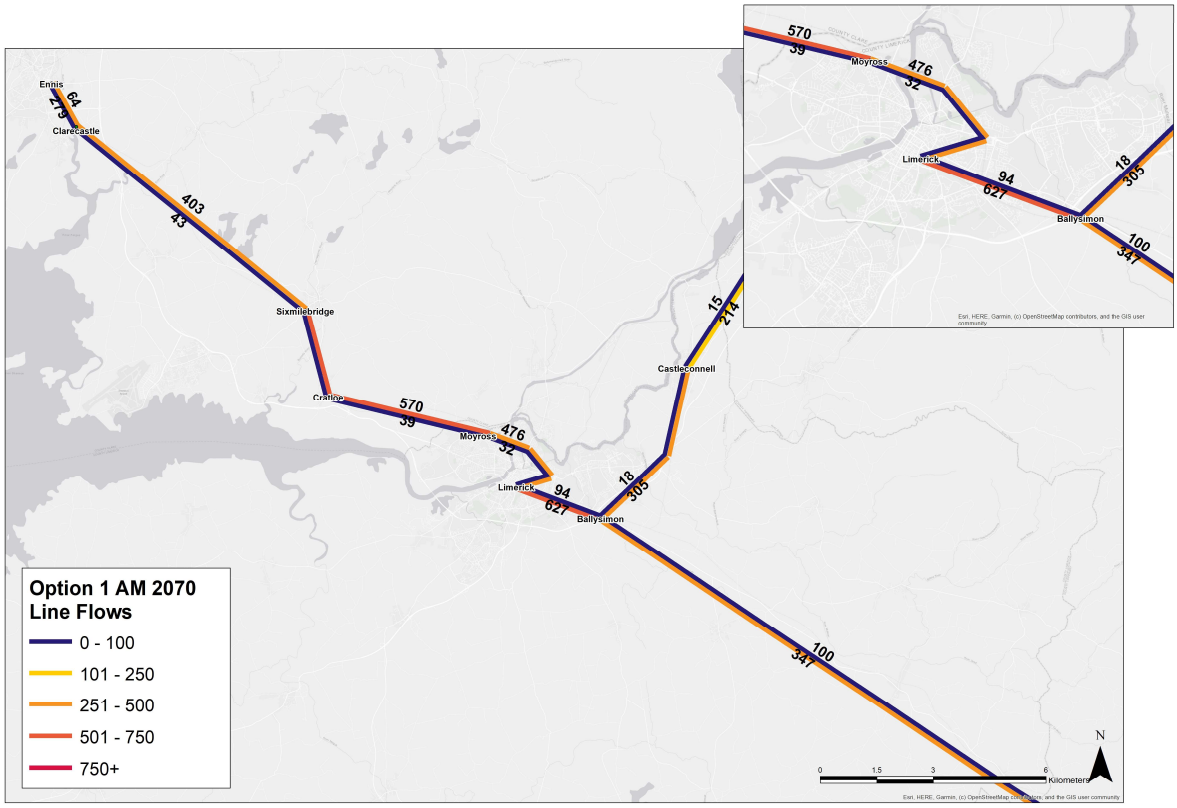


Figure 4.4 Option 1 – 2070 Line Flows



4.2.3 Option 1 Station Performance

Table 6 outlines the boardings and alightings for each station for both forecast year by service line, or combined service lines where the station is served by more than one service. As outlined, the busiest station on the Ennis Line in 2040 is Sixmilebridge followed by Ennis which has the highest boardings demand in 2070.

Along the Ballybrophy Line Castleconnell has the highest boardings in both 2040 & 2070 though demand is similar at Birdhill, Nenagh & Roscrea. Limerick Junction is the busiest station overall in terms of boardings. It should be noted that these Boardings only include the Limerick Junction to Limerick Service and not intercity services.

Table 6 – Station AM Boardings & Alightings

Line	Station	2040		2070	
		Boardings	Alightings	Boardings	Alightings
Ennis	Ennis	72	31	279	64
	Clarecastle	27	5	154	9
	Sixmilebridge	88	7	190	19
	Moyross	9	31	22	110
Ballybrophy	Ballybrophy	3	48	4	62
	Roscrea	64	6	92	8
	Cloughjordan	19	1	26	2
	Nenagh	46	18	87	27
	Birdhill	60	3	93	4
	Castleconnell	77	5	94	6
Limerick Junction	Limerick Junction	183	30	347	100
Ballybrophy/ Junction	Ballysimon	10	16	39	41
All	Colbert	55	510	126	1103

4.3 Option 2 Results

Option 2 is as per Option 1 with the addition of a new rail line to Shannon Airport with associated rail stations and additional stations at Newport Road, on the Ballybrophy line, and Cratloe at the point where the Shannon line branches off the Ennis line.

4.3.1 Option 2 Max Volume & Capacity

Figure 4.5 and Figure 4.6 show the maximum passengers volumes along each line modelling in Option 2 for 2040 and 2070 respectively. The graphs also outline the spare capacity on each service (proposed service capacity less than maximum volume). The full boardings and alighting graphs with the end to end volume and station demand can be found in Appendix C of this report.

In 2040, the Ballybrophy line is expected to have the highest number of passengers, closely followed by the Limerick Junction line. By 2070, the Ennis line is expected to have the highest passenger volume, followed by Shannon reflecting the increase in population growth along these lines in the interim period. The Ballybrophy line is expected to be closest to proposed service capacity by 2070, although the proposed service capacity is lower for this line.

In 2070 the Ennis line reaches seated capacity (shown in the graphs in Appendix C) at Cratloe and remains close to seated capacity for the remainder of the journey to Limerick Colbert. However, the line still operates with considerable spare capacity. For the Shannon line, seated capacity is not reached at any point on the line. The maximum passenger volume is modelled at Cratloe. The line to Limerick Junction also does not reach seated capacity at any point.

Figure 4.5 – Option 2 – 2040 AM Peak Max Volume & Spare Capacity

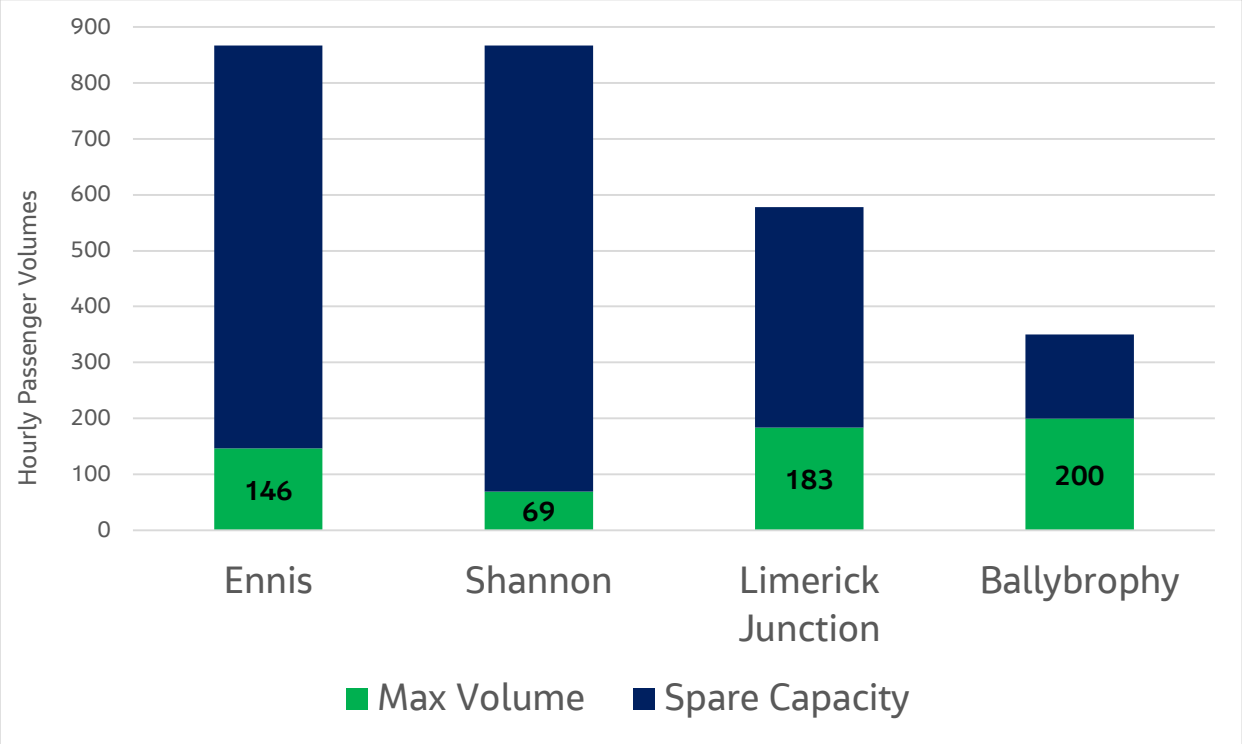
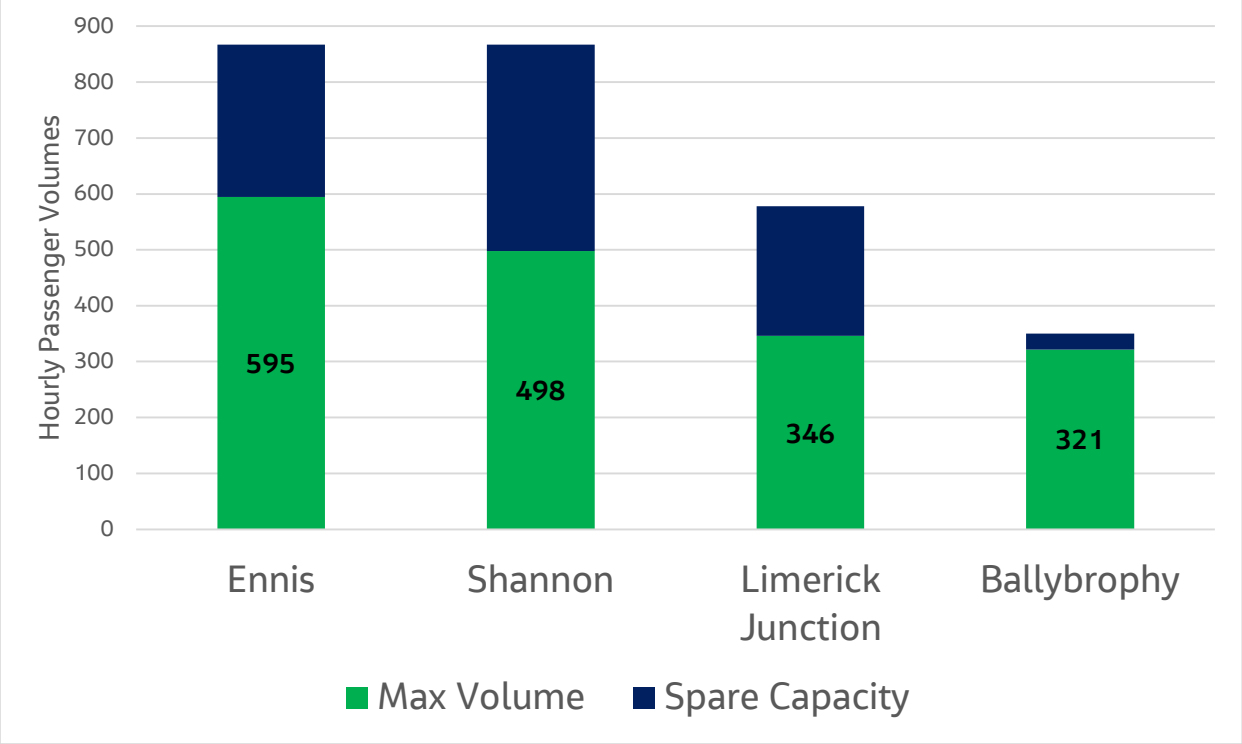


Figure 4.6 – Option 2 – 2070 AM Peak Max Volume & Spare Capacity



4.3.2 Option 2 Line Flows

Show the line flows for 2040 and 2070 for Option 2. In 2040, the busiest section of the rail network is between Ballysimon and Colbert, after the Limerick Junction and Ballybrophy lines merge. This is followed by the section from Cratloe to Moyross, where again the Shannon and Ennis lines merge.

By 2070, there is a substantial increase in volumes on the Ennis and Shannon lines resulting from the significant population growth along the line in the interim period as well as delays on the wider network increasing the attractiveness and competitiveness of the rail services. This is less evident in the Ballybrophy and Limerick Junction lines where less population growth has been assumed.

Figure 4.7 Option 2 – 2040 Line Flows

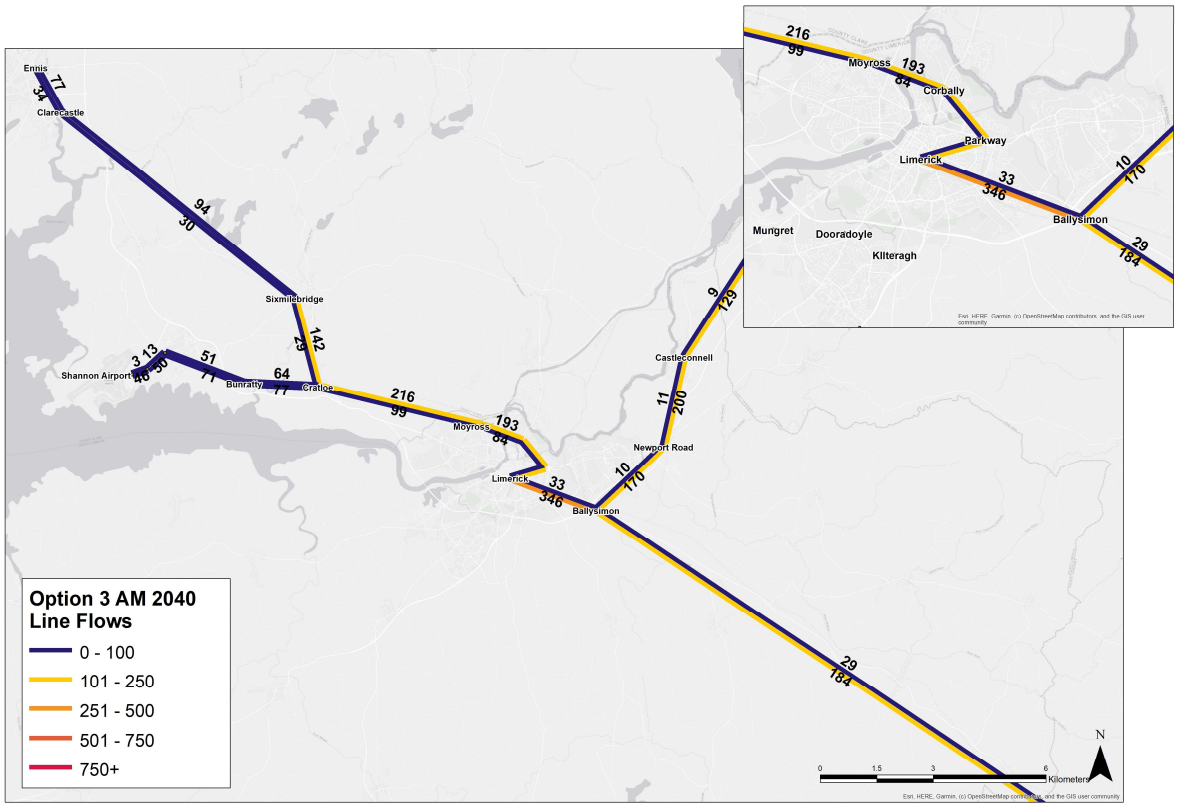
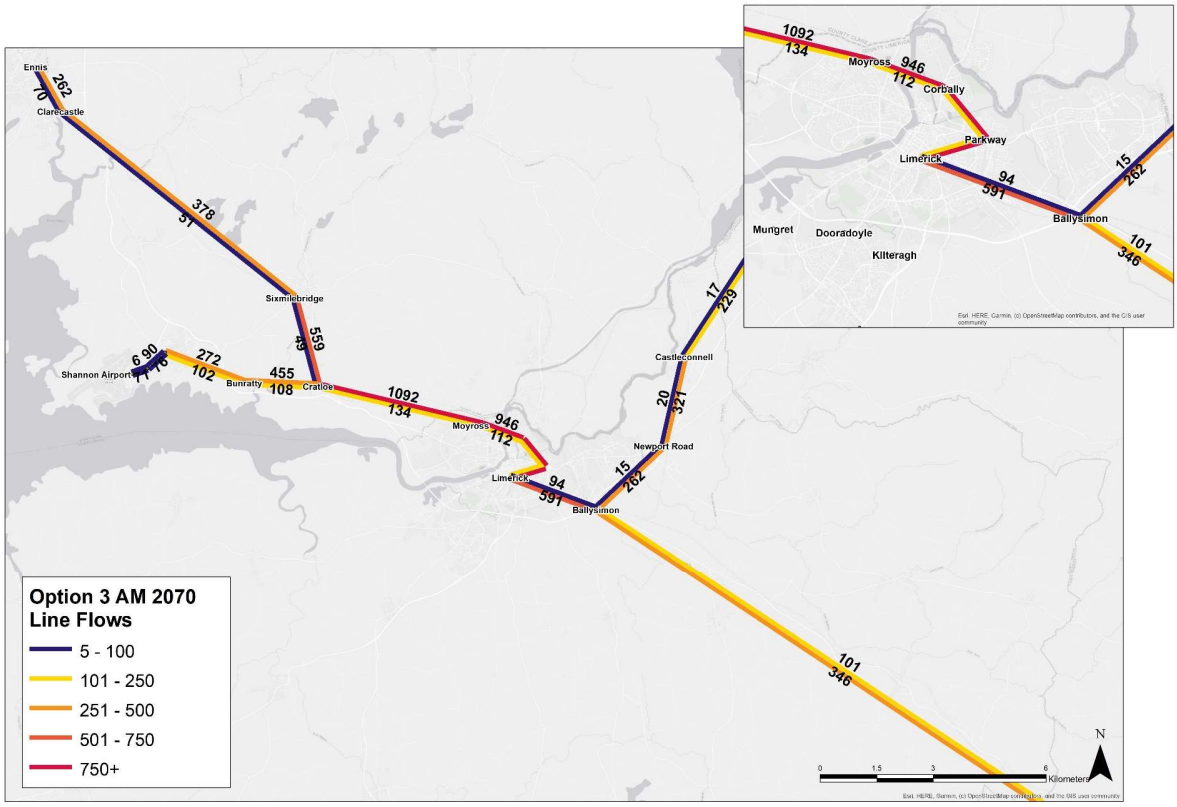


Figure 4.8 – Option 2 – 2070 Line Flows



4.3.3 Option 2 Station Performance

Table 3 outlined the boardings and alightings for each station for both forecast year by line, or combined line where served by more than one service. This boardings and alightings include only the suburban rail line services and not intercity or regional routes.

On the Ennis line the busiest station is Ennis in both 2040 & 2070 though there is a significant increase in boardings between the two forecast years. On the Shannon line, Shannon Town and Bunratty have the highest demand. The highest demand for alighting across the combined lines, excluding Colbert, is Moyross.

On the Ballybrophy line, there is similar levels of boardings at Roscrea, Birdhill & Castleconnell with lower demand at other stations along the line. Alightings are highest at Ballybrophy, end of the service, and Newport Road. On the Limerick Junction line, the Junction station is the busiest of all stations in the table in both 2040 & 2070. Demand at Ballysimon, served by both the Ballybrophy and Limerick Junction line is low however this station is also served by Bus which provides connection directly to the city centre.

Table 7 – Station AM Boardings & Alightings

Line	Station	2040		2070	
		Boardings	Alightings	Boardings	Alightings
Ennis	Ennis	77	34	262	70
	Clarecastle	27	6	146	11
	Sixmilebridge	55	6	196	12
Shannon	Shannon Airport	3	46	6	71
	Shannon Ind Estate	10	4	86	7
	Shannon Town	39	22	185	28
	Bunratty	16	10	193	16
Ennis/Shannon	Cratloe	30	13	129	28
	Moyross	34	41	71	196
Ballybrophy	Ballybrophy	4	48	5	62
	Roscrea	68	6	104	8
	Cloughjordan	19	1	27	2
	Nenagh	45	18	88	29
	Birdhill	60	3	92	4
	Castleconnell	74	5	96	6
	Newport Road	4	32	7	62
Limerick Junction	Limerick Junction	183	29	346	101
Ballybrophy/ Junction	Ballysimon	10	12	38	34
All	Colbert	117	539	207	1537

4.4 Option 3 Results

Option 3 is as per Option 2 with additional lines to Adare and Mungret. This option also includes additional stations on the Ennis/Shannon line at Corbally & Parkway. All lines, bar Limerick Junction line, are modelled as single track.

4.4.1 Option 3 Max Volume

Figure 4.9 and Figure 4.10 show the Max Volume results for Option 3 along with the estimated spare capacity for 2040 & 2070 respectively. The 2040 results show the Limerick Junction service carrying the most passengers, varying slightly from Option 2. In 2040, the Shannon and Adare lines have similar passenger numbers to each other while the Mungret Line has very low passenger numbers. This is likely as the rail service is uncompetitive relative to bus services to Dooradoyle & Mungret which serve the city centre more directly. No line reaches seated capacity by 2040 as shown in the graphs within Appendix C.

By 2070, the demand on all lines has increased significantly as a result of the population growth. However, growth on the Mungret line is still limited with this service still operating with significant spare capacity. The Ennis and Ballybrophy line are both above seated capacity with the Ballybrophy line approaching proposed service capacity. Though demand is significantly higher than 2040 the remaining lines do not reach design or seated capacity.

Figure 4.9 – Option 3 – 2040 AM Peak Max Volume & Spare Capacity

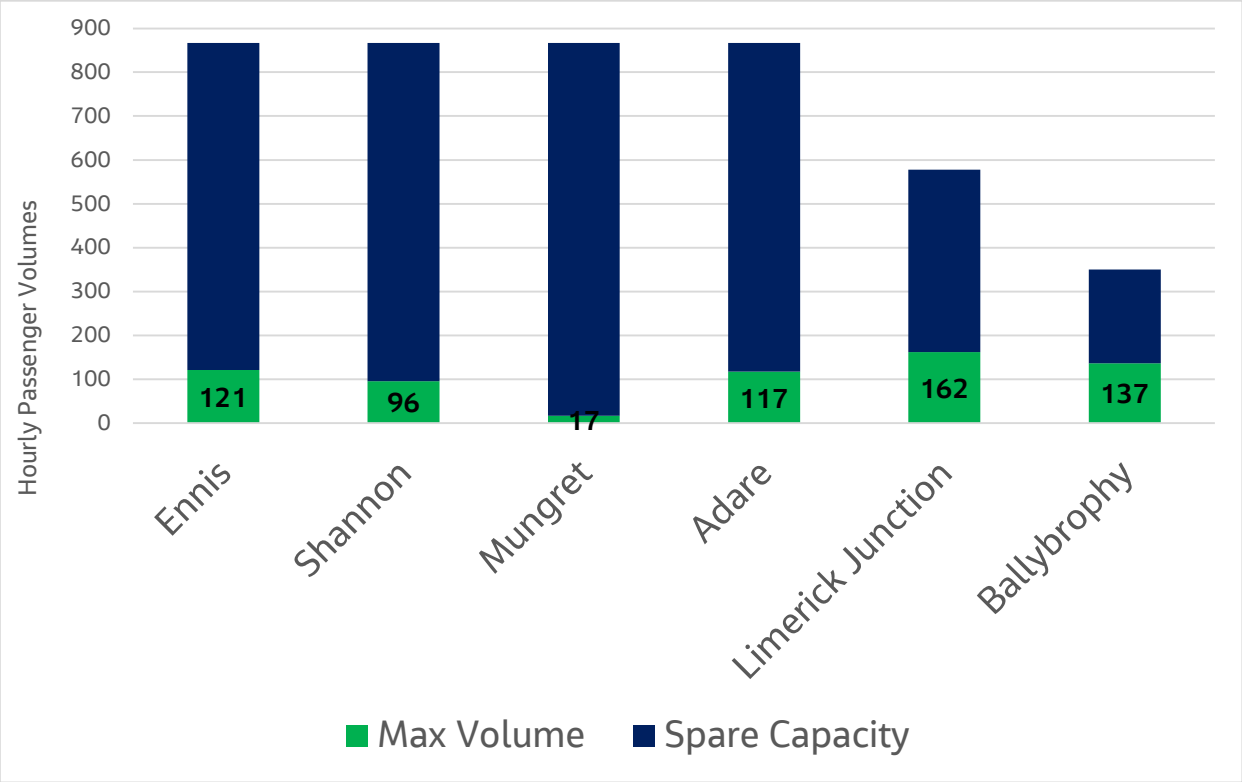
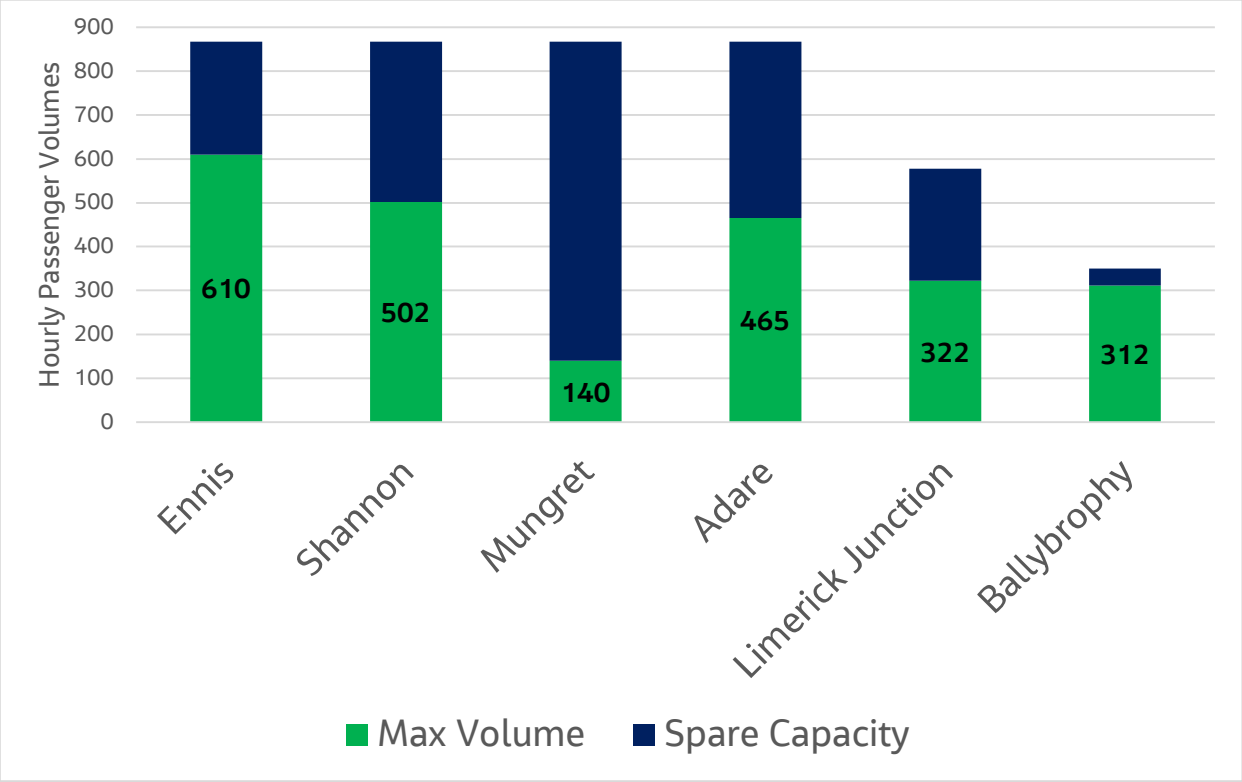


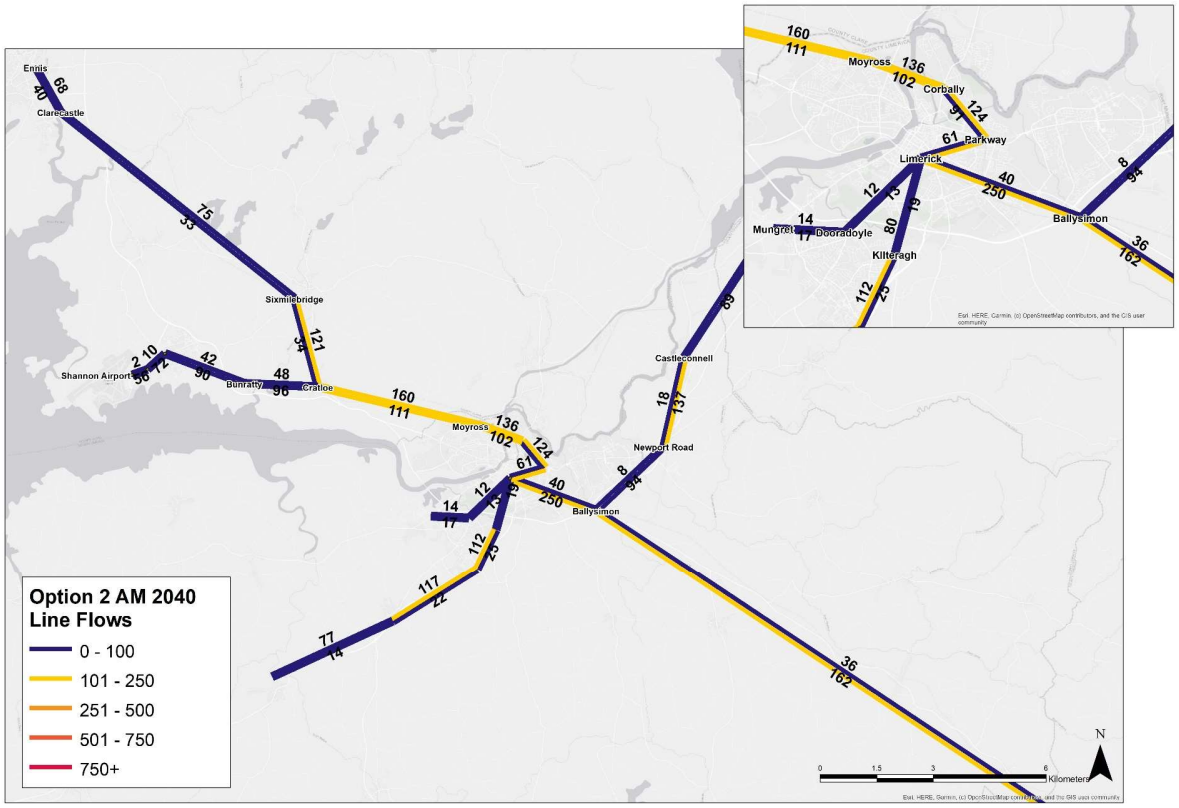
Figure 4.10 – Option 3 – 2070 AM Peak Max Volume & Spare Capacity



4.4.2 Option 3 Line Flows

Figure 4.11 and Figure 4.12 show the line flows for Option 3 for 2040 & 2070 respectively. The busiest section of the network in 2040 is between Ballysimon and Colbert (after the Limerick Junction and Ballybrophy lines merge), followed by the section of track between Moyross and Cratloe (again where the Shannon and Ennis tracks merge).

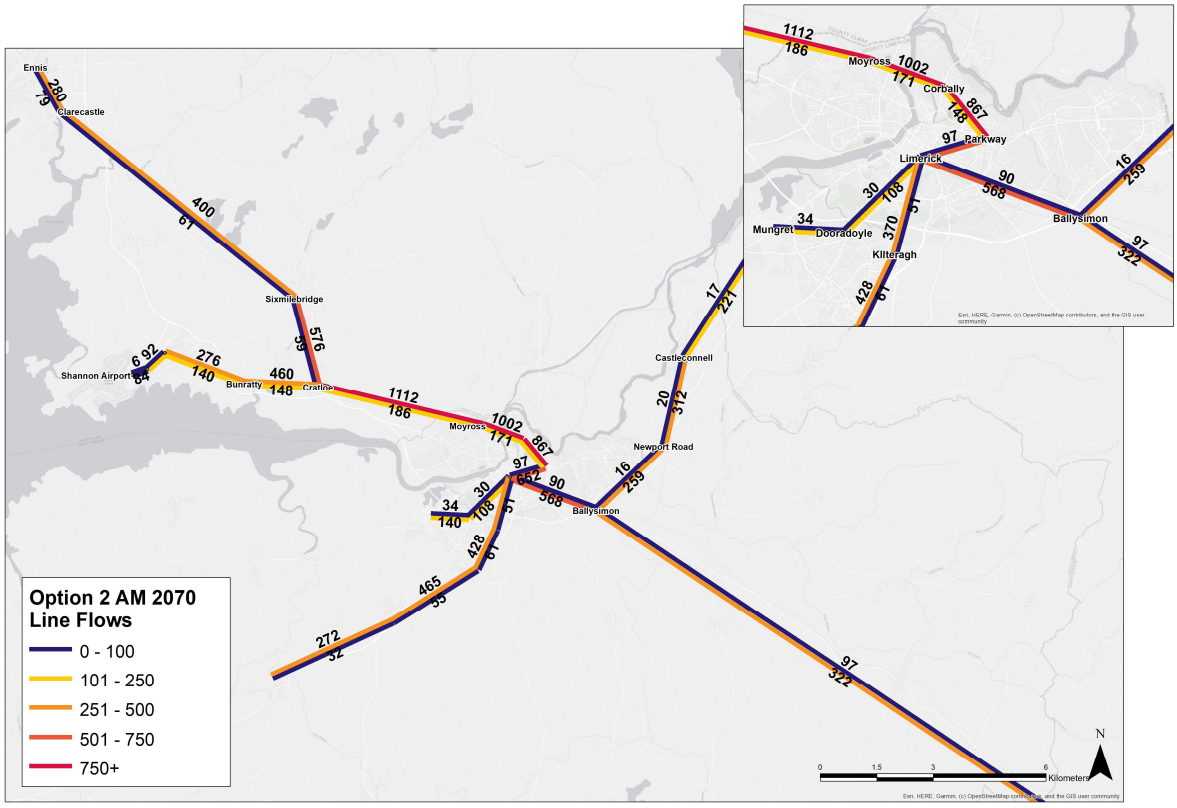
Figure 4.11 – Option 3 2040 Line Flows



The 2070 line flows show a significant increase across the network as a result of the population growth. Line flows along the Ennis/Shannon line increase the most from 2040 reaching 1112 hourly passengers between Cratloe & Moyross.

Line flows along the Adare line increase from 117 in 2040 to 465 between Patrickswell & Raheen, a 4-fold increase. Demand outbound on the Mungret lines increase in 2070 to 140 between Dooradoyle and Mungret but are still quite low.

Figure 4.12 – Option 3 2070 Line Flows



4.4.3 Option 3 Station Performance

Table 5 outlines the boardings and alightings for each station for both forecast year by line, or combined line where served by more than one service. On the Ennis line the busiest station is again Ennis in both 2040 & 2070 though there is a significant increase in boardings between the two forecast years. On the Shannon line, Shannon Town and Bunratty have the highest demand. The highest demand for alighting across the combined lines, excluding Colbert, is Parkway.

On the Ballybrophy line, there is similar levels of boardings at Roscrea, Nenagh, Birdhill & Castleconnell with lower demand at other stations along the line. Alightings are highest at Ballybrophy, end of the service, and Newport Road. On the Limerick Junction line, the Junction station is the busiest of all stations in the table in both 2040 & 2070 in terms of boardings. Demand at Ballysimon, served by both the Ballybrophy and Limerick Junction line is low in 2040 though increases by 2070.

Compared to Option 2, alightings at Colbert in 2040 are lower likely because the of the increase in alternative stations close to the city. Both boardings and alightings are both higher than Option 2 in 2070.

Table 8 – Station AM Boardings & Alightings

Line	Station	2040		2070	
		Boardings	Alightings	Boardings	Alightings
Ennis	Ennis	68	40	281	79
	Clarecastle	20	6	149	12
	Sixmilebridge	50	6	187	9
Shannon	Shannon Airport	2	56	6	85
	Shannon Ind Estate	10	18	88	28
	Shannon Town	36	23	187	33
	Bunratty	10	10	193	18
Ennis/Shannon	Cratloe	36	25	127	30
	Moyross	15	31	56	150
	Corbally	15	16	36	148
	Parkway	57	25	93	257
Ballybrophy	Ballybrophy	4	49	5	62
	Roscrea	71	16	97	8
	Cloughjordan	14	0	27	2
	Nenagh	36	26	87	28
	Birdhill	44	3	91	4
	Castleconnell	50	6	94	6
	Newport Road	11	44	7	55
Limerick Junction	Limerick Junction	162	36	322	97
Ballybrophy/ Junction	Ballysimon	6	9	40	31
All	Colbert	132	467	345	1619

4.5 Option 4 Results

Option 4 which is the dual track version of the full network, that was tested in Option 3. This results in faster journey times along each of the lines.

4.5.1 Option 4 Max Volume

The maximum passenger volumes for each of the rail lines for Option 4 in 2040 and 2070 are shown in Figure 4.13 and Figure 4.14 respectively. As a result of the decreased journey times the maximum volumes along each line are higher than Option 3 for 2040 and higher or similar for 2070.

No services reach seated capacity in 2040, as shown in the boarding and alightings graphs in Appendix C. By 2070, both the Ennis and Ballybrophy lines are over seated capacity with the Shannon service just reaching seated capacity in 2070. No lines reach proposed service capacity by 2070 and operate with spare capacity as shown in Figure 4.14. The Ballybrophy and Ennis Lines each 92% and 72% of proposed service capacity respectively.

Figure 4.13 – Option 4 – 2040 AM Peak Max Volume & Spare Capacity

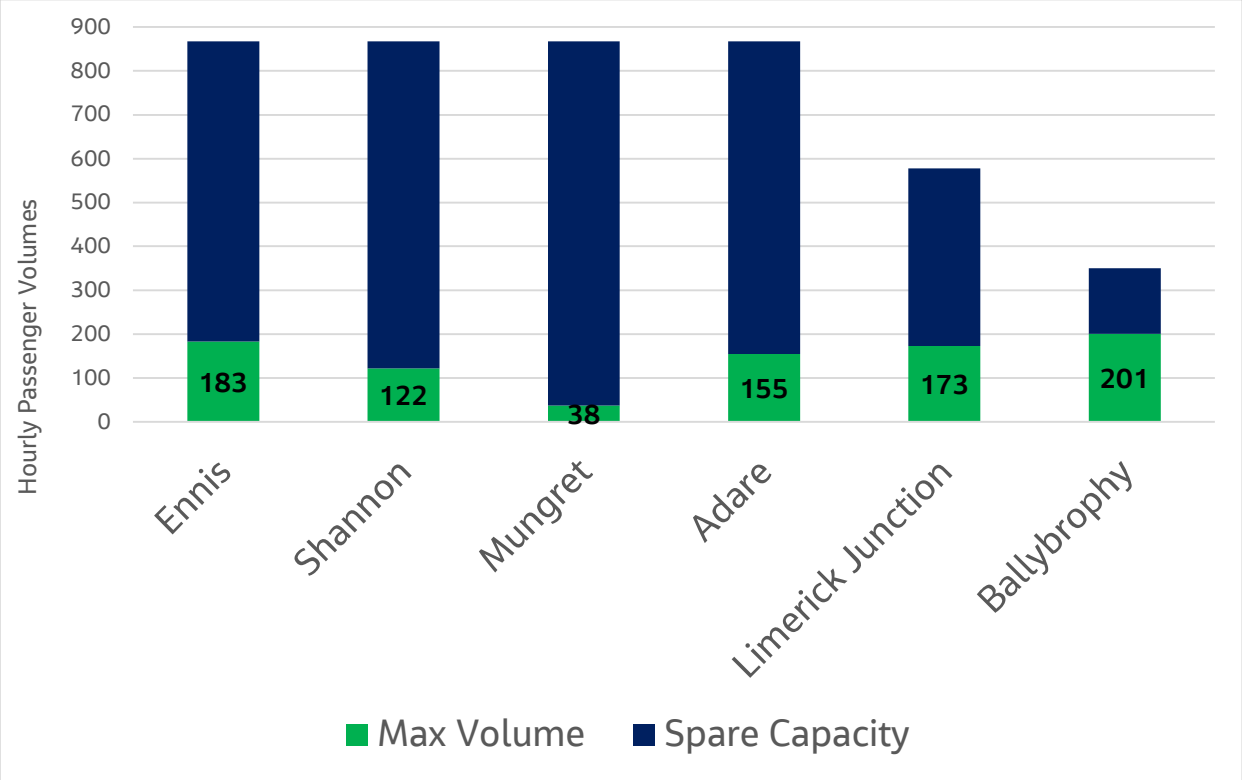
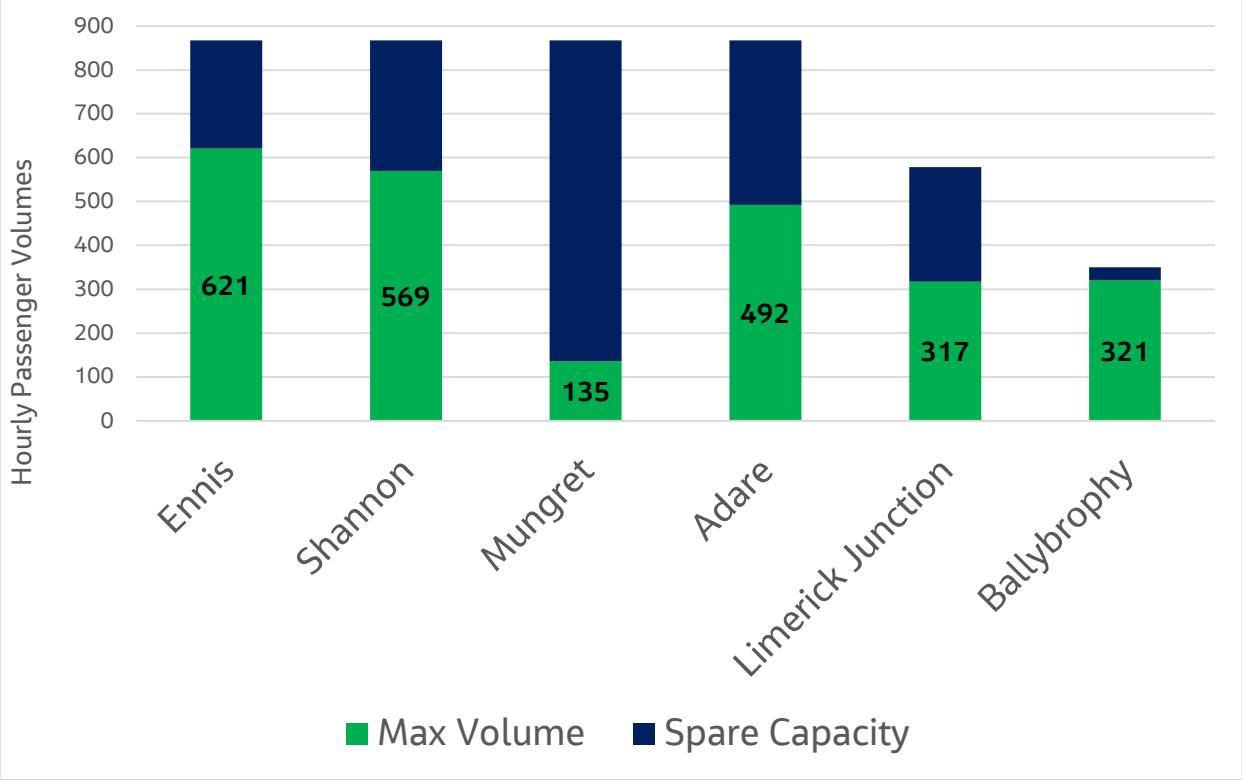


Figure 4.14 – Option 4 – 2070 AM Peak Max Volume & Spare Capacity



4.5.2 Option 4 Line Flows

Figure 4.15 and Figure 4.16 show the line flows graphically for 2040 & 2070 respectively. Compared to Option 3 the flows across the network are generally notably higher than Option 3 as a result of the improved Journey Times.

In 2040, as before the highest flows on the network is again between inbound from Ballysimon to Colbert, after the Limerick Junction & Ballybrophy lines merge. In 2070, the highest flow across the network is again between Cratloe and Moyross at 1198, after the Shannon and Ennis lines merge.

Figure 4.15 – Option 4 2040 Line Flows

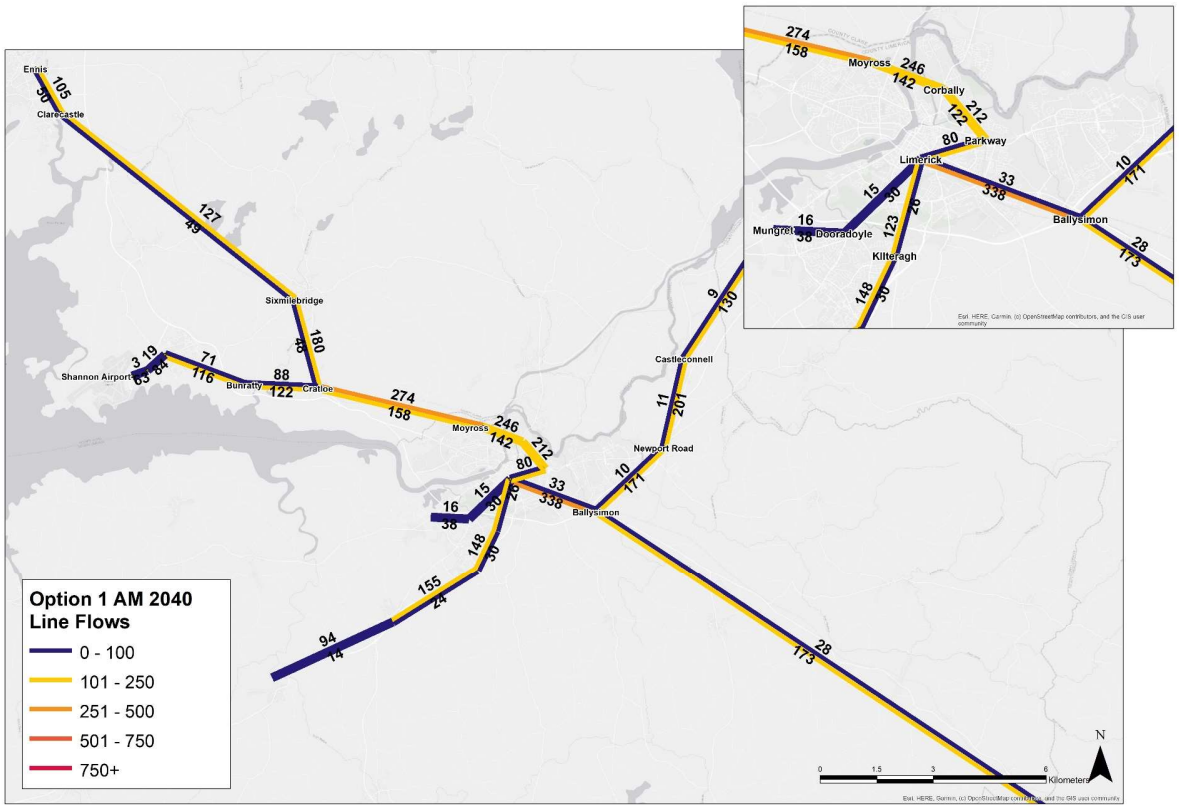
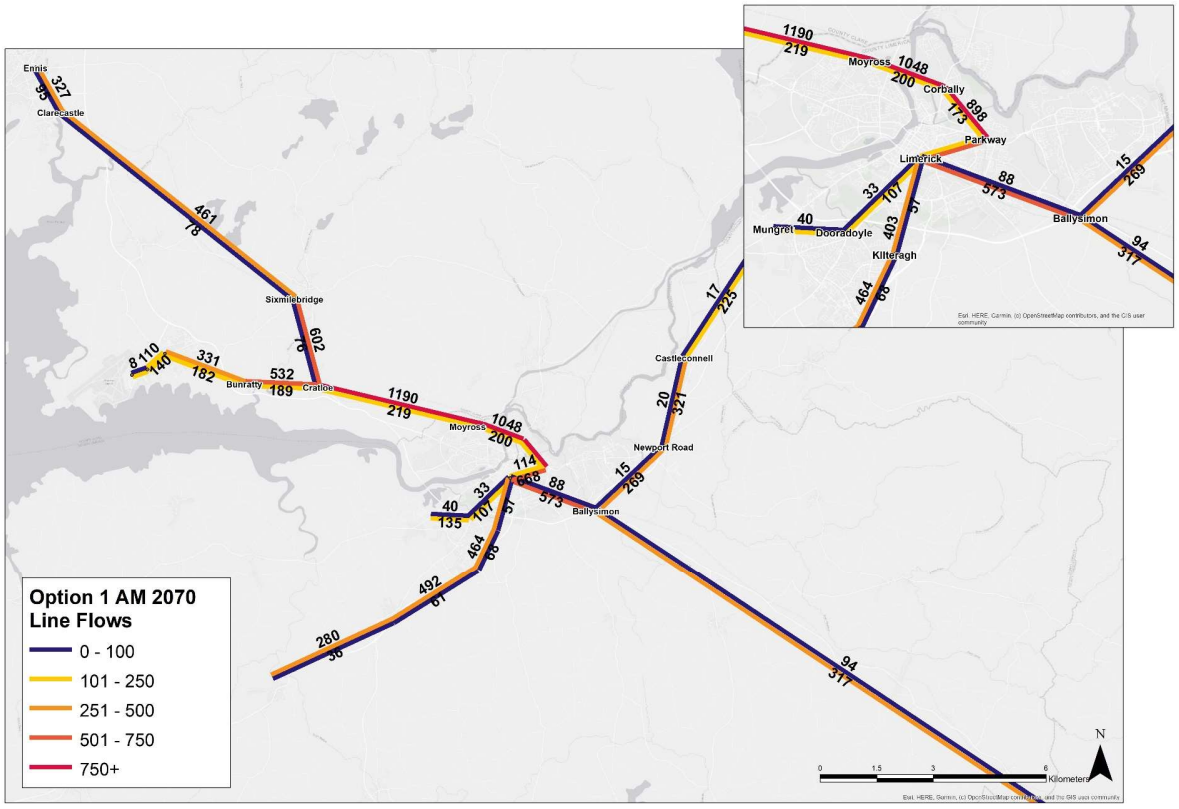


Figure 4.16 – Option 1 2070 Line Flows



4.5.3 Option 4 Station Performance

Table 6 outlines the boardings and alightings for each station for both forecast year by line, or combined line where served by more than one service. Compared to Option 3 the overall boardings and alightings are notably higher in 2040 though the increases are more marginally by 2070. This would suggest that the increase in rail journey times has less of an impact over times as competing bus and car journey times increase as a result of the growth in congestion up to 2070.

Table 9 – Station AM Boardings & Alightings

Line	Station	2040		2070	
		Boardings	Alightings	Boardings	Alightings
Ennis	Ennis	105	50	327	95
	Clarecastle	32	9	163	14
	Sixmilebridge	62	7	157	13
Shannon	Shannon Airport	3	63	8	114
	Shannon Ind Estate	16	22	104	28
	Shannon Town	53	32	224	45
	Bunratty	20	9	211	16
Ennis/Shannon	Cratloe	37	19	154	53
	Moyross	31	42	59	181
	Corbally	25	40	40	163
	Parkway	51	61	100	272
Ballybrophy	Ballybrophy	4	48	5	62
	Roscrea	68	6	97	8
	Cloughjordan	19	1	27	2
	Nenagh	45	18	86	28
	Birdhill	61	3	96	4
	Castleconnell	74	5	99	6
	Newport Road	3	31	6	54
Limerick Junction	Limerick Junction	173	28	317	94
Ballybrophy/ Junction	Ballysimon	9	11	38	30
All	Colbert	169	636	366	1677

5. Cost Benefit Analysis

5.1 Overview

To further assess the performance of each of the options tested, a cost benefit analysis was completed for each option.

5.2 Methodology

5.2.1 Transport User Benefits Appraisal

The cost benefit module of the MWRM modelling suite was used to complete the cost benefit analysis. This module makes use of the Transport User Benefit Appraisal (TUBA) program to estimate the transport user benefits arising from the scheme. For the LSMATS rail options TUBA v1.9.8 was used to complete the appraisal.

The TUBA program has been used to estimate transport user benefits arising each rail option assessed. The assessment compares the "Do-Minimum" scenario (i.e. not to progress with the proposals, in this case the draft strategy) with a "Do-Something" scenario (i.e. each rail option) and estimates the benefits resulting from the scheme in terms of:

- Transport user time impacts;
- Vehicle operating cost impacts;
- Transport provider revenue impacts; and
- Impacts related to emissions (greenhouse gases).

TUBA is the 'best practice' software used in transport scheme appraisal across the UK and Ireland and was developed specifically for the purpose of cost benefit analysis and economic appraisal.

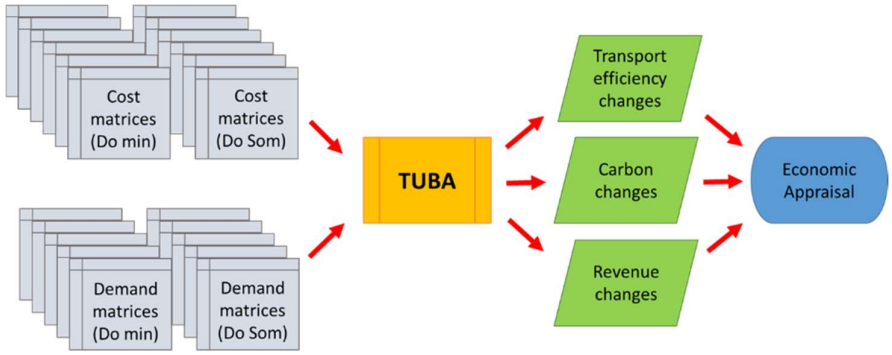
5.2.2 Inputs from the Transport Models

To calculate the changes in travel costs as a result of the implementation of the different rail improvement options, travel demand and cost skims are extracted from the Do Minimum and Do Something (Options 1, 2 and 3) MWRM model runs. The demand for travel is split into journey purposes (e.g. Commute) which have a common value of time. The travel costs are also split into the appropriate sub-components (e.g. distance, time etc.) which is a requirement of appraisal guidance.

For the purposes of this assessment, it is assumed that each rail option proposed will be fully operational from 2040 onwards and benefits therefore are assumed to start accruing in 2040 though elements of the network improvement could be operational prior to this. Matrices have been extracted for both modelled years (i.e. 2040 – Opening Year and 2070 (+30 year) – Design Year), comparing the change in demand and costs across the transport network between the case with and without the proposed scheme.

Figure 5.1 provides a graphical representation of the economic appraisal process using TUBA software.

Figure 5.1 – TUBA process diagram



5.2.3 Standard economic parameters

Standard transport appraisal parameters in Ireland are available from the following documents:

- Department of Public Expenditure and Reform 'Public Spending Code', 2013;
- Department of Transport 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes', 2016 - Appendix 1: Application Rules for Cost-Benefit Parameter Values; and
- NRA 2011 'Project Appraisal Guidelines', 2011 - Unit 6.11 National Parameters Values Sheet.

All general transport appraisal parameters are taken from the above documents. Updated vehicle purpose splits and vehicle occupancy rates were derived from the NTA's National Household Travel Survey (2012).

The other main input assumptions to the assessment are as follows:

- A price base year and present value year of 2016;
- A opening year of 2040 and design year of 2070;
- A standard appraisal period of 30 years;
- Residual value period of a further 30 years;
- A discount rate of 4% for the first 30 years and 3.5% thereafter as per the DPER 'Public Spending Code';
- Shadow pricing has been included in line with the DPER 'Public Spending Code', i.e. a shadow price of public funds of 130% and a shadow price of labour of 100%;
- All outputs are presented in market prices; and
- Annualisation factors have been developed from a detailed analysis of observed data and transport model outputs.

5.2.4 Costs

The costs have been estimated for each option as detailed in Section 2.7 of this report and within the costings report contained within Appendix B.

These costs were adjusted by accounting for inflation and shadow pricing before inputting into TUBA. The following assumptions related to costs were included:

- Cost incurred evenly between 2030-2040;
- Foynes Cost removed as benefits not reflected in model outputs (freight only);
- Cost of dual tracking Limerick Junction Line has not been included in the present value costs used to calculate the benefit cost ratio;
- No Operating and Maintenance costs included at this stage;
- Costs include a 66% risk allowance.

5.3 Results

The cost benefit analysis by option is shown in Table 10 below. The ratios are low due to the high costs of all of the rail improvement options. The results show that the although the benefits of option 4 are the highest, the high cost means that it is the lowest value for money option. Options 2 and 3 have a similar BCR as although the benefits of option 3 are higher than those in option 2, the costs are again higher. Option 1 has the lowest level of benefits but also the lowest costs meaning that the BCR for Option 1 is the highest of all options. All the values would be classified as poor value for money.

Table 10 – Cost Benefit Analysis by Option

	Draft Strategy	Option 1	Option 2	Option 3	Option 4
Discounted Benefits (PVB)	2622	292.7	302.8	334.9	365.5
Discounted Costs (PVC)	1234	344.6	590	903	1661
Estimated BCR	2.1	0.85	0.51	0.37	0.22

The BCR values were also calculated in combination with the rest of the LSMATS strategy since the rail improvements are not proposed to be implemented in isolation. This shows that the Strategy plus option 1 achieves the best BCR and that the overall rail scheme in combination with the rest of the strategy would be considered low value for money. The results are shown in Table 11.

Table 11 – Cost Benefit Analysis – combined with Strategy

	Strategy + Option 1	Strategy + Option 2	Strategy + Option 3	Strategy + Option 4
Discounted Benefits (PVB)	2915	2925	2957	2988
Discounted Costs (PVC)	1579	1824	2137	2895
Estimated BCR	1.8	1.6	1.4	1.0

6. Summary

6.1 Overview

Published in September 2020, the draft Limerick Shannon Metropolitan Area Transport Strategy (LSMATS) sets out a framework for transport investment for the metropolitan area for the next 20 years. A key principal of the strategy's vision is to "provide a high level of public transport connectivity to key destinations and within high demand corridors."

Through the public consultation process undertaken for the draft Strategy, a submission was received from Iarnród Éireann (IE) outlining potential additional improvements to the rail network including inter-urban, freight and sub-urban rail improvements, which could provide benefits to the mid-west region over a longer term horizon.

Building upon the rail enhancements proposed in the draft strategy, this report presents the assessment of additional rail options in response to both the Iarnród Éireann submission and the 2020 programme for Government which outlined the prioritisation of rail projects in regional cities.

A total of four options were tested using an iterative approach starting with improvements to existing lines only, and then increasing the accessibility, capacity and frequency of the rail network with each subsequent iteration. The options tested are set out below:

- **Option 1** – Existing network with new stations & increased frequencies on existing lines;
- **Option 2** – Option 1 with addition of a new line to Shannon;
- **Option 3** – Option 2 with addition of new lines to Adare & Mungret;
- **Option 4** - Option 3 with dual track elements to improve journey times and reliability

Significant work was undertaken as part of option development to determine the required infrastructure needed to enable an increase in the frequency of services. A detailed rail timetabling review was completed to understand the feasibility of increasing service frequencies, the need and location of any passing loops to accommodate increased service frequency and calculate the journey times on new routes.

Based on the outcome of the infrastructure needs assessment, cost estimates were generated for each element of the rail options being tested. This allowed for a comparison of cost and demand to be made on a line by line basis. As is standard practice a risk allowance has been allowed for in the costs and these have been included in the Cost Benefit Analysis.

The NTA's Mid-West Regional Model (MWRM) version 3 was used to assess demand for travel across the rail network. The original draft strategy modelled a single forecast year aligned with the 2040 National Planning Framework and Regional Spatial and Economic Strategies projections for the Limerick region. Whilst there are currently no growth distribution plans beyond 2040, to assess the potential longer term benefits of investing in rail infrastructure a 2070 forecast land use was developed which distributed additional population within the catchment of the proposed rail stations. This exercise was completed for the sole purpose of this modelling assessment and to ensure that the forecast land use was orientated around rail.

The results for the modelling assessment for each option are summarised as follows:

- **Option 1** - All services operate with significant levels of spare capacity with no service reaching seated or proposed service capacity in 2040. By 2070, demand on all lines has increased significantly, particularly on the Ennis line which is now the busiest service and the Ballybrophy line which reaches 87% of proposed service capacity.

- **Option 2** - All services operate with significant levels of spare capacity with no service reaching seated or proposed service capacity in 2040. By 2070, the Ennis line is expected to have the highest passenger volume, followed by Shannon reflecting the increase in population growth along these lines in the interim period. The Ballybrophy line is expected to be closest to proposed service capacity by 2070, although the proposed service capacity is lower for this line.

- **Option 3** - All services operate with significant levels of spare capacity with no service reaching seated or proposed service capacity in 2040. By 2070, the demand on all lines has increased significantly, with the Ennis and Ballybrophy lines both above seated capacity and the Ballybrophy line approaching proposed service capacity. Though demand is significantly higher than 2040 the remaining lines do not reach design or seated capacity.

- **Option 4** - Whilst the dual tracking of the network and resultant increase in rail network speeds increases the demand for rail travel compared to option 3, all services still operate with significant levels of spare capacity with no service reaching seated or proposed service capacity in 2040. By 2070, the demand on all lines has increased significantly, with the Ennis and Ballybrophy lines each at 92% and 72% of proposed service capacity respectively.

To further assess the performance of each of the options tested, a cost benefit analysis was completed for each option using the Transport User Benefit Appraisal (TUBA) program in the NTA's MWRM modelling suite.

When reviewing the rail costs and benefits in isolation, the results of the analysis indicate that option 4 has the highest benefits, but also by far the highest costs. This results in the lowest Benefit Cost Ratio (BCR) of 0.22. Whilst Option 1 provides the overall lowest benefits, the costs are considerably lower than the other options, resulting in a BCR value of 0.85.

The BCR values were also calculated in combination with the rest of the LSMATS strategy since the rail improvements are not proposed to be implemented in isolation. The results show that the Strategy plus Option 1 performed the best, with an estimated BCR of 1.8. The Strategy + Option 4 scored the lowest with a BCR of 1.0.

In summary, the modelling assessment has shown that under the current planned land use scenario for the metropolitan area for 2040, the level of passenger usage is low and significantly below the levels normally associated with heavy rail commuter networks. Under this land use scenario, the creation of additional commuter rail lines would not represent good value for money.

The 2070 forecast modelling scenario results in a substantial increase in demand for travel by rail. Whilst still below passenger numbers associated with heavy rail networks, the assessment highlights the substantial benefits of delivering an alternative land use approach that focuses future development around a network of rail stations.

Appendix A – Rail Timetabling Technote

1. Rail Timetabling

1.1 Introduction

The following outlines a brief summary of the approach undertaken to assess the interventions to the rail network proposed as part of the draft Limerick Shannon Metropolitan Area Transport Strategy (LSMATS) from an operational perspective. A timetable and operational assessment were conducted for each proposed option, considering both dual and single track in the latter case considering requirements for passing loops. The work was conducted in parallel with engineering development work ensuring that as far as possible the infrastructure requirements identified for timetable options were deliverable in practice.

1.2 Methodology

The interventions proposed within the LSMATS that formed the basis of our analysis were as follows:

- Improvements to existing assets:
  - Increased frequency on existing services towards Limerick Junction, Ennis and Ballybrophy
  - New stations at Ballysimon, Parkway, Corbally, Moyross, Cratloe, and Newport Road
  - Dual track between Limerick Junction and Limerick Colbert
- Re-instatement of disused rail lines:
  - Limerick – Mungret Line, with stations at Mungret and Dooradoyle
  - Limerick – Foynes Line, with a passenger service to Adare including stations at stations at Kilteragh, Raheen, Patrickswell and Adare, with capacity provided for an hourly freight path to Foynes
- New rail spur to Shannon Airport:
  - A new spur branching from the proposed Cratloe station, with new stations at Bunratty, Shannon Town, Shannon Free Zone, and Shannon Airport

The options were assessed based on both full dual track and single track configurations, against either 20 minute or 30 minute headways. Timetables were developed for a standard weekday with no variation in frequency between peak and off peak hours to establish the principal of operation.

Services from Limerick Colbert to Mungret and Adare were assessed both with and without the proposed Foynes Curve in place to determine the impact upon journey times. The Foynes Curve reinstates the link between Limerick Colbert station and the mothballed Foynes and Mungret branches. The link was removed after passenger services towards Adare were withdrawn in 1963. The alternative option requires services to run from Colbert to Limerick Check before reversing onto the Foynes Line using the existing link. This would incur a significant journey time penalty.

Journey times for the new services on existing routes were calculated by taking existing running times for services and incorporating the journey time penalties associated with new stations, offset by assumed increases in average speeds through upgrades to the existing line. For new or reinstated routes a review of average speeds for similar services across Ireland was undertaken from which journey times were inferred for the new services. This include the impact of significant infrastructure constraints such as the low radius curve at Dooradoyle.

For single track options loop lengths were determined based on the distance a train would cover in three minutes. This was chosen based on the assumption that trains passing each other would enter opposite ends of the loops at the same time and that three minutes would provide sufficient time for the signalled system to reset the routes whilst both trains were in loop. More work on loop lengths would be required if single track options were to be pursued further.

1.3 Outcomes

The findings of each assessment are outlined in the following sections. We have divided our analysis spatially, therefore each section of the report covers the options assessed in each geographical area the rail lines cover.

Limerick Colbert to Mungret and Adare

Services to Mungret and Adare were assessed based upon both dual and single track configurations with either a 20 minute or a 30 minute headway.

For our assessments of a single track configuration, we have assumed two independent lines running between Foynes Jn and Kilteragh Jn (where the Mungret line diverges from the Foynes line), with single track from Kilteragh Jn to Mungret and Adare to align with current track configurations. The use of two independent lines to Kilteragh continues the practice already in place with the existing freight lines and avoids the need for infrastructure associated with a full 3signalled junction at Kilteragh.

Table 1 below presents the journey times from Limerick Colbert used in the timetable and operational assessment of the services. Journey times without the Foynes Curve in place include an allowance of three minutes to account for the reversal needed at Limerick Check.

Table 1 – Limerick Colbert to Mungret and Adare Journey Times

SERVICE TO	JOURNEY TIME WITH FOYNES CURVE	JOURNEY TIME WITHOUT FOYNES CURVE	REDUCED JOURNEY TIME WITH FOYNES CURVE	REDUCED JOURNEY TIME WITHOUT FOYNES CURVE
Mungret	11	16	10	15.5
Adare	22	27.5	20	25

On a full dual track configuration with the Foynes Curve in place and a 20 minute frequency, for both the standard and reduced journey times, services to Mungret would be operated by 2 units and services to Adare by 3 units. If the services were to be operated without the Foynes Curve in place, this would increase the number of units required to operate the services from 5 to 6 due the additional journey time imposed by the reversal at Limerick Check.

In all assessments of dual track configuration each service has only a five minute turnaround time at Limerick Colbert, however, to achieve a longer turnround period would increase the number of units required to run the services and the associated operational costs. Whilst a five minute turnaround at Limerick is relatively tight, it is plausible in the context of the Adare and Mungret routes being self-contained. It may technically be possible to work the service entirely from the existing Platform 4 at Limerick Colbert, though further development work may show the opening of a supporting Platform 5 is required.

Single Track and 20 Minute Frequency

Operation of services to Mungret and Adare on a single track configuration with a 20 minute headway would require 6 units to operate both services, both with and without the Foynes Curve in place.

As part of operating the services upon a single track configuration, an assessment was conducted of the passing loops requirements, outlined in Table 2 below.

Table 2 – Passing Loop Requirements – Limerick Colbert to Mungret and Adare– Single Track and 20 Minute Headway

CONFIGURATION	PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
With Foynes Curve	Dooradoyle Station	Mungret	1.5
	Raheen Station	Adare	2.0

CONFIGURATION	PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
	13km	Adare	3.1
Without Foynes Curve	Dooradoyle Station	Mungret	1.7
	Kilteragh Station	Adare	1.7
	11km	Adare	3.1

Single Track and 30 Minute Frequency

Reducing the service frequency from 30 minutes from 20 results in a reduction of the number of units needed to operate the services from 6 to 4.

In reducing the frequency, the number of bypass loops required is also reduced from 3 to only 1. A loop approximately 2.3Km in length would be required at Patrickswell station to allow inbound and outbound services to Adare to pass one another.

The number of units needed to operate and the bypass loop requirements is applicable to running the services both with and without the Foynes Curve in place.

With both services to Mungret and Adare in operation at a 20 or 30 minute frequency significant pressure would be placed upon Platform 4 at Limerick Colbert.

Limerick to Foynes Freight Service

As part of our work we assessed the feasibility of incorporating an hourly freight service between Limerick and Foynes into the Limerick Colbert to Mungret and Adare passenger timetables.

The freight service would travel upon the existing curve between Foynes Jn and Limerick Check, not entering Limerick Colbert Station.

The tests were conducted assuming a single track configuration between Kilteragh Jn, Mungret, and Adare and a double track configuration between Kilteragh Jn and Limerick Check as has been assumed for the previously mentioned testing.

Assessments were also conducted of incorporating the hourly freight service into the passenger timetable for services to Adare only, removing the services to Mungret, as results from modelling exercises showed services to Mungret to have poor performance.

Table 3 details the passing loops that would be required for each scenario to incorporate the hourly freight service into the timetable. A length of 700m has been assumed for all loops. These would be in addition to the loops mentioned in the previous sections needed for the operational feasibility of the passenger timetable alone.

Table 3 – Additional Passing Loops Needed per Scenario to Incorporate an Hourly Freight Service Between Limerick and Foynes

SERVICE SCENARIO	PASSENGER FREQUENCY	PASSING POINT (DISTANCE FROM LIMERICK COLBERT)
Mungret and Adare	20 minutes	Patrickswell Station
		28km

SERVICE SCENARIO	PASSENGER FREQUENCY	PASSING POINT (DISTANCE FROM LIMERICK COLBERT)
Mungret and Adare - Without Foynes Curve	20 minutes	8.5km
		41km
Mungret and Adare	30 minutes	Raheen Station
		Adare Station
Mungret and Adare – Without Foynes Curve	30 minutes	7km
		20.9km
Adare	20 minutes	Patrickswell Station
		28km
Adare – Without Foynes Curve	20 minutes	8.5km
		41km
Adare	30 minutes	Raheen Station
		35.5km
Adare – Without Foynes Curve	30 minutes	Raheen
		36.5km

Limerick Colbert to Ennis and Shannon Airport

Services to Ennis and Shannon Airport were assessed based upon both dual and single track configurations with either a 20 minute or a 30 minute headway.

For our assessments of single track configuration, an assumption has been made that the section of track between Limerick Colbert and approximately 2.3km out of the station (1.2km beyond the point at which the Ennis line diverges from the Limerick Jn line) will be a dual track configuration, with single track then onwards to Ennis and Shannon Airport.

It has also been assumed that the section of track between new stations at Shannon Town, Shannon Free Zone, and Shannon Airport will be a dual track configuration.

Table 4 below presents the journey times from Limerick Colbert used in the timetable and operational assessment of the services.

Table 4 – Limerick Colbert to Ennis and Shannon Airport Journey Times

SERVICE TO	JOURNEY TIME	REDUCED JOURNEY TIME
Ennis	46.5	41
Shannon Airport	40	36

On a full dual track configuration and a 20 minute frequency, for both the standard and reduced journey times, services to Ennis and Shannon Airport would be operated by a total of ten units.

In assessments of dual track configuration with standard journey times each service would have only a five minute turnaround time at Limerick Colbert, however to achieve a longer turnround period would increase the number of units required to run the services and the associated operational costs. It would also increase the number of platforms required at Shannon Airport from 1 to 2.

Single Track and 20 Minute Frequency

On a single track configuration with a 20 minute frequency, services to Ennis would be operated by 6 units and services to Shannon Airport by 5 units.

As part of operating the services upon a single track configuration, an assessment was conducted of the bypass loop requirements, outlined in Table 5 below.

Table 5 – Bypass Loop Requirements – Limerick Colbert to Ennis and Shannon Airport – Single Track and 20 Minute Headway

PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
Corbally Station	Both	1.8
8km	Both	2.9
12.5km	Both	2.9
20km	Shannon Airport	2.4
21.2km	Ennis	2.9

Single Track and 30 Minute Frequency

Reducing the service frequency from 30 minutes from 20 results in a reduction of the number of units needed to operate the services from 11 to 8.

In reducing the frequency, the number of bypass loops required is also reduced from 6 to 5.

For services to Ennis, inbound and outbound services pass approximately 0.72km before Ennis station. If the journey time between Sixmilebridge and Ennis were to be slightly reduced through an increase in speed, this pass could be retimed so as to be at Ennis station in the existing dual track configuration. Table 6 below outlines the bypass loop requirements for this configuration.

Table 6 – Bypass Loop Requirements – Limerick Colbert to Ennis and Shannon Airport – Single Track and 30 Minute Headway

PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
Corbally Station	Both	1.8

PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
10.5km	Both	2.9
22km	Shannon Airport	2.1
24km	Ennis	2.9
39km	Ennis	2.9

A further assessment was conducted of the operational feasibility of incorporating one service an hour to Galway from Limerick Colbert into the timetable by extending a service that would otherwise terminate at Ennis. However, to operate this upon the existing single track configuration would require the construction of additional infrastructure between Ennis and Galway that would allow services to pass one another. It would also result in increased operational costs associated with an increase in the number of units required to operate the services.

Limerick Colbert to Nenagh and Ballybrophy

Services to Nenagh and Ballybrophy were assessed for operational feasibility of running services on a single track configuration, with a 30 minute frequency to Nenagh and hourly frequency to Ballybrophy. In addition to existing stations, these services would call at the two proposed new stations between Limerick Colbert and Castleconnell; Ballysimon and Newport Road.

These services were tested against a dual track configuration between Limerick Colbert and Killonan Junction and single track configuration from Killonan Junction to Nenagh and Ballybrophy as that reflects the current track configuration.

Table 7 below presents the journey times from Limerick Colbert used in the timetable and operational assessment of the services.

Table 7 – Limerick Colbert to Nenagh and Ballybrophy Journey Times

SERVICE TO	JOURNEY TIME	REDUCED JOURNEY TIME
Nenagh	61.5	59
Ballybrophy	125.5	123

Operation of the services would require a combined eight units, for both the standard and reduced journey times. Table 8 below displays the bypass loop requirements for operation.

Table 8 – Bypass Loop Requirements – Limerick Colbert to Nenagh and Ballybrophy – Single Track and 30 Minute Headway

PASSING POINT (DISTANCE FROM LIMERICK COLBERT)	COVERS SERVICES TO	LOOP LENGTH REQUIRED (KM)
13.5km	Both	2.1
24km	Both	2.3
36.5km	Both	2.3
71km	Ballybrophy	2.4

Limerick Colbert to Limerick Junction

The following outlines our assessment of the operational feasibility of running services to Limerick Junction from Limerick Colbert at a thirty minute frequency. We conducted our assessment with a thirty minute frequency to replicate the existing service frequency between the two stations.

On route services would call at the proposed new station, Ballysimon.

Table 9 below presents the journey times from Limerick Colbert used in the timetable and operational assessment of the services. The journey times have been modelled with a journey time one minute faster than the reverse journey to reflect the existing average difference in journey time between the two stations depending on direction of travel.

Table 9 – Limerick Colbert to Limerick Junction Journey Times

SERVICE TO	JOURNEY TIME	REDUCED JOURNEY TIME
Limerick Colbert to Limerick Junction	30	28
Limerick Junction to Limerick Colbert	29	27

Single Track and 30 Minute Headway

Services would be operated by three units, with a 6 minute turnaround at Limerick Junction and a 25 minute turnaround at Limerick Colbert.

Timetabling the services as such with an extended dwell at Limerick Colbert allows the services to pass each other in existing dual track configurations, between Limerick Colbert and Killonan Jn, and in the Dromkeen Loop, eliminating the need for construction of any additional bypass loops.

Dual Track and 30 Minute Headway – Reduced Journey Times

Our assessment of services between Limerick Colbert and Limerick Junction operated on a full dual track configuration with a 30 minute headway and reduced journey times would require 3 units to operate the services.

1.4 Summary

Within the preceding sections we have detailed a range of timetable and operational assessments conducted upon the proposed interventions to the rail network as part of the LSMATS.

Our assessment of the options has concluded that:

- It is possible to operate services at 20 or 30 minutes headways with both dual and single track options towards Ennis, Shannon, Adare and Mungret.

- Additional passing loops would be required on the route towards Ennis, Adare and Mungret to operate either 20 or 30 minute headway services whilst retaining sections of single line
- Operation of services to both Mungret and Adare upon a single track configuration at a 20 or 30 minute frequency would place significant pressure upon Platform 4 at Limerick Colbert
- Operation of services to Mungret & Adare would either require the reinstatement of the Foynes curve or investment in reversal facilities at Limerick Check, the latter incurring journey time penalties.
- Operation of services to both Ennis and Shannon Airport at either a 20 or 30 minute frequency upon a single track configuration would require significant upgrades to the existing infrastructure, with multiple passing loops required.

Appendix B – Costings Report

Jacobs

Limerick Shannon Metropolitan Area Transport Strategy

Rough Order of Magnitude Cost Estimate

Revision: 4

Date: 01.07.21

National Transport Authority (NTA)

DRAFT

ROUGH ORDER OF MAGNITUDE ESTIMATE (ROM)

LSMATS

ESTIMATE CLASSIFICATION

The estimate has been prepared within the accuracy range of a Class 5 estimate in accordance with the Jacobs estimate classification table, shown below.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Functional area, or concept screening	SF or m^2 factoring, parametric models, judgment, or analogy	L: -20% to -30% H: +30% to +50%
Class 4	1% to 15%	or Schematic design or concept study	Parametric models, assembly driven models	L: -10% to -20% H: +20% to +30%
Class 3	10% to 40%	Design development, budget authorization, feasibility	Semi-detailed unit costs with assembly level line items	L: -5% to -15% H: +10% to +20%
Class 2	30% to 75%	Control or bid/tender, semi-detailed	Detailed unit cost with forced detailed take-off	L: -5% to -10% H: +5% to +15%
Class 1	65% to 100%	Check estimate or pre bid/tender, change order	Detailed unit cost with detailed take-off	L: -3% to -5% H: +3% to +10%

Assumptions

Main contractor preliminaries have been calculated based on a percentage of 30% to allow for any possessions or night working required;
Main contractor overheads & profit has been calculated based on a percentage of 10%;
In the absence of a Quantitative Cost Risk Assessment (QCRA), an allowance of 66% has been applied to the 'Base Cost' to derive the 'P80' value in accordance with recognised practice associated with historical projects at similar stages in their development. For the purposes of representing the cost range, the P50 (53%) and P90 (76%) values have also been presented;
All quantities and infrastructure works were costed based on the information provided within the engineer's asset register;
All costs have been rounded up to the nearest €1m;
The asset register provides a rough area of each bridge/structure to be demolished. The estimate has doubled the demolition area to establish an assumed new build bridge/structure area (for dual track only);
In the absence of any design information, a total of 4nr buffer stops have been allowed within each route;
It has been assumed that a substation is required every 15km;
A provisional allowance of €58k has been allowed for the removal of any existing level crossing;
A provisional allowance of €232k has been included for the reinstatement/replacement of level crossings;
A provisional allowance of €29k has been allowed for the removal of any existing farm crossing;
A provisional allowance of €116k has been included for the reinstatement/replacement of farm crossings;
A rate of €900/m2 has been allowed for the demolition and disposal of any existing bridge structures (crossing land, roads etc);
A rate of €1800/m2 has been allowed for the demolition and disposal of any existing bridge structures (crossing water, rivers etc);
A rate of €5800/m2 has been allowed for the construction of any new bridge structures (crossing land, roads etc);
A rate of €17400/m2 has been allowed for the construction of any new bridge structures (crossing water, river etc);
As advised by the design team, it has been assumed that only 20% of any existing track will be replaced or reinstated;
As advised by the design team, it has been assumed that only 10% new tracks will be constructed using piled retaining walls, with the remaining 90% being constructed using standard rail construction methods;
It has been assumed that all lines are to be electrified;

ROUGH ORDER OF MAGNITUDE ESTIMATE (ROM)

LSMATS

CAPEX ASSUMPTIONS & EXCLUSIONS

Specific Exclusions
Client specific costs;
VAT;
Fees, including but not limited to design fees, main contractor fees and legal fees;
Cost for additional security during the works;
Inflation beyond 2Q 2021;
Any financial, programme or legal implications caused by Co-vid or similar events;
Signalling costs;
Land or building purchase costs;
Landowner interface costs;
Survey costs;
Utilities costs, other than stated;
Utilities networks strengthening costs;
Third party costs;
Traffic management costs in relation to road and highway closures/diversions;
Ecological mitigation measures;
Contaminated land remediation;
Rolling stock;
Costs associated with the Limerick Colbert to Foynes line

ROUGH ORDER OF MAGNITUDE ESTIMATE (ROM)

LSMATS

SUMMARY

	Option 1 - Low (P50)	Option 1 - Mid (P80)	Option 1 - High (P90)	Option 2 - Low (P50)	Option 2 - Mid (P80)	Option 2 - High (P90)	Option 3 - Low (P50)	Option 3 - Mid (P80)	Option 3 - High (P90)	Option 4 - Low (P50)	Option 4 - Mid (P80)	Option 4 - High (P90)
Existing Routes												
Limerick Junction to Limerick Colbert	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00	€ 223,000,000.00
Limerick Colbert to Ennis	N/A	N/A	N/A	€ 112,000,000.00	€ 112,000,000.00	€ 112,000,000.00	€ 119,000,000.00	€ 119,000,000.00	€ 119,000,000.00	€ 368,000,000.00	€ 368,000,000.00	€ 368,000,000.00
Ballybrophy to Limerick Colbert	N/A	N/A	N/A	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00	€ 170,000,000.00
New Routes												
Cratloe to Shannon	N/A	N/A	N/A	€ 98,000,000.00	€ 98,000,000.00	€ 98,000,000.00	€ 98,000,000.00	€ 98,000,000.00	€ 98,000,000.00	€ 192,000,000.00	€ 192,000,000.00	€ 192,000,000.00
Limerick Colbert to Adare	N/A	N/A	N/A	N/A	N/A	N/A	€ 121,000,000.00	€ 121,000,000.00	€ 121,000,000.00	€ 241,000,000.00	€ 241,000,000.00	€ 241,000,000.00
Limerick Colbert to Mungret	N/A	N/A	N/A	N/A	N/A	N/A	€ 49,000,000.00	€ 49,000,000.00	€ 49,000,000.00	€ 71,000,000.00	€ 71,000,000.00	€ 71,000,000.00
Limerick Colbert to Foynes	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl
Total Works	**€ 223,000,000.00**	**€ 223,000,000.00**	**€ 223,000,000.00**	**€ 603,000,000.00**	**€ 603,000,000.00**	**€ 603,000,000.00**	**€ 780,000,000.00**	**€ 780,000,000.00**	**€ 780,000,000.00**	**€ 1,265,000,000.00**	**€ 1,265,000,000.00**	**€ 1,265,000,000.00**
Main contractor's preliminaries (30%)	€ 67,000,000.00	€ 67,000,000.00	€ 67,000,000.00	€ 180,900,000.00	€ 180,900,000.00	€ 180,900,000.00	€ 234,000,000.00	€ 234,000,000.00	€ 234,000,000.00	€ 380,000,000.00	€ 380,000,000.00	€ 380,000,000.00
Main contractor's overheads and profit (10%)	€ 29,000,000.00	€ 29,000,000.00	€ 29,000,000.00	€ 78,390,000.00	€ 78,390,000.00	€ 78,390,000.00	€ 101,400,000.00	€ 101,400,000.00	€ 101,400,000.00	€ 165,000,000.00	€ 165,000,000.00	€ 165,000,000.00
Fees	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl
Other Development/Client Costs/Land or Asset Purchase	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl
Sub-total	**€ 319,000,000.00**	**€ 319,000,000.00**	**€ 319,000,000.00**	**€ 862,290,000.00**	**€ 862,290,000.00**	**€ 862,290,000.00**	**€ 1,115,400,000.00**	**€ 1,115,400,000.00**	**€ 1,115,400,000.00**	**€ 1,810,000,000.00**	**€ 1,810,000,000.00**	**€ 1,810,000,000.00**
Risk Allowance (53%/66%/76%)	€ 169,000,000.00	€ 211,000,000.00	€ 242,000,000.00	€ 457,000,000.00	€ 570,000,000.00	€ 655,000,000.00	€ 591,000,000.00	€ 736,000,000.00	€ 848,000,000.00	€ 959,000,000.00	€ 1,195,000,000.00	€ 1,376,000,000.00
Inflation	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl
VAT	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl	Excl
Total (Rounded up to €1m)	**€ 488,000,000.00**	**€ 530,000,000.00**	**€ 561,000,000.00**	**€ 1,319,000,000.00**	**€ 1,432,000,000.00**	**€ 1,517,000,000.00**	**€ 1,706,000,000.00**	**€ 1,851,000,000.00**	**€ 1,963,000,000.00**	**€ 2,769,000,000.00**	**€ 3,005,000,000.00**	**€ 3,186,000,000.00**

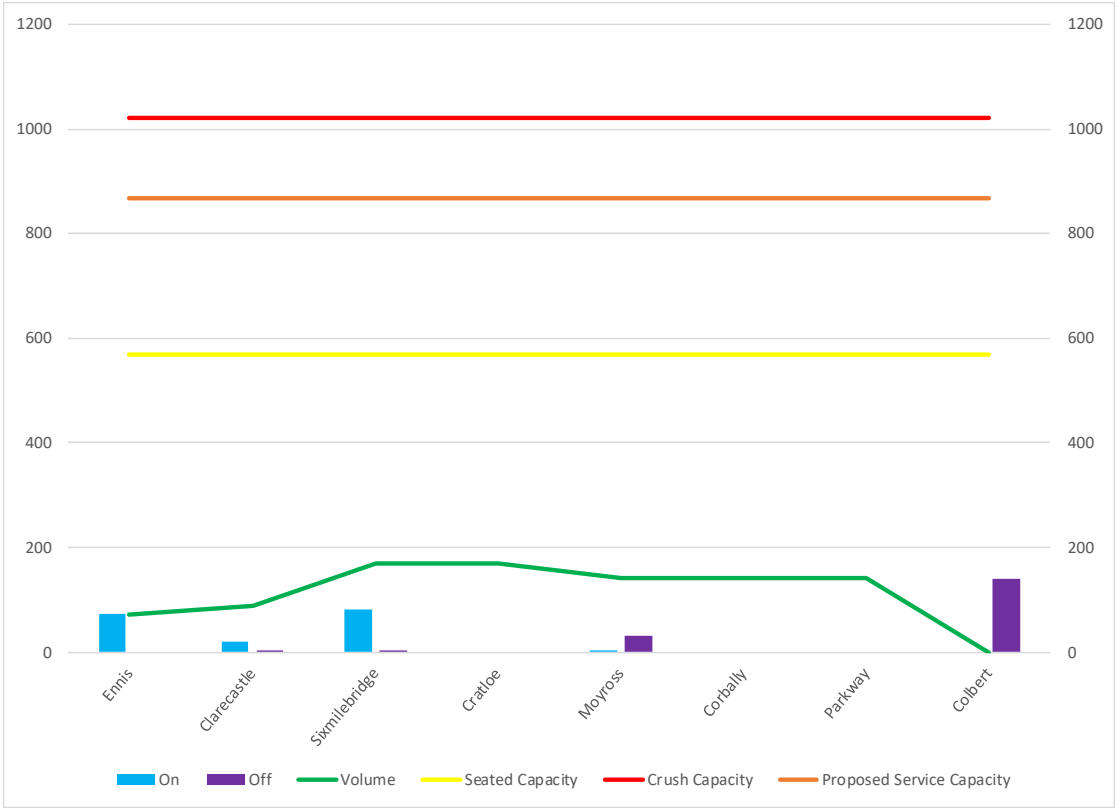
Appendix C – Boarding and Alighting Graphs

Please note that some stations shown on the graphs are non-stopping stations.

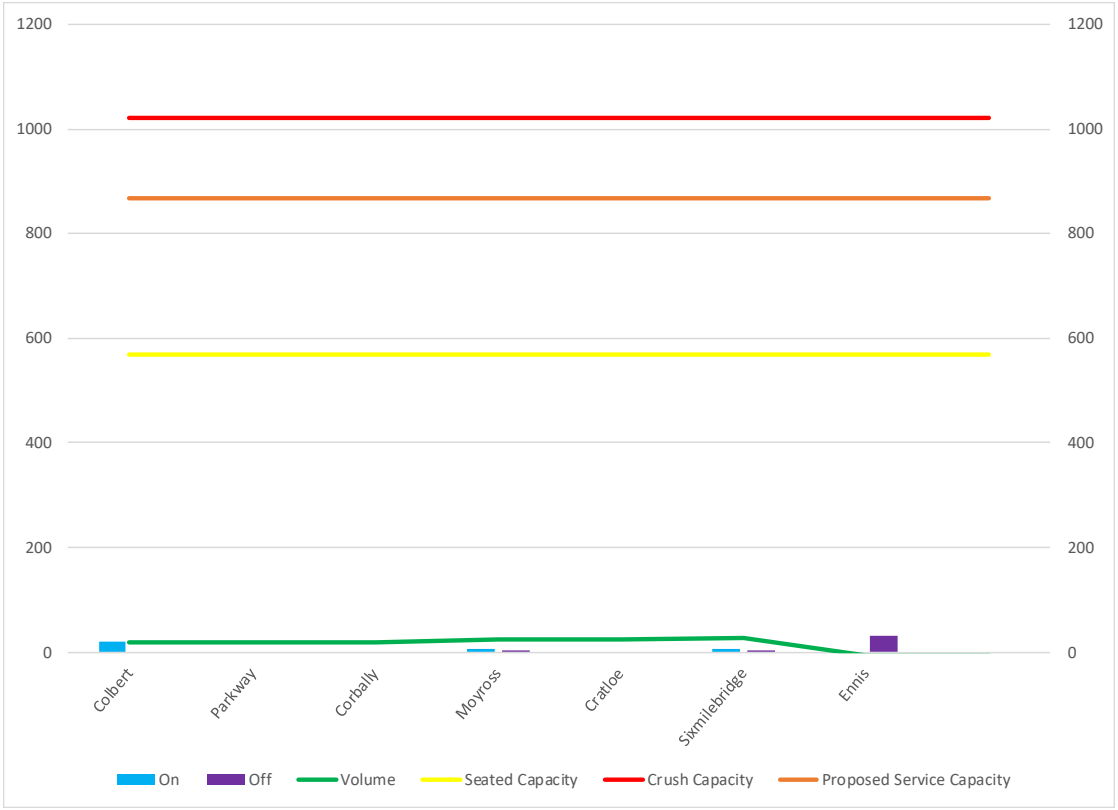
Appendix C – Boarding and Alighting Graphs

Option 1 B&A Graphs

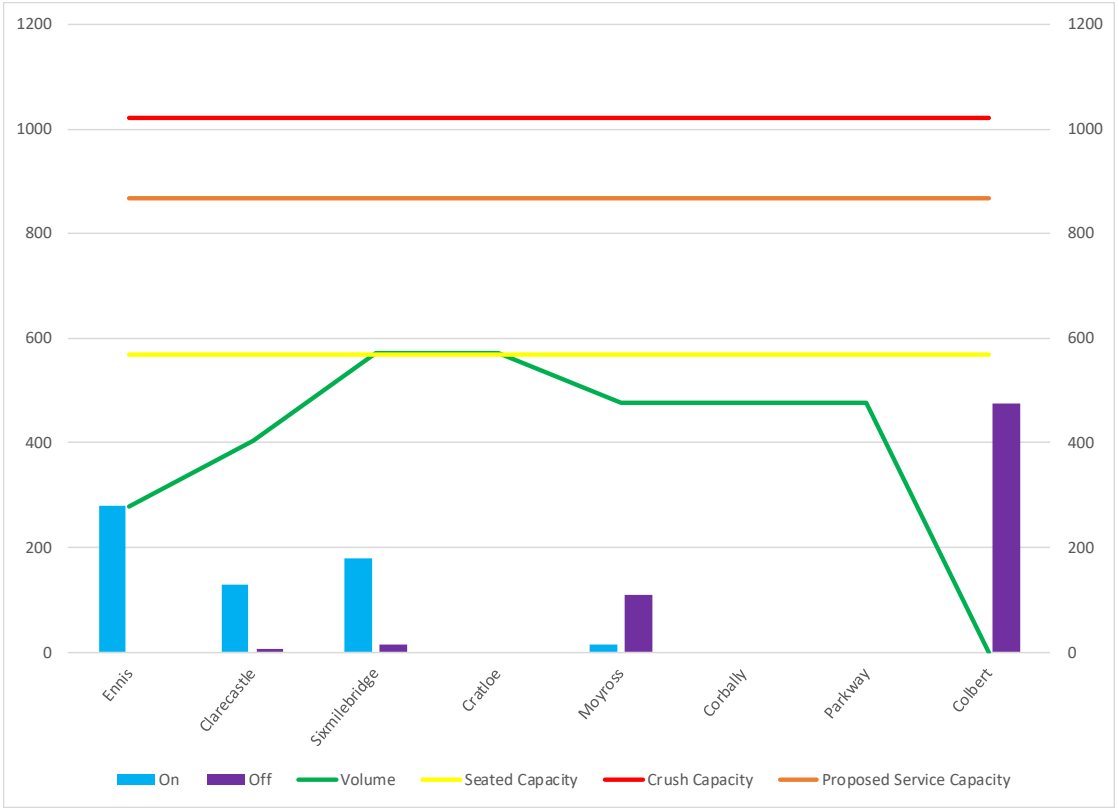
Ennis to Limerick - 2040



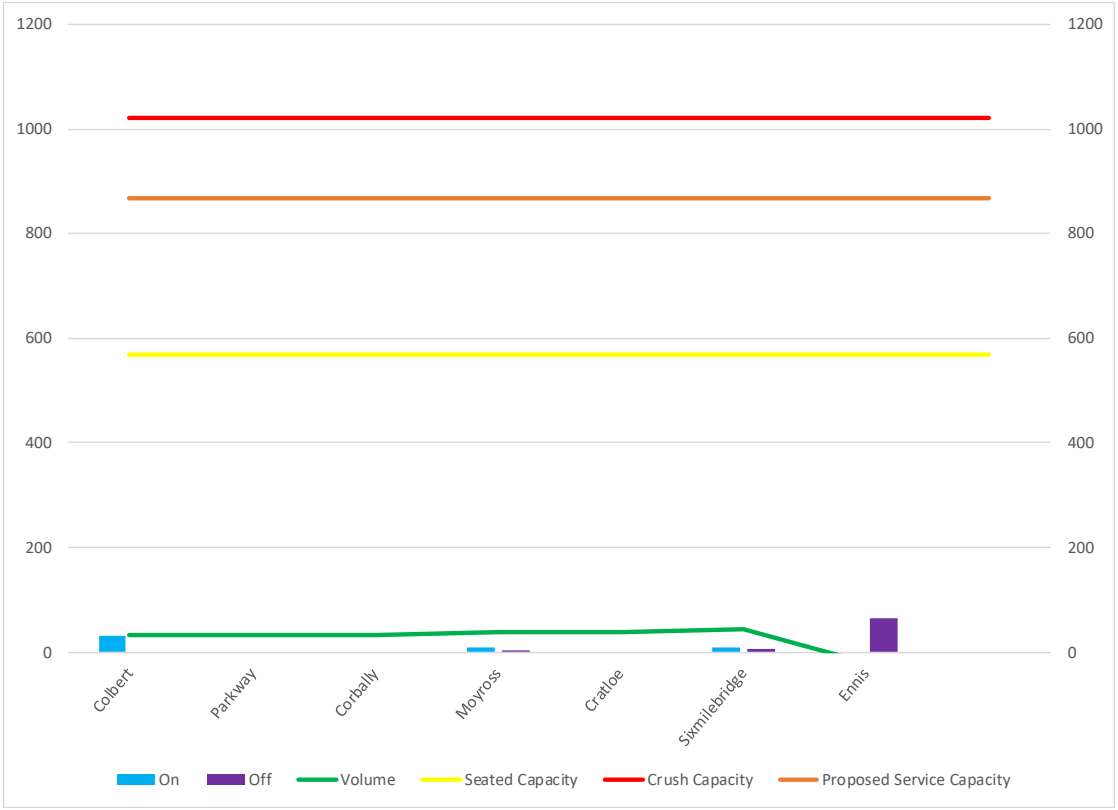
Limerick to Ennis - 2040



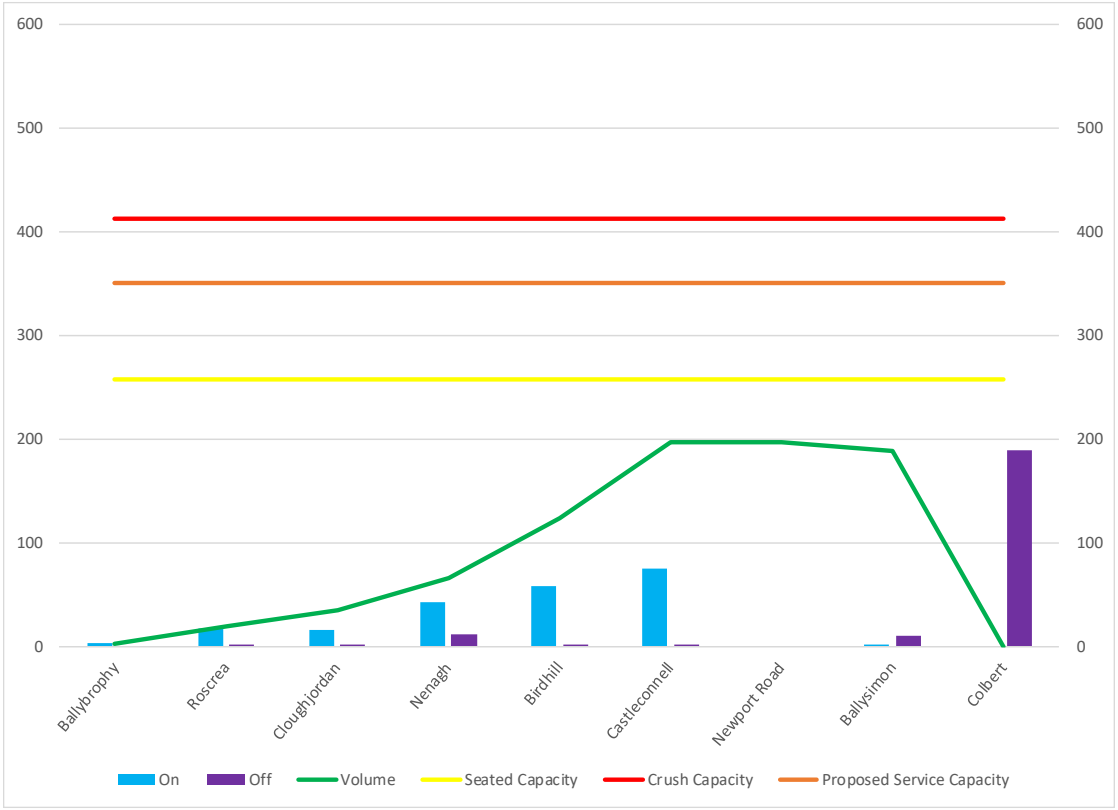
Ennis to Limerick - 2070



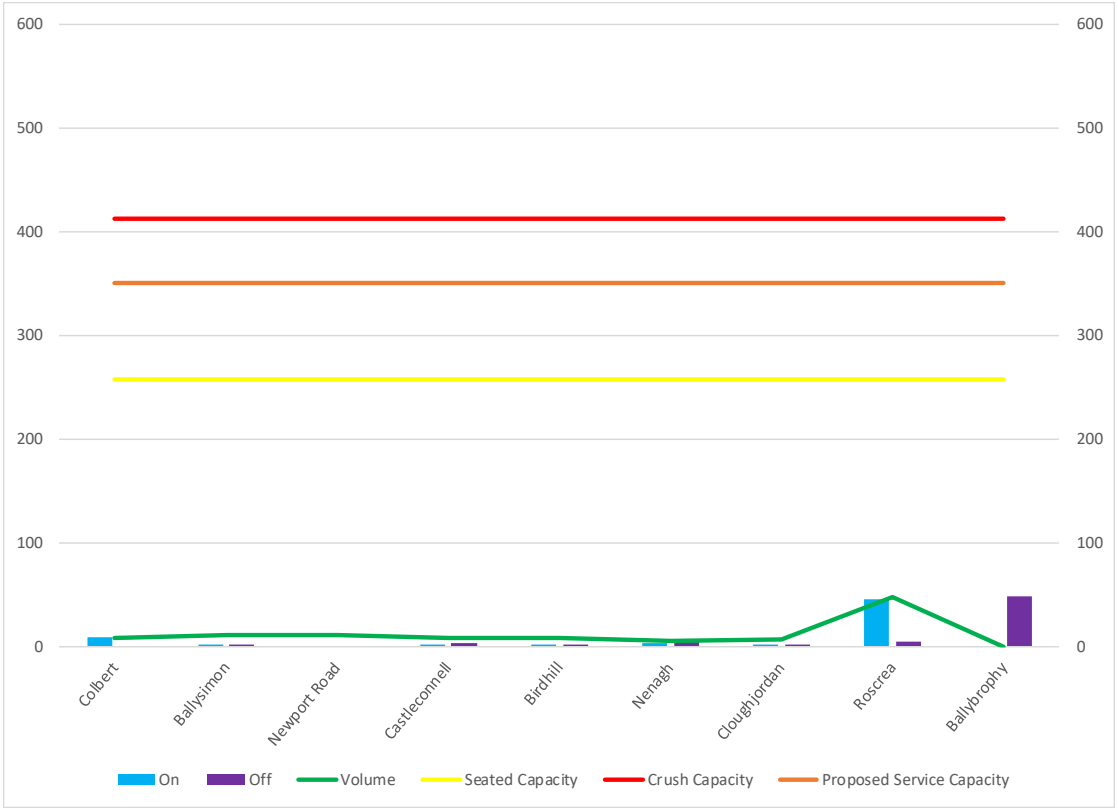
Limerick to Ennis - 2070



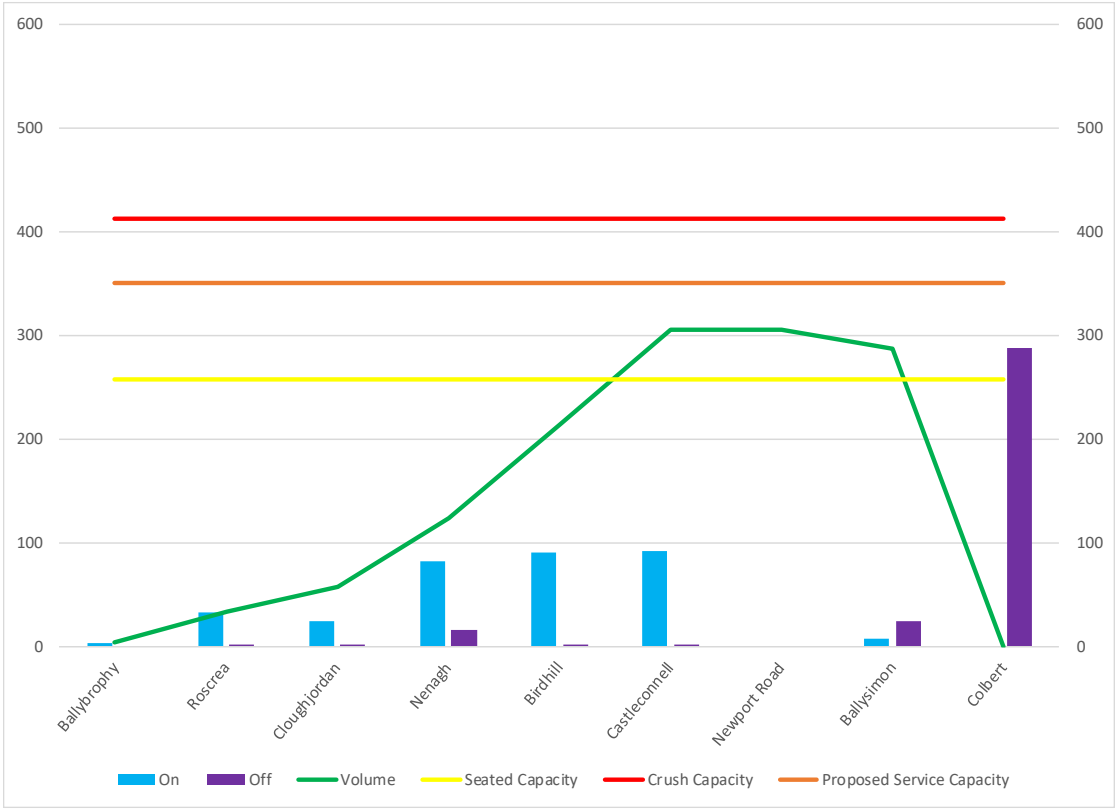
Ballybrophy to Limerick - 2040



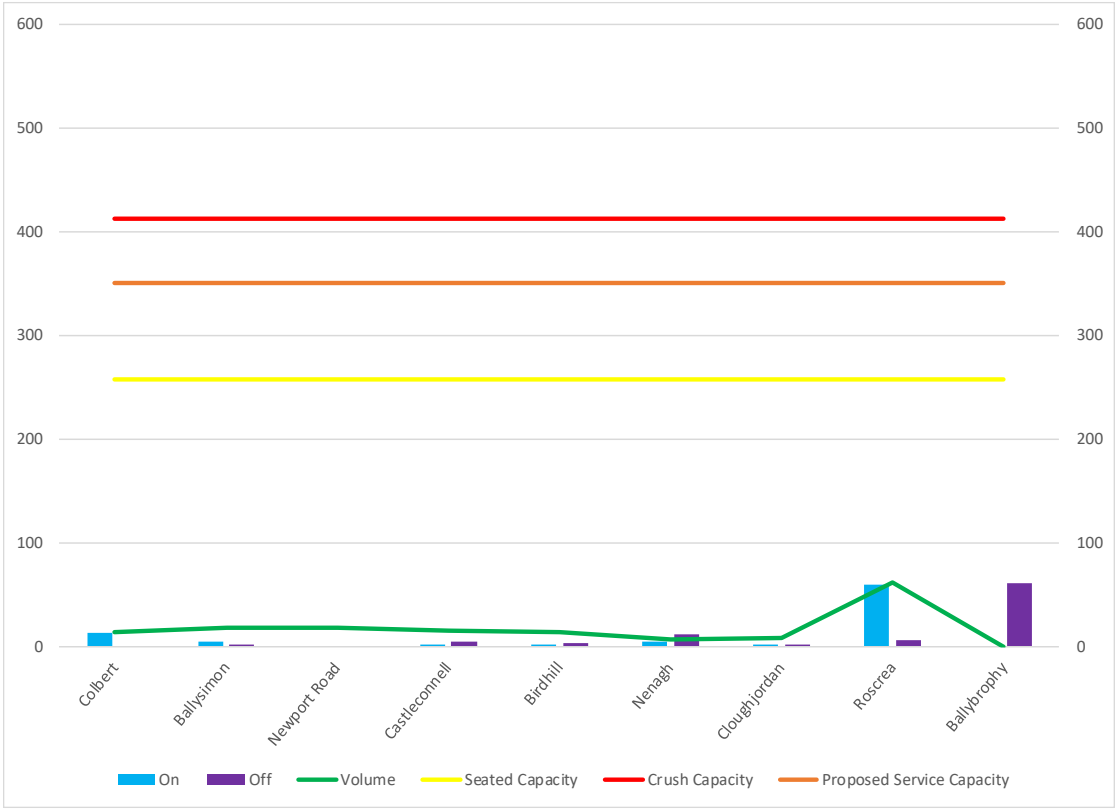
Limerick to Ballybrophy - 2040



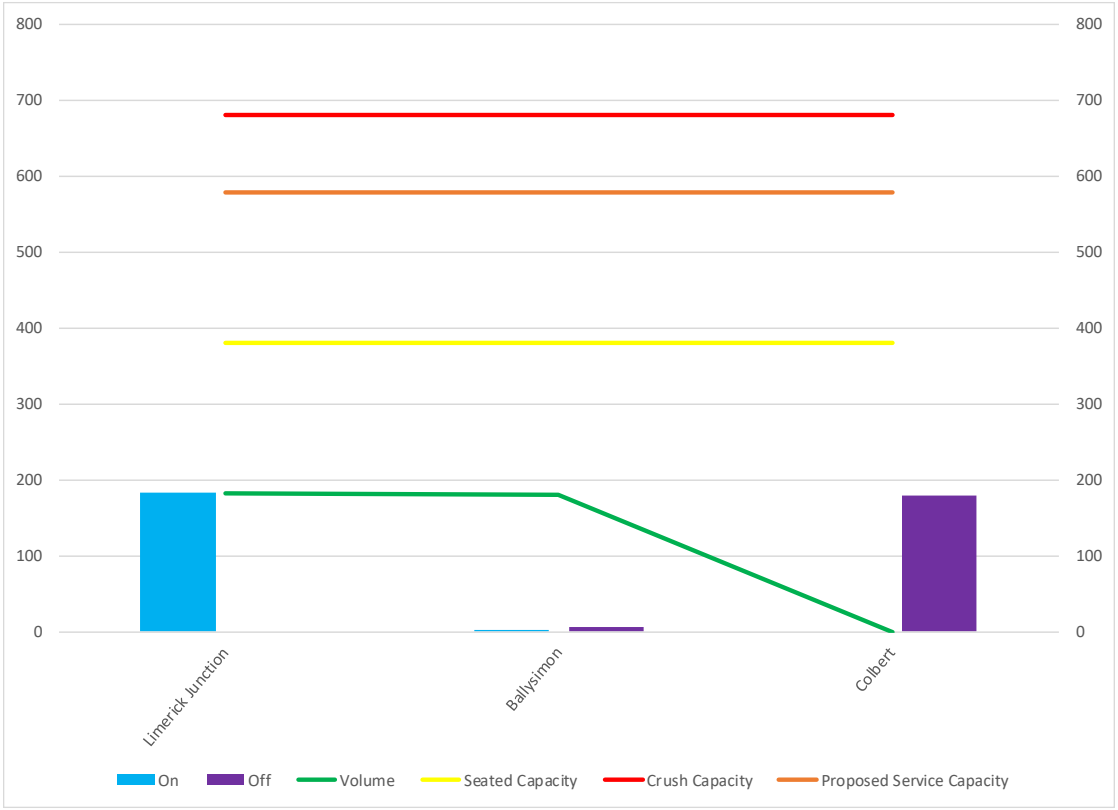
Ballybrophy to Limerick - 2070



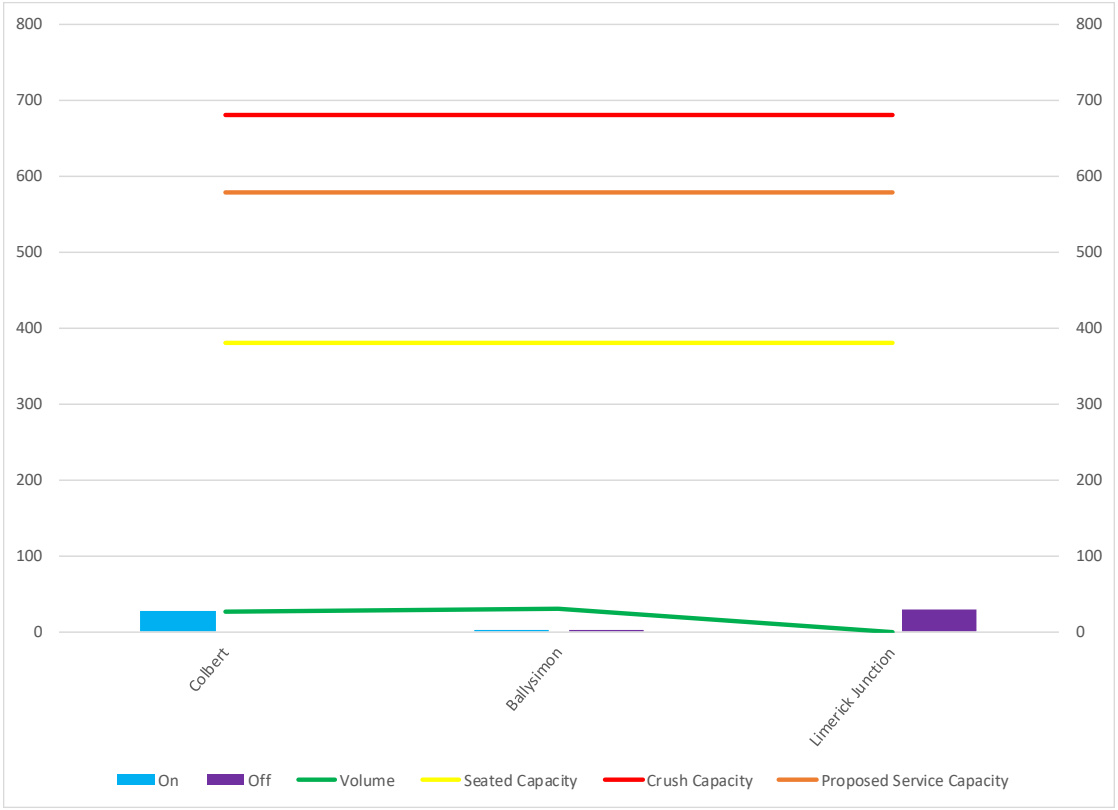
Limerick to Ballybrophy - 2070



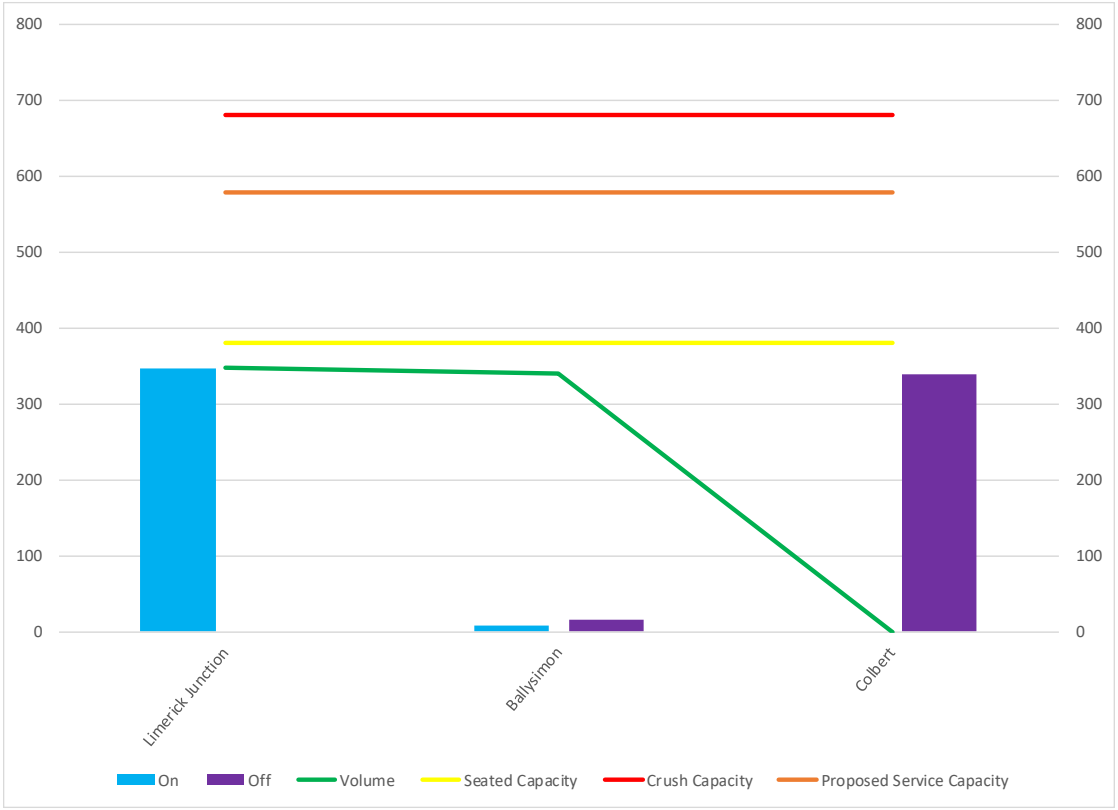
Limerick Junction to Limerick - 2040



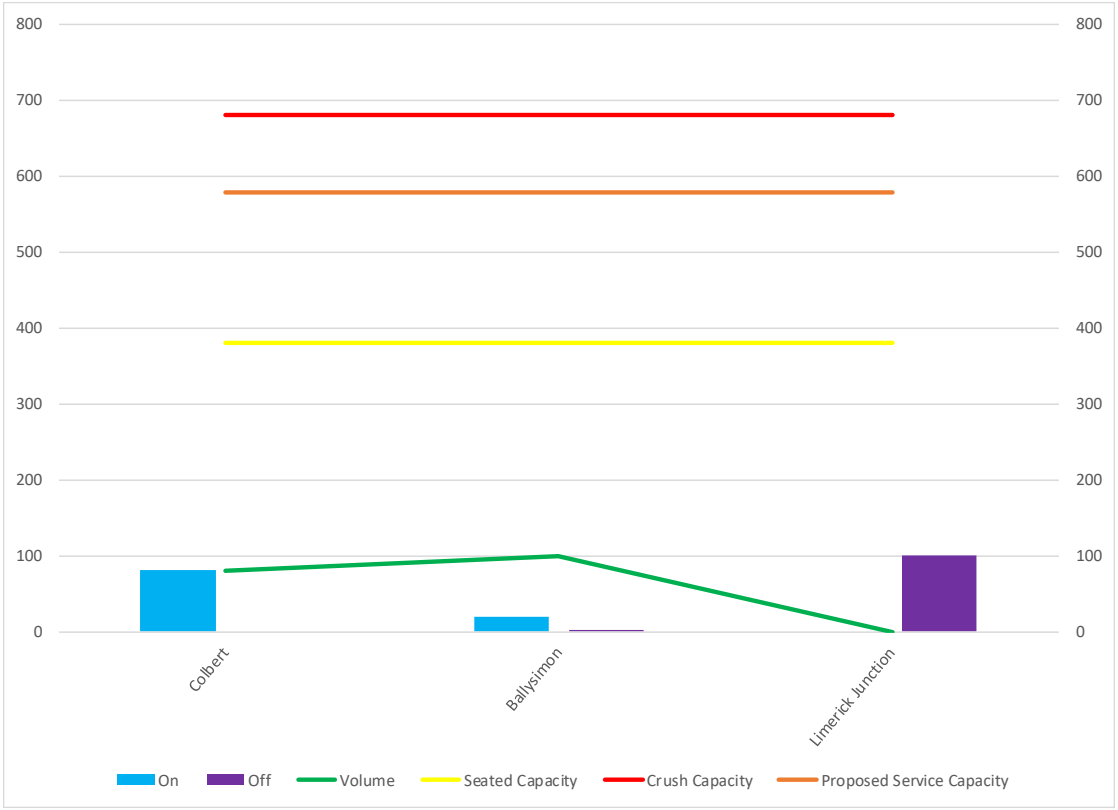
Limerick to Limerick Junction - 2040



Limerick Junction to Limerick - 2070

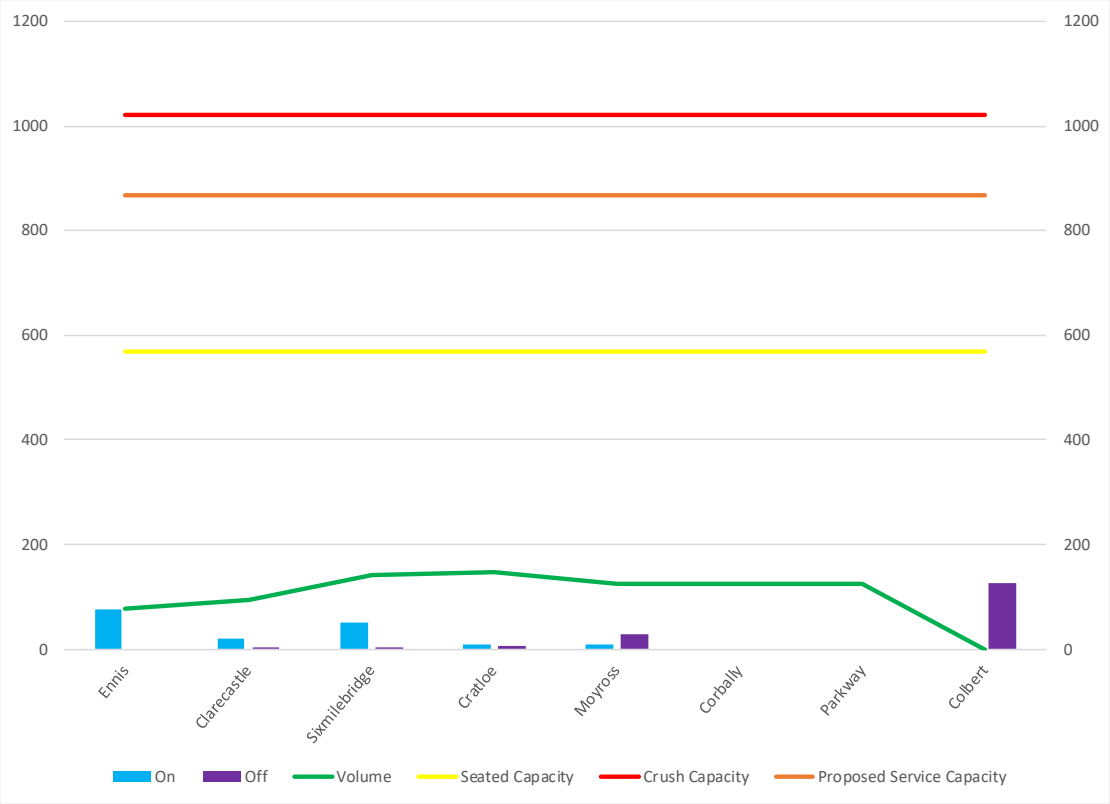


Limerick to Limerick Junction - 2070

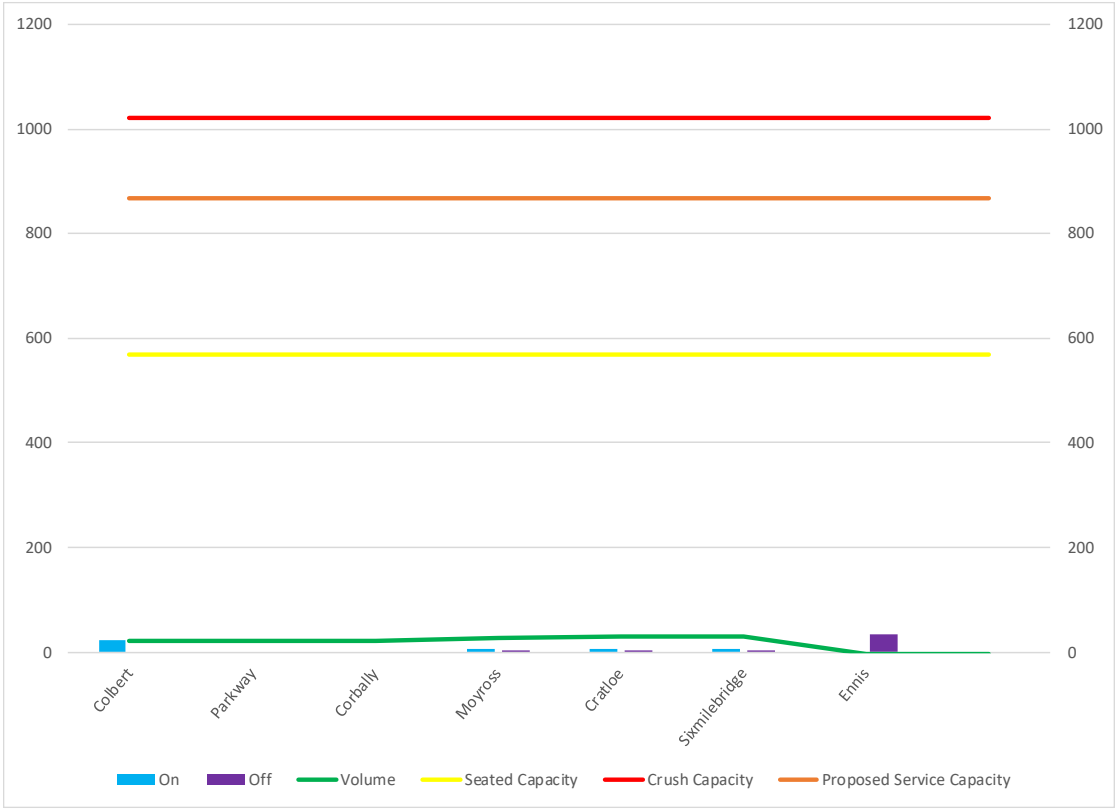


Option 2 B&A Graphs

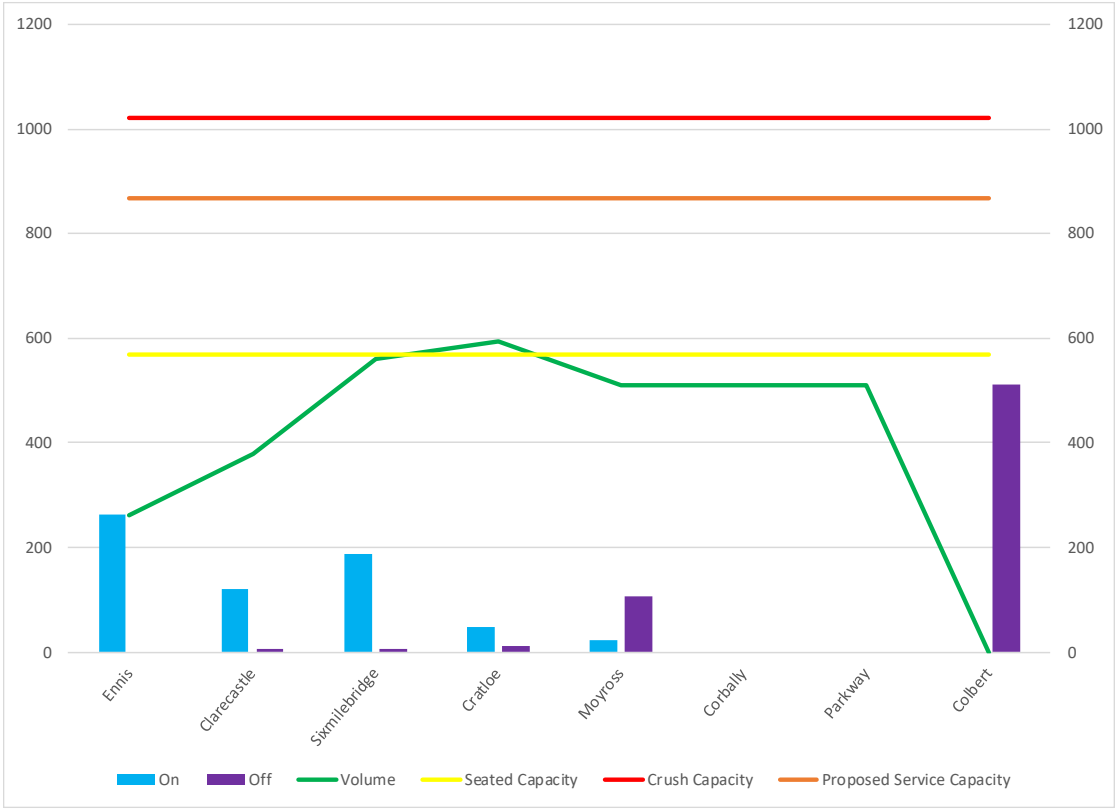
Ennis to Limerick - 2040



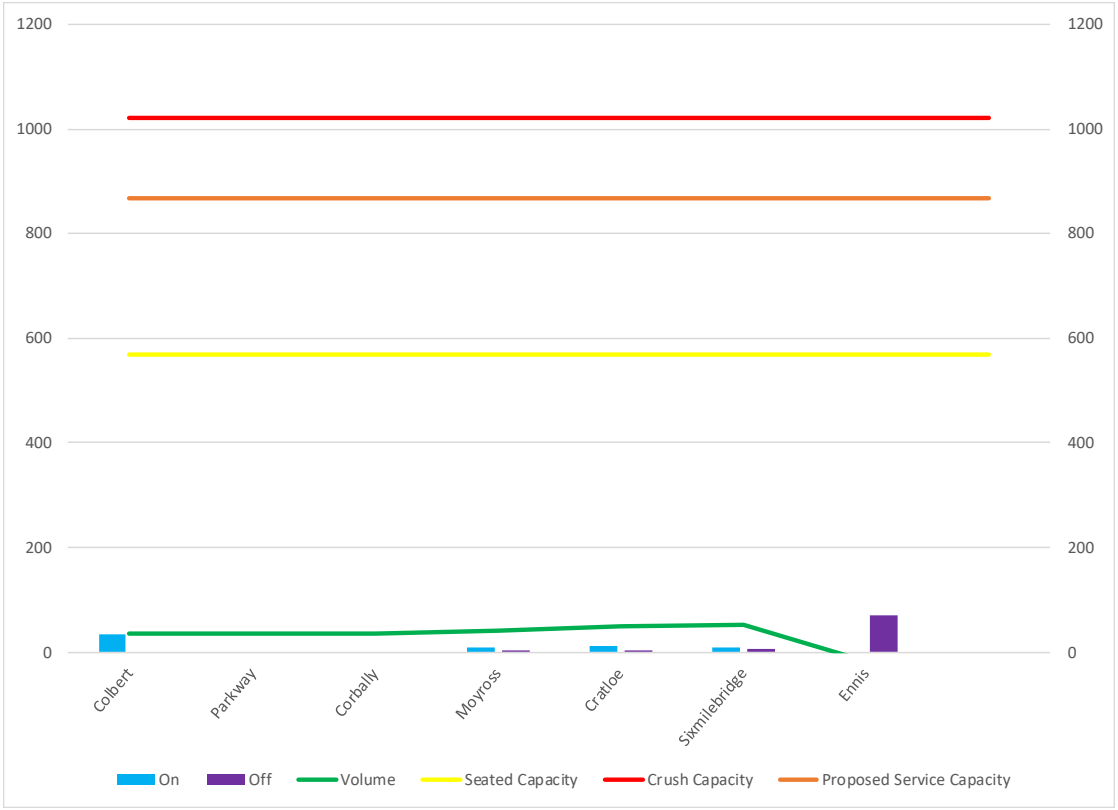
Limerick to Ennis - 2040



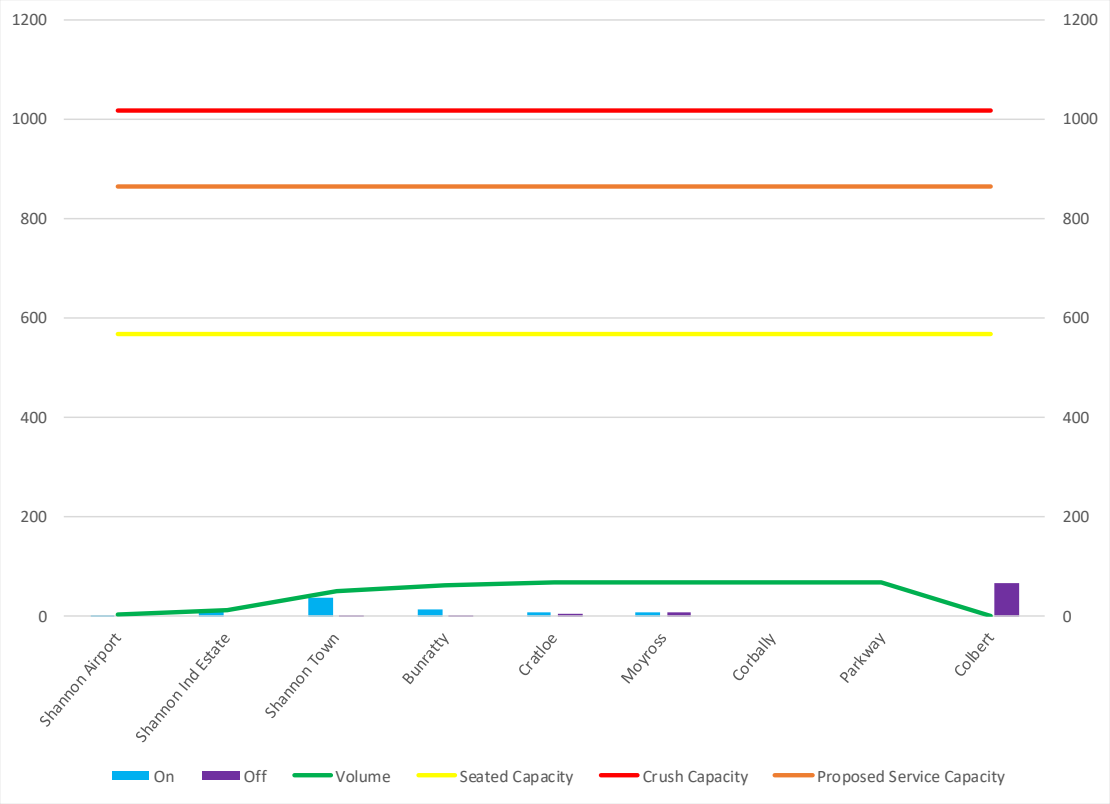
Ennis to Limerick - 2070



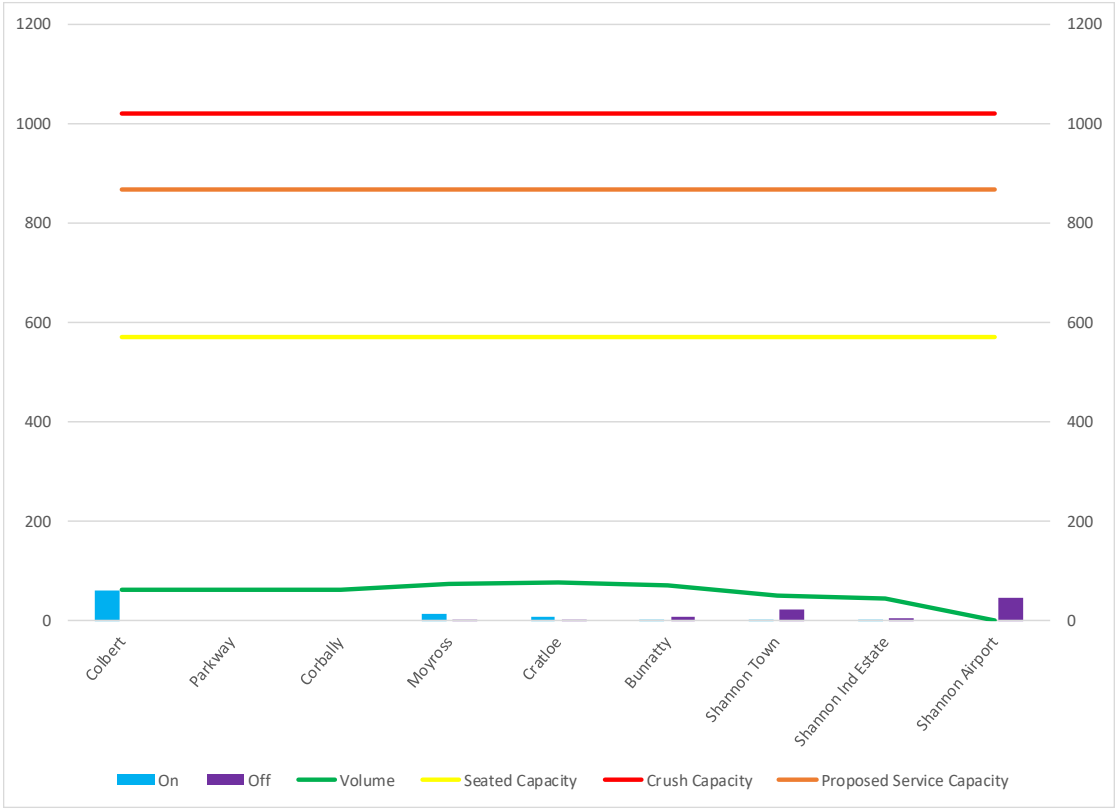
Limerick to Ennis - 2070



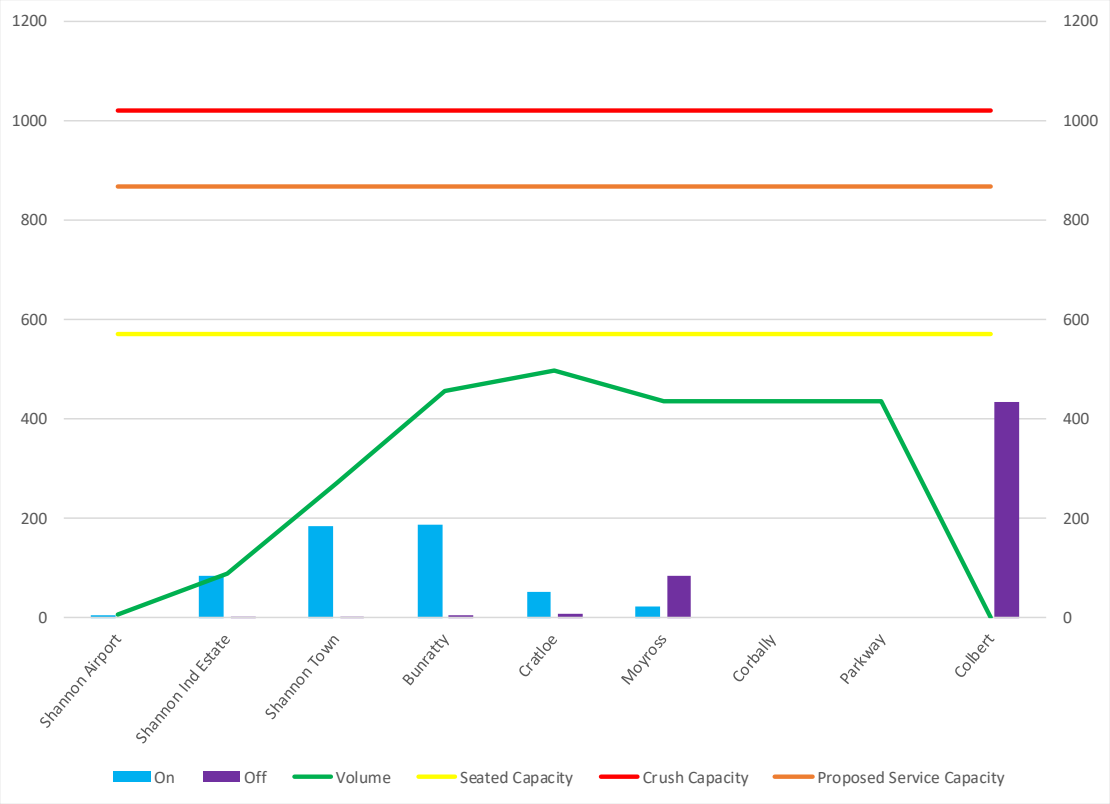
Shannon to Limerick - 2040



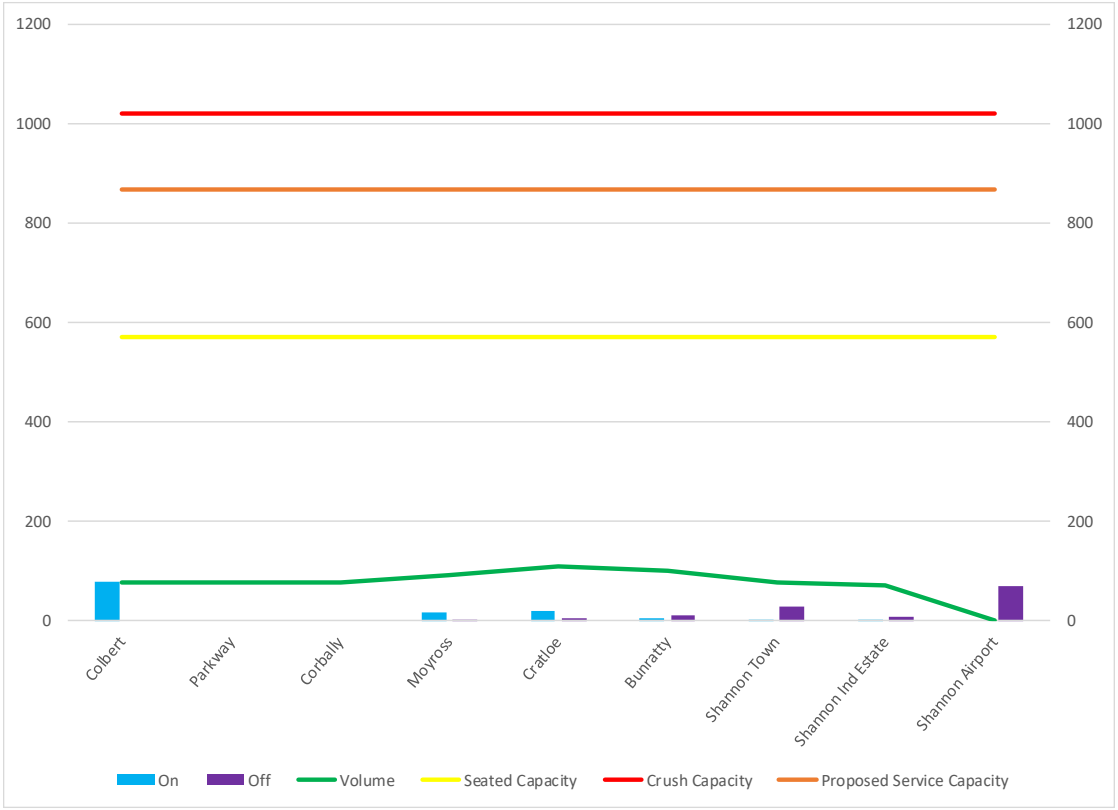
Limerick to Shannon - 2040



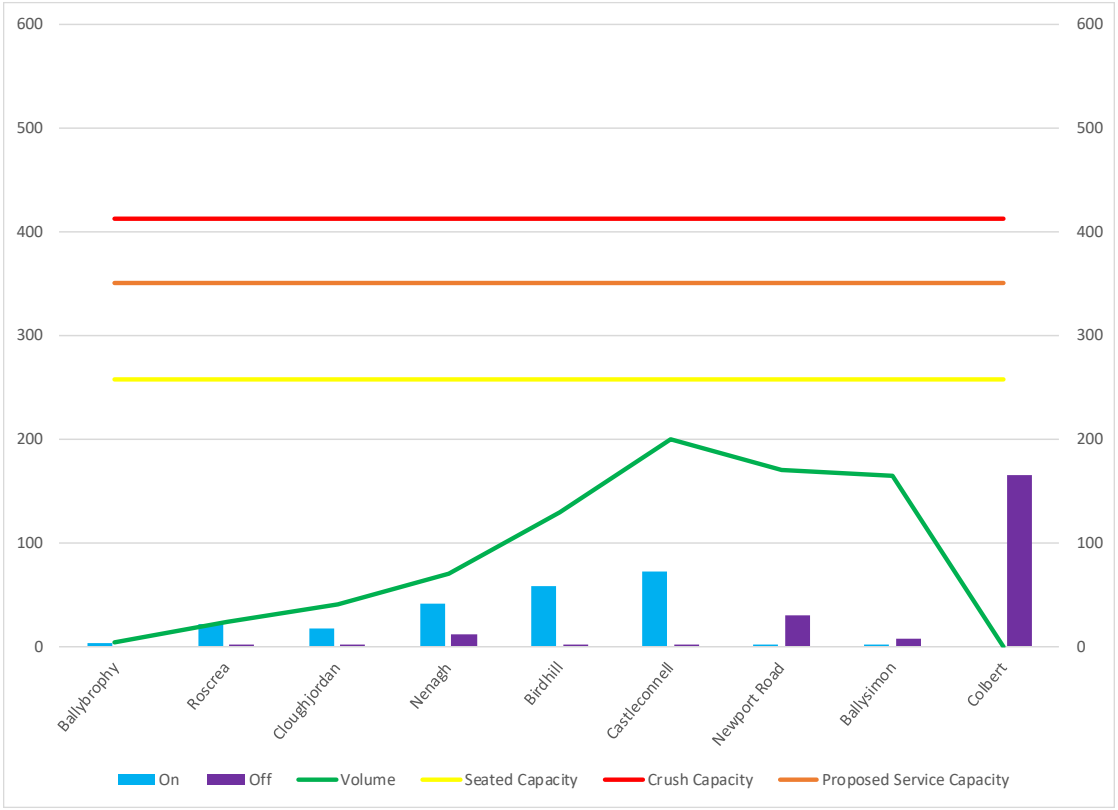
Shannon to Limerick - 2070



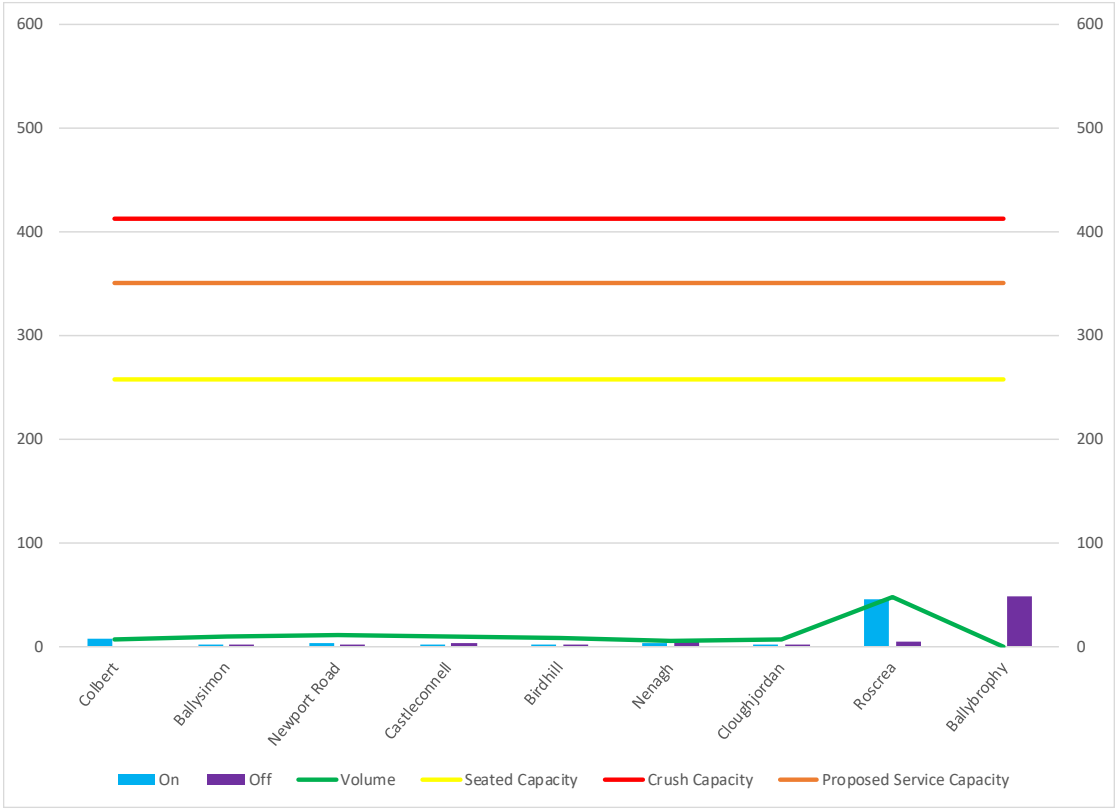
Limerick to Shannon - 2070



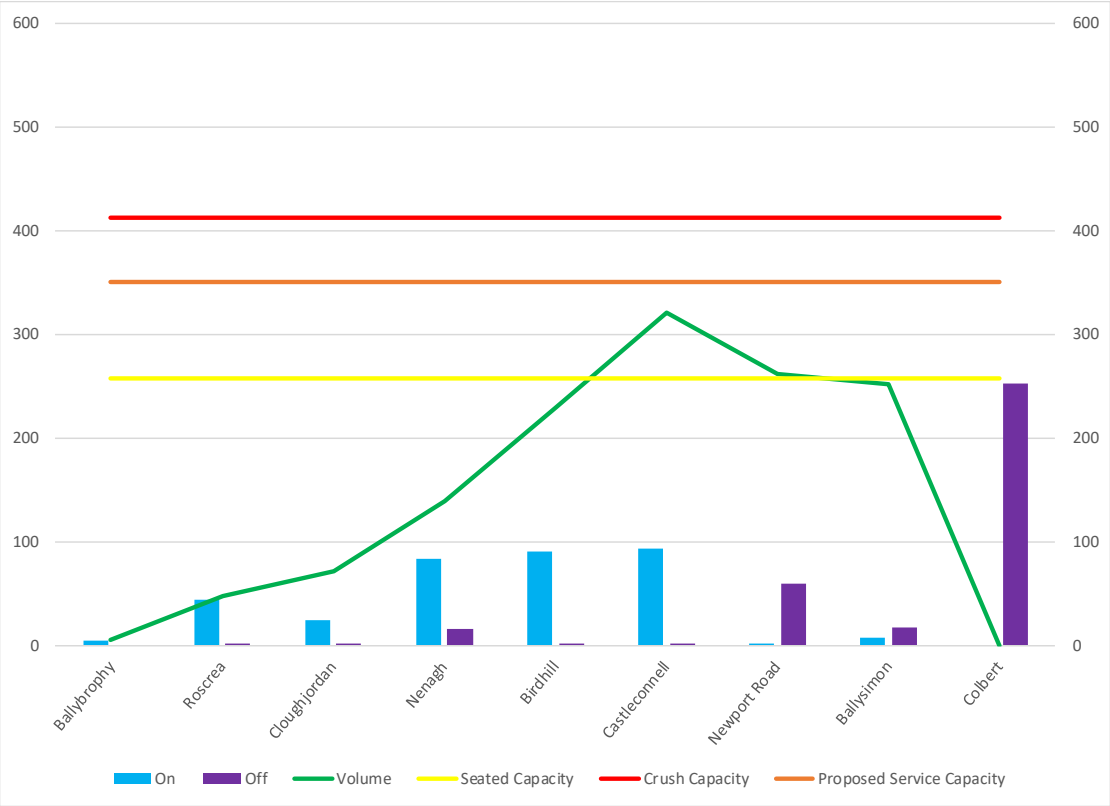
Ballybrophy to Limerick - 2040



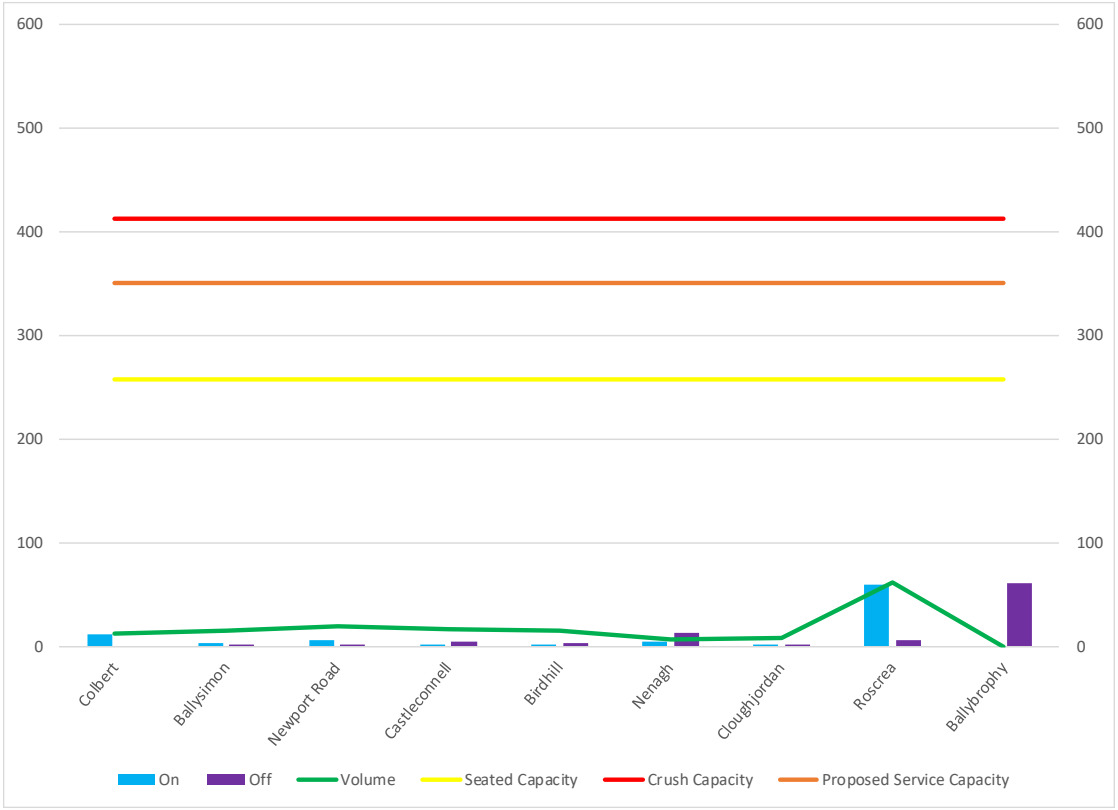
Limerick to Ballybrophy - 2040



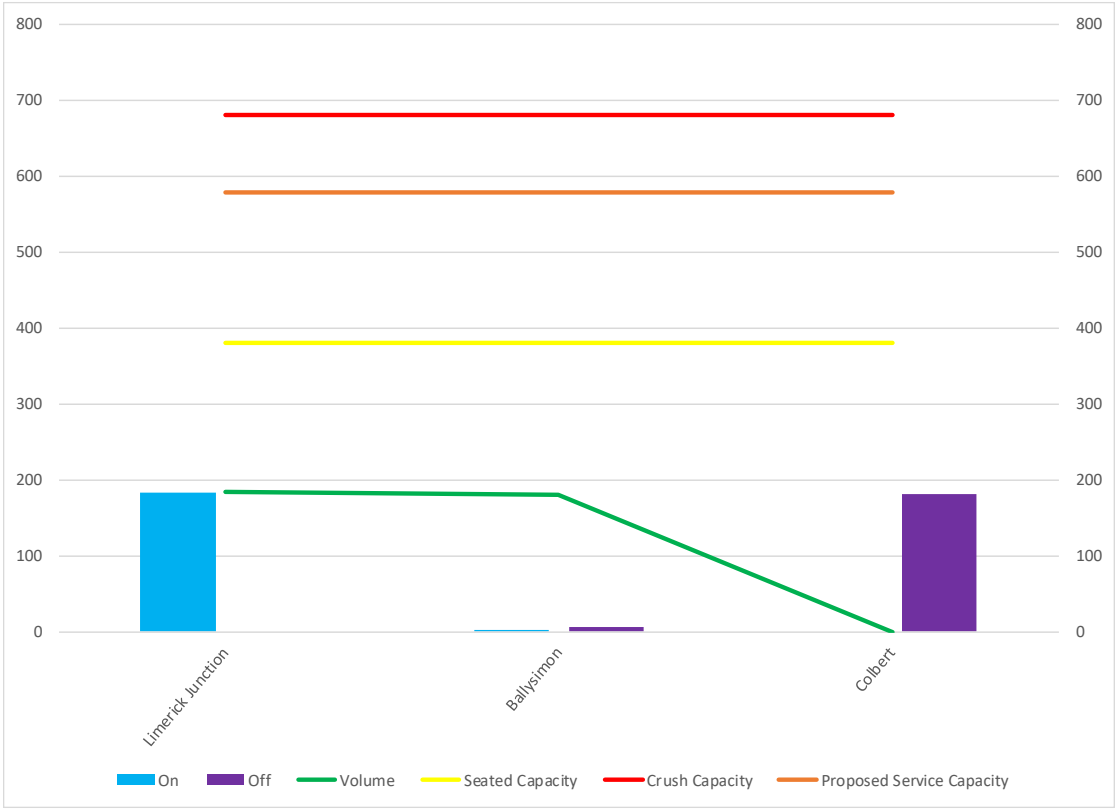
Ballybrophy to Limerick - 2070



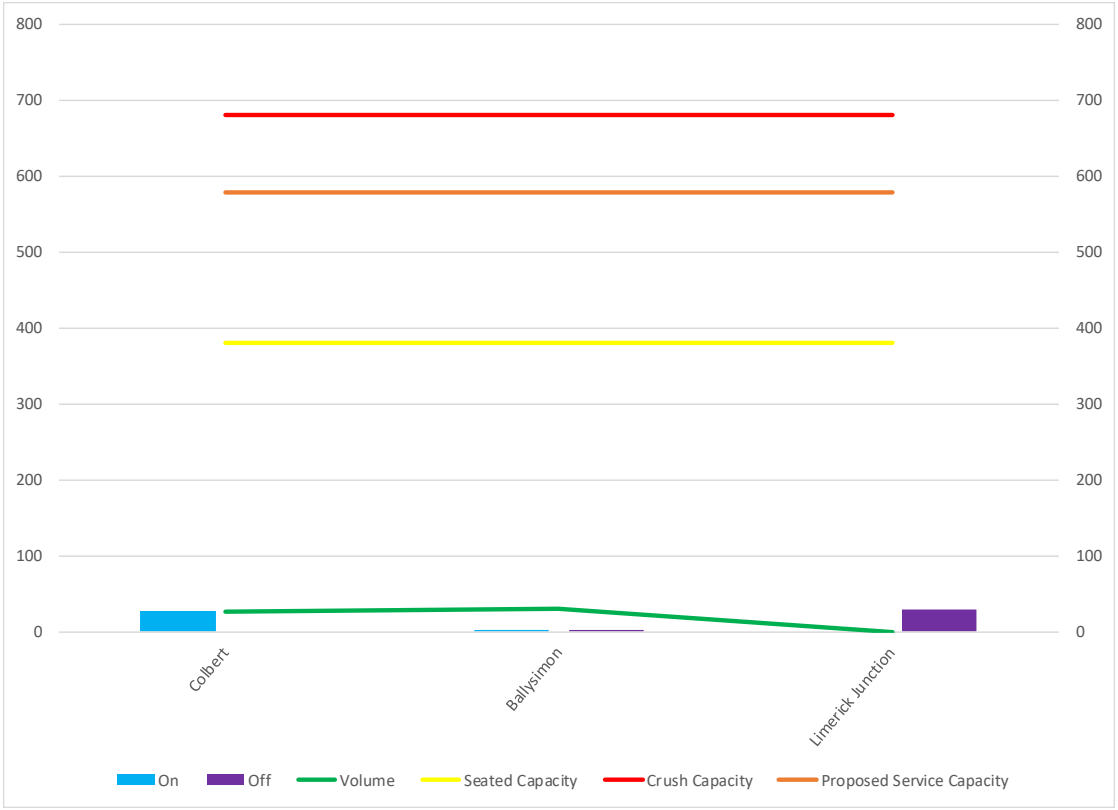
Limerick to Ballybrophy - 2070



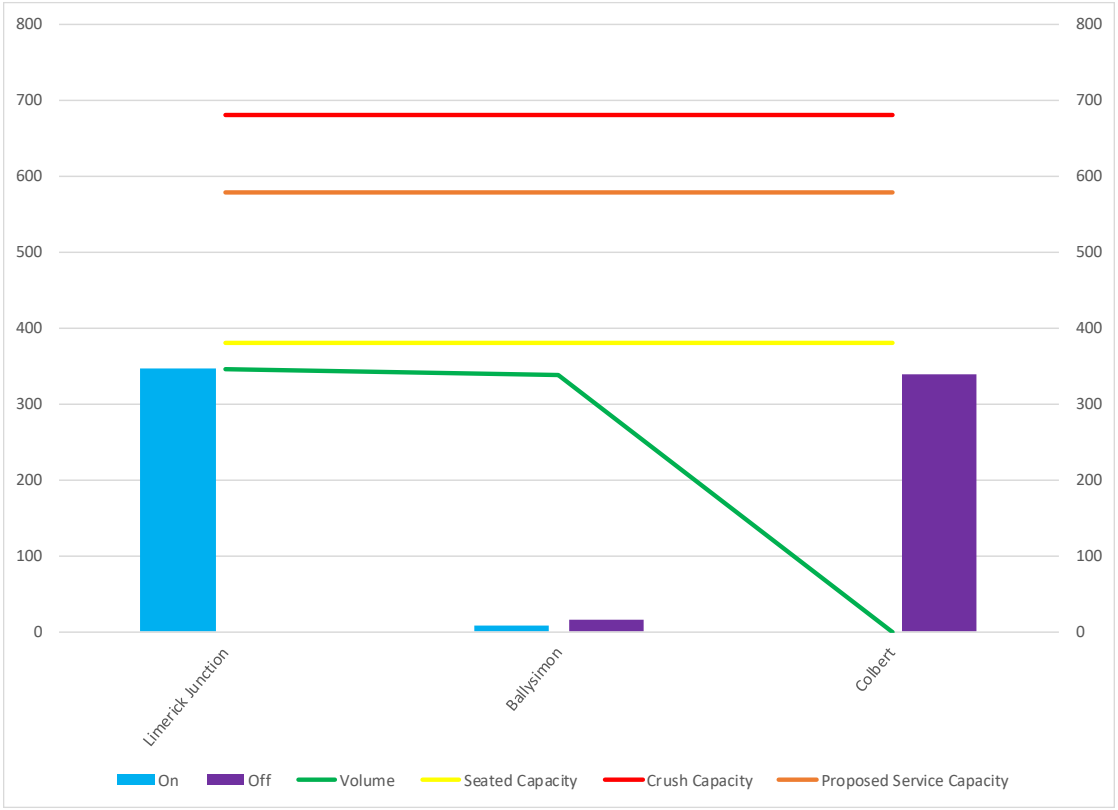
Limerick Junction to Limerick - 2040



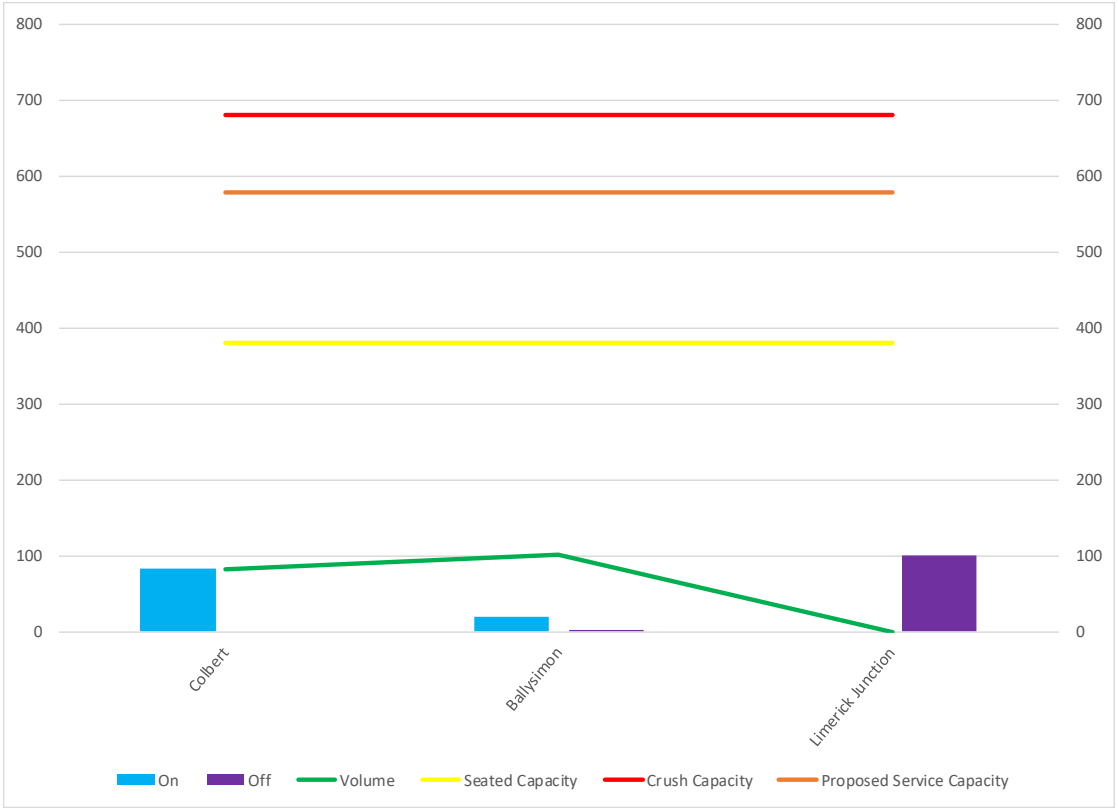
Limerick to Limerick Junction - 2040



Limerick Junction to Limerick - 2070

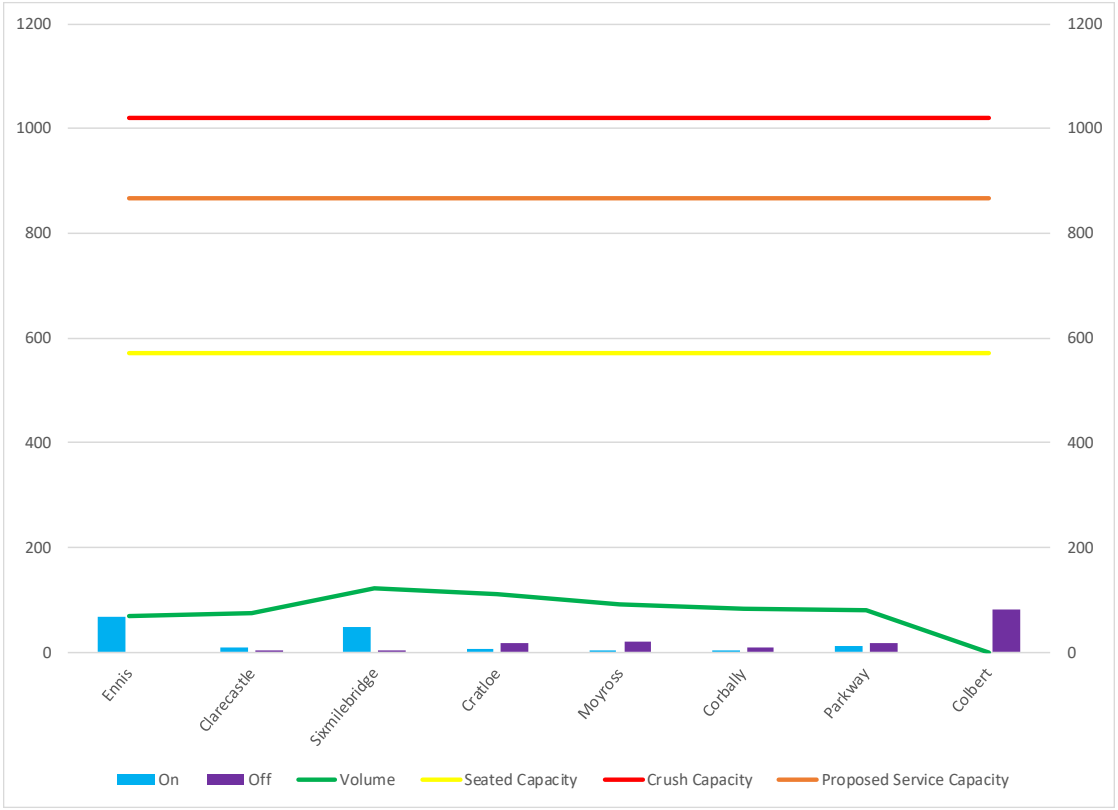


Limerick to Limerick Junction - 2070

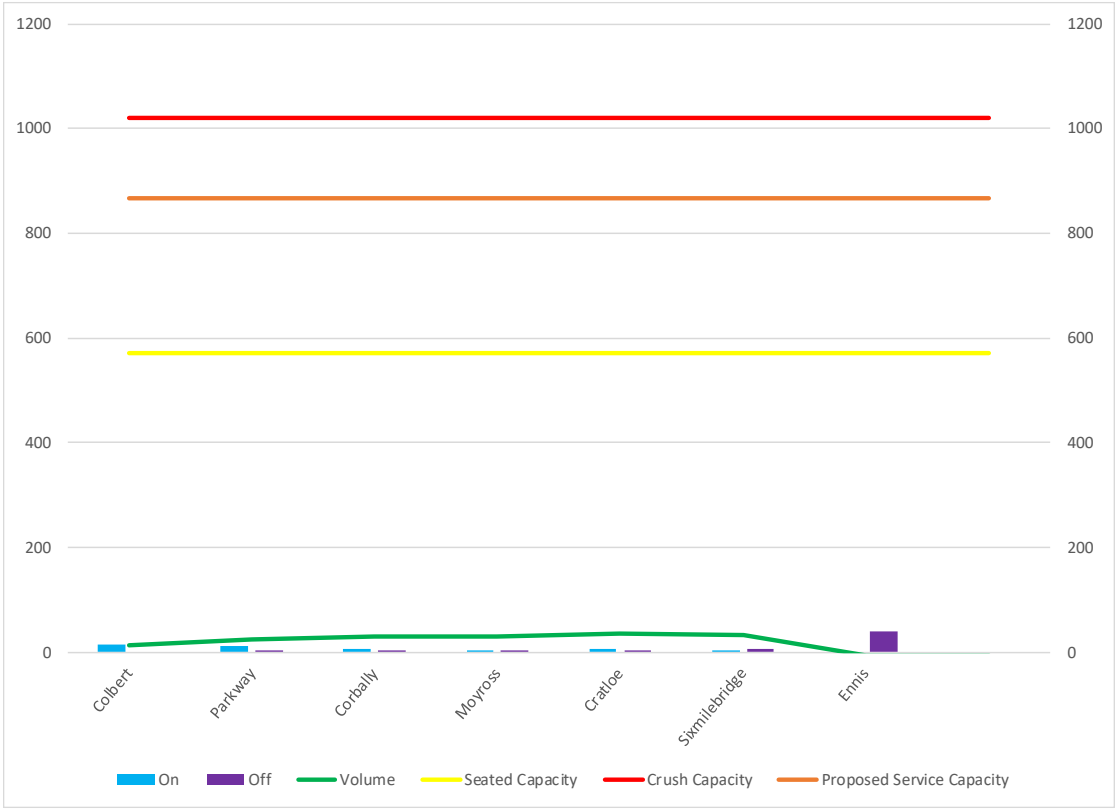


Option 3 B&A Graphs

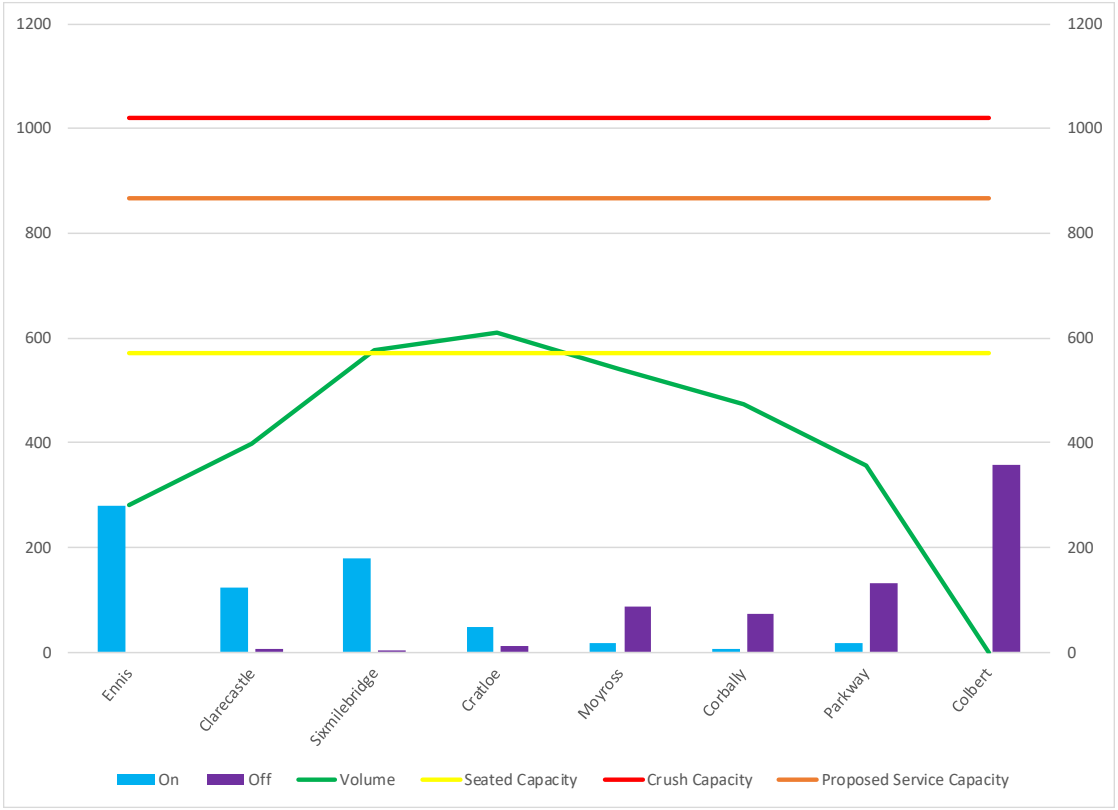
Ennis to Limerick - 2040



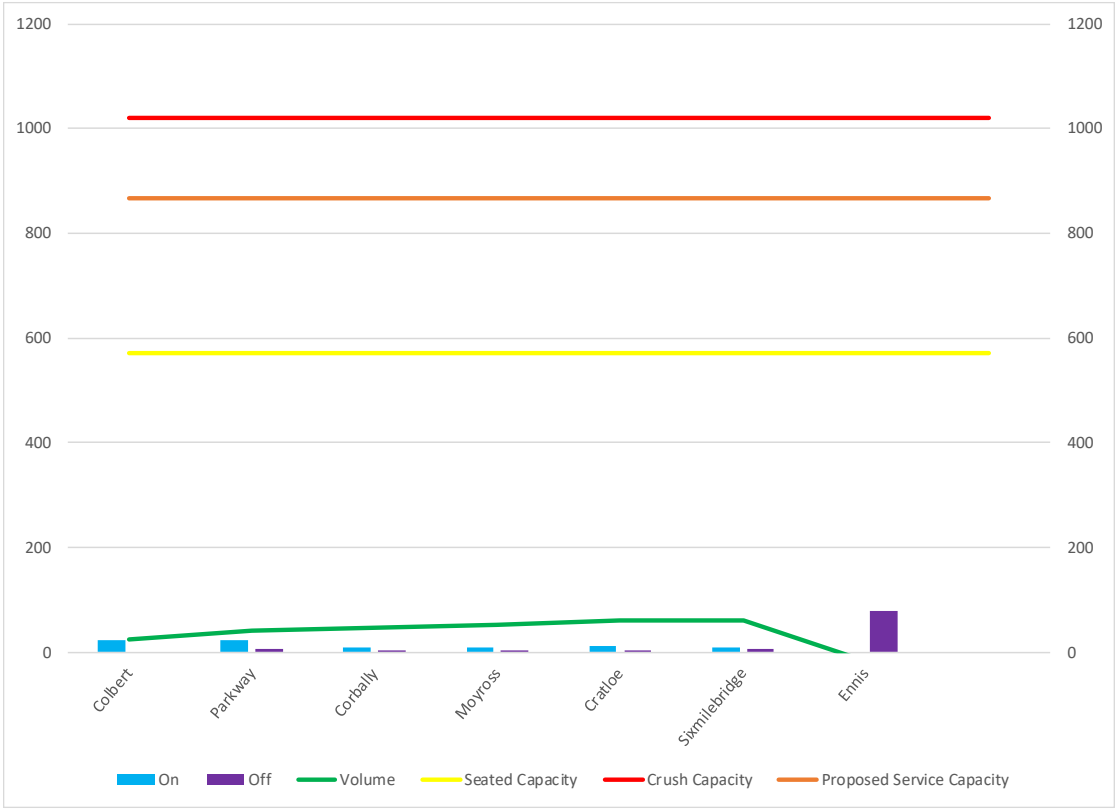
Limerick to Ennis - 2040



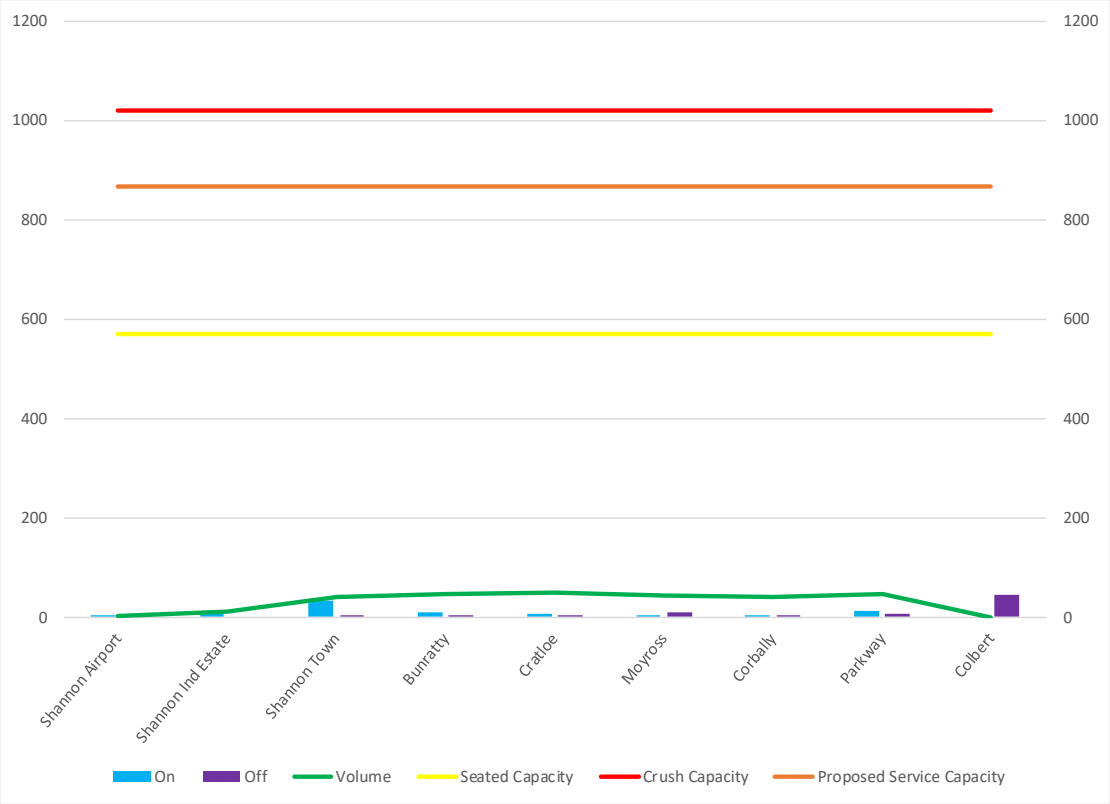
Ennis to Limerick - 2070



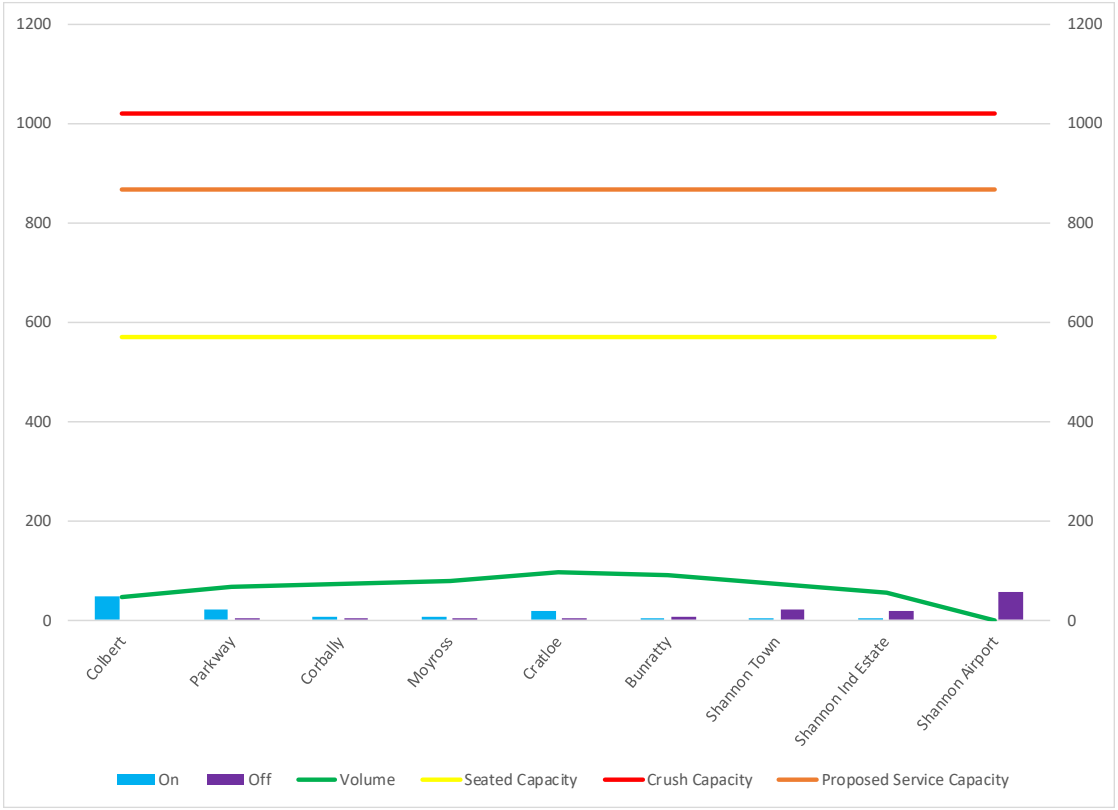
Limerick to Ennis - 2070



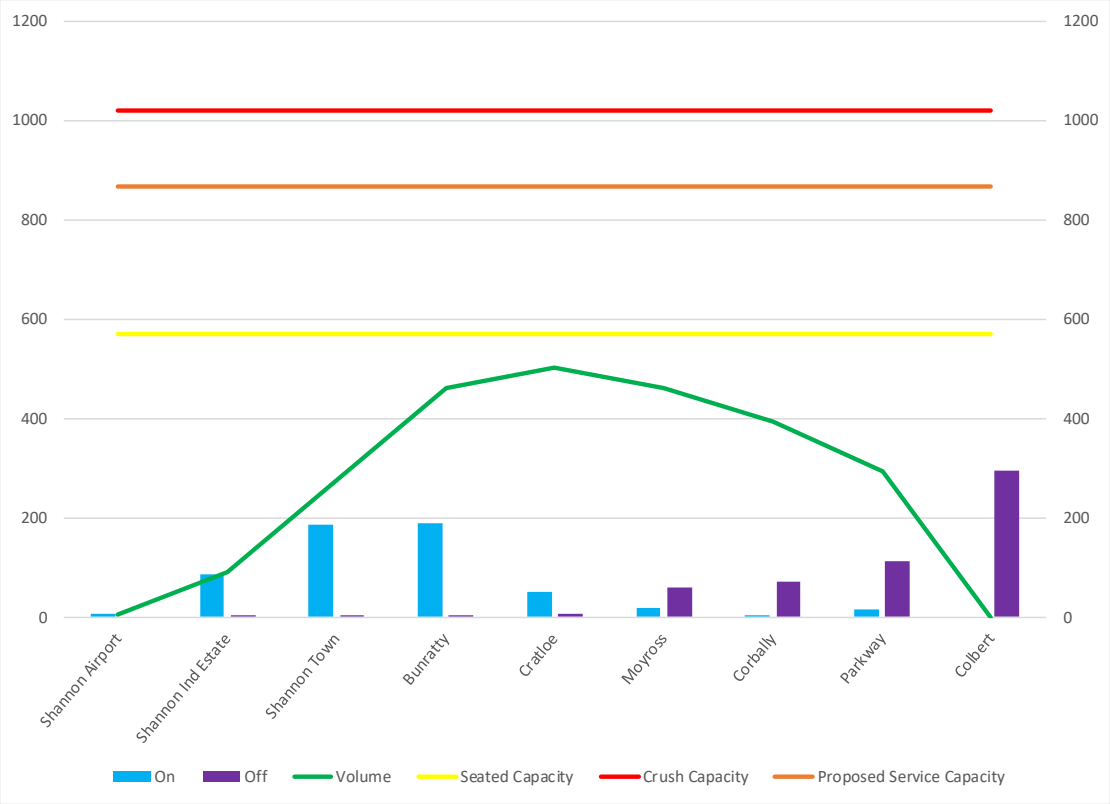
Shannon to Limerick - 2040



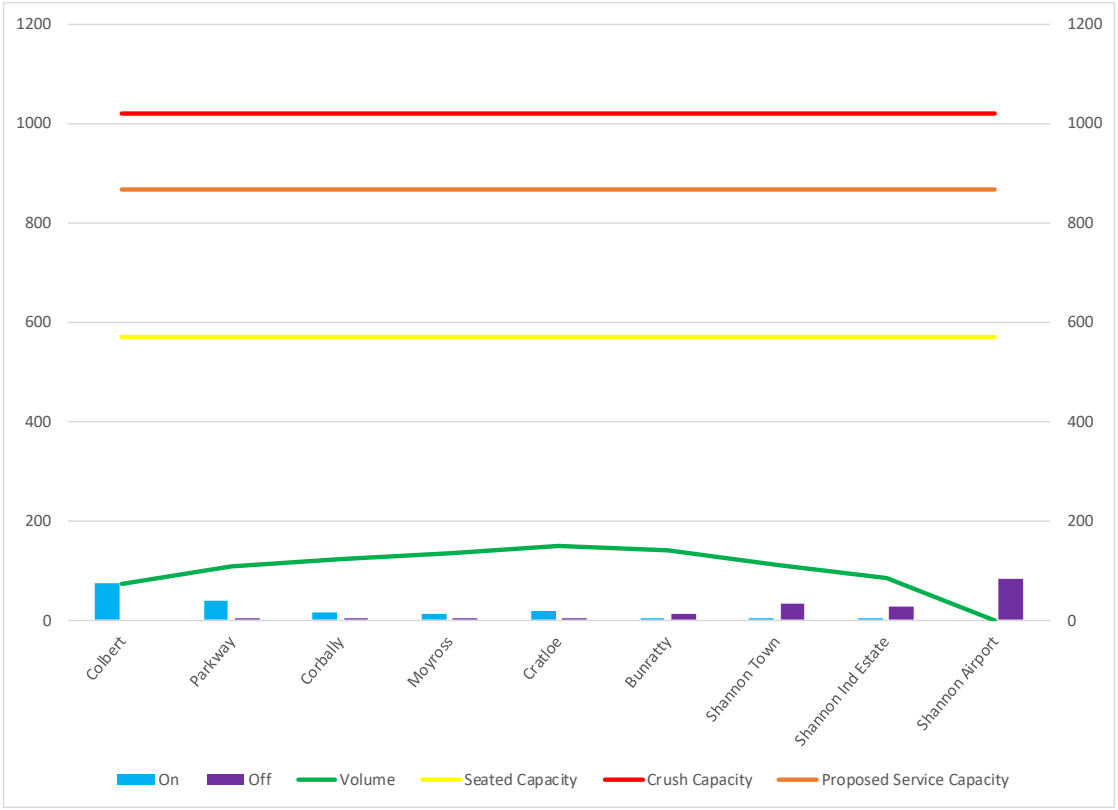
Limerick to Shannon - 2040



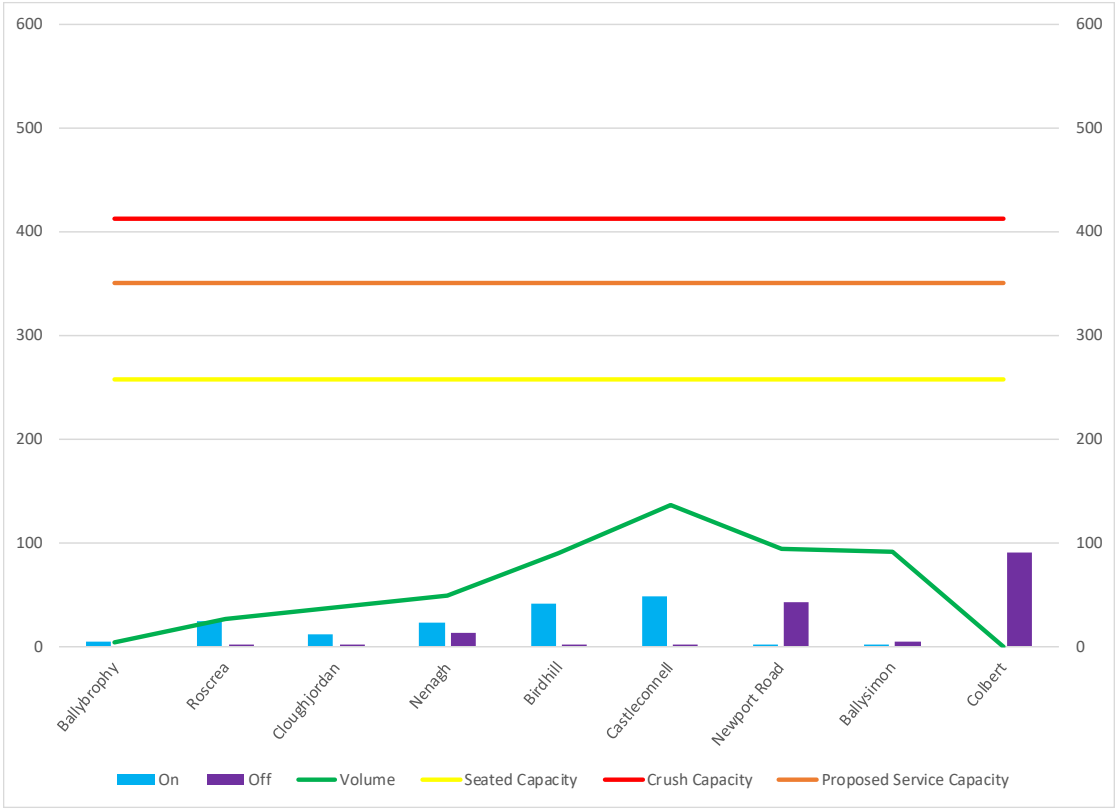
Shannon to Limerick - 2070



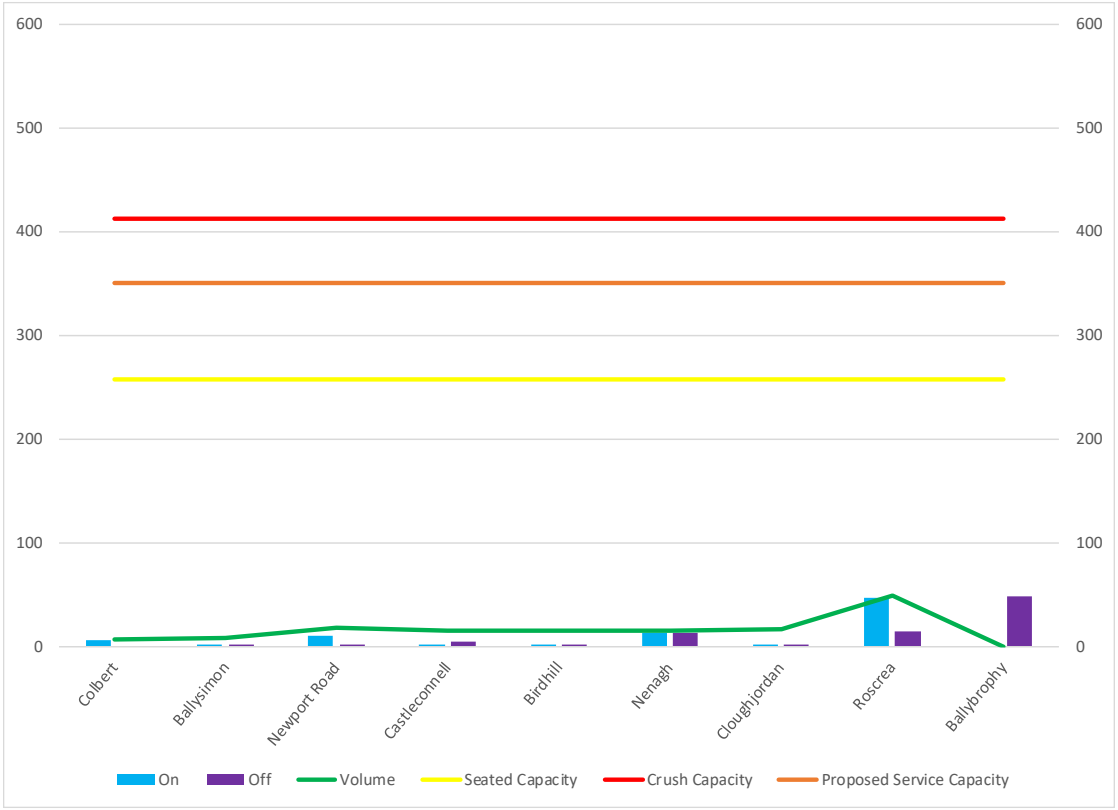
Limerick to Shannon - 2070



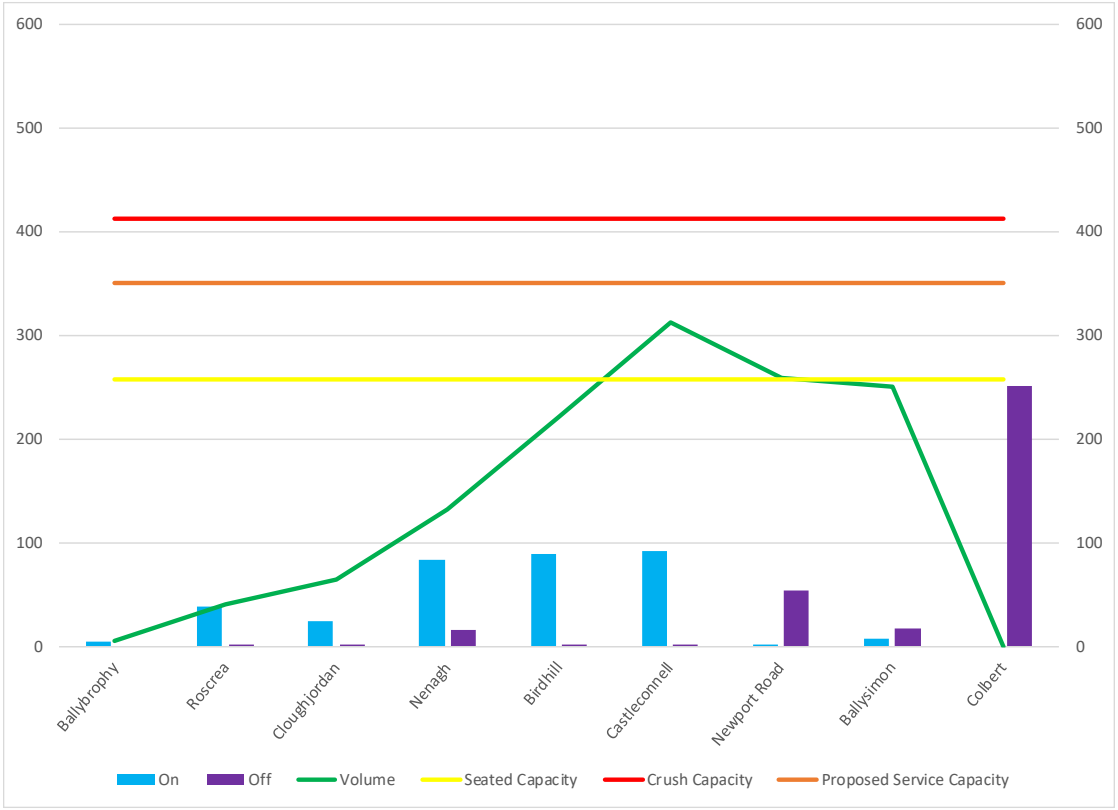
Ballybrophy to Limerick - 2040



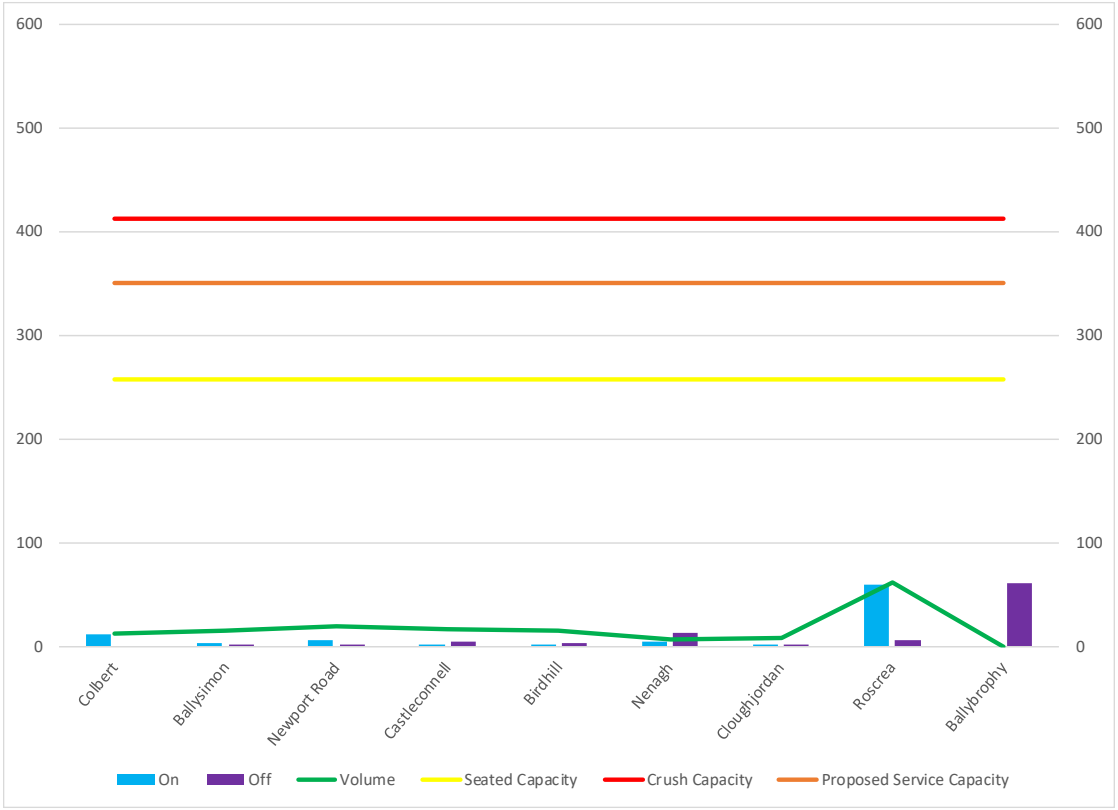
Limerick to Ballybrophy - 2040



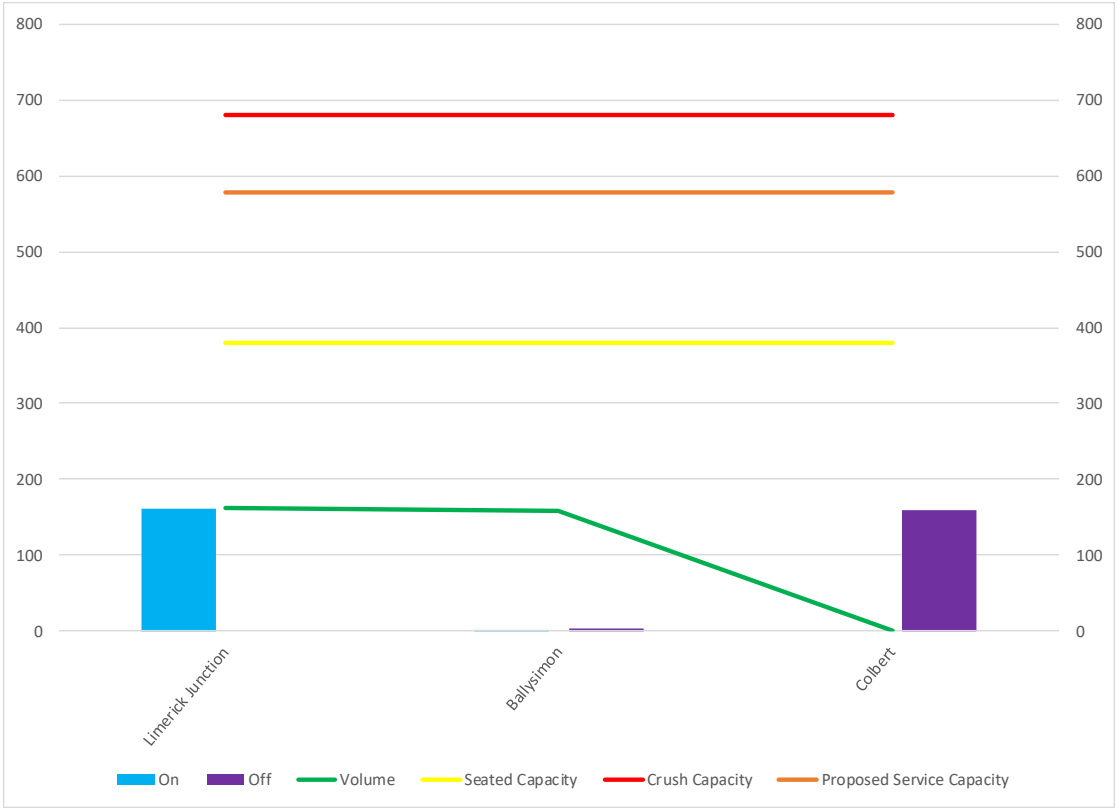
Ballybrophy to Limerick - 2070



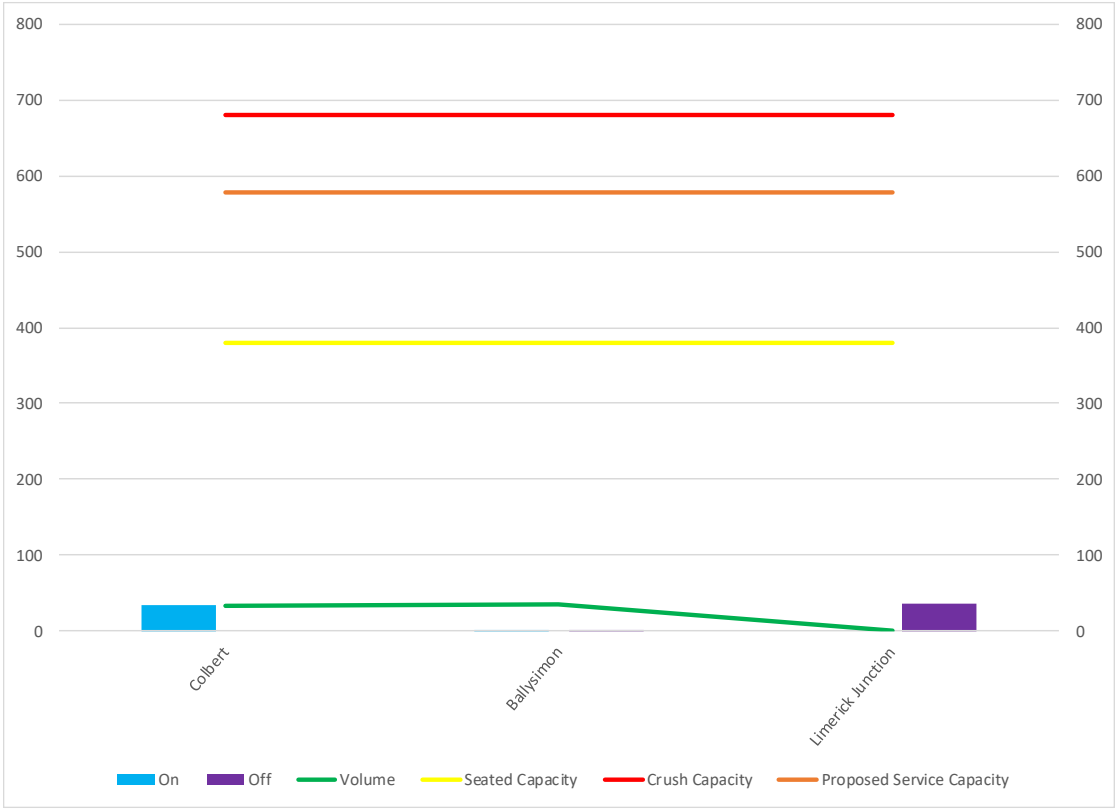
Limerick to Ballybrophy - 2070



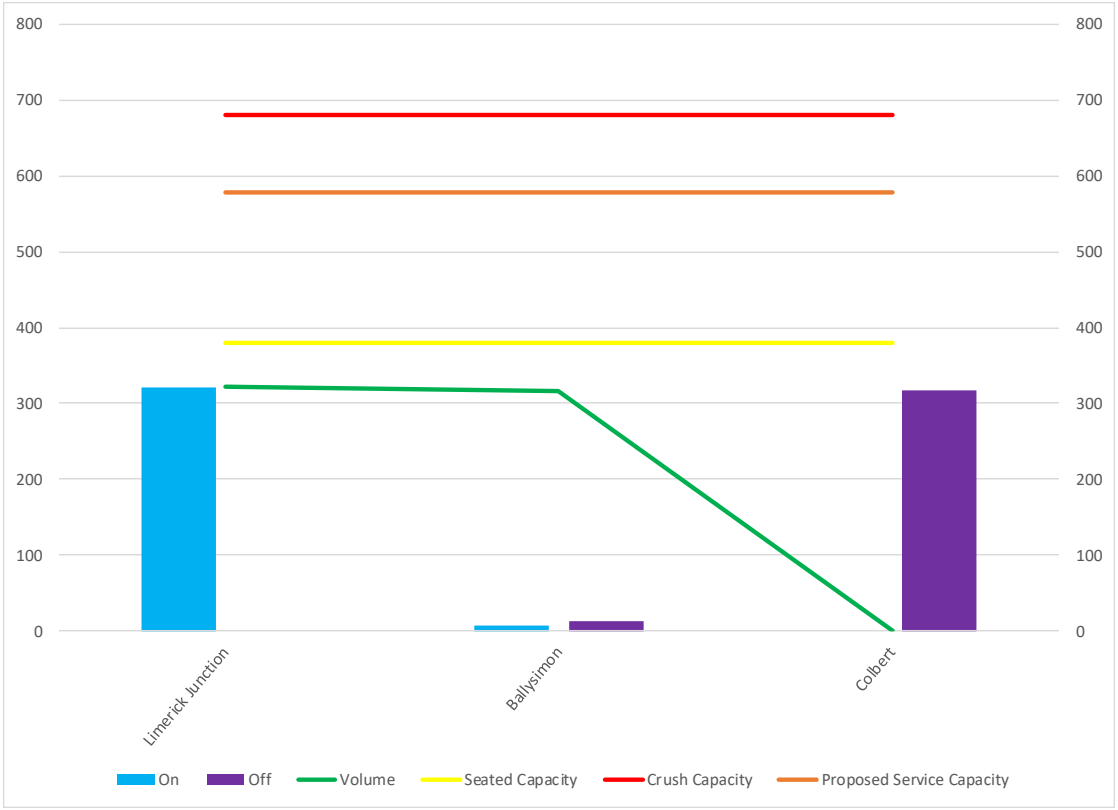
Limerick Junction to Limerick - 2040



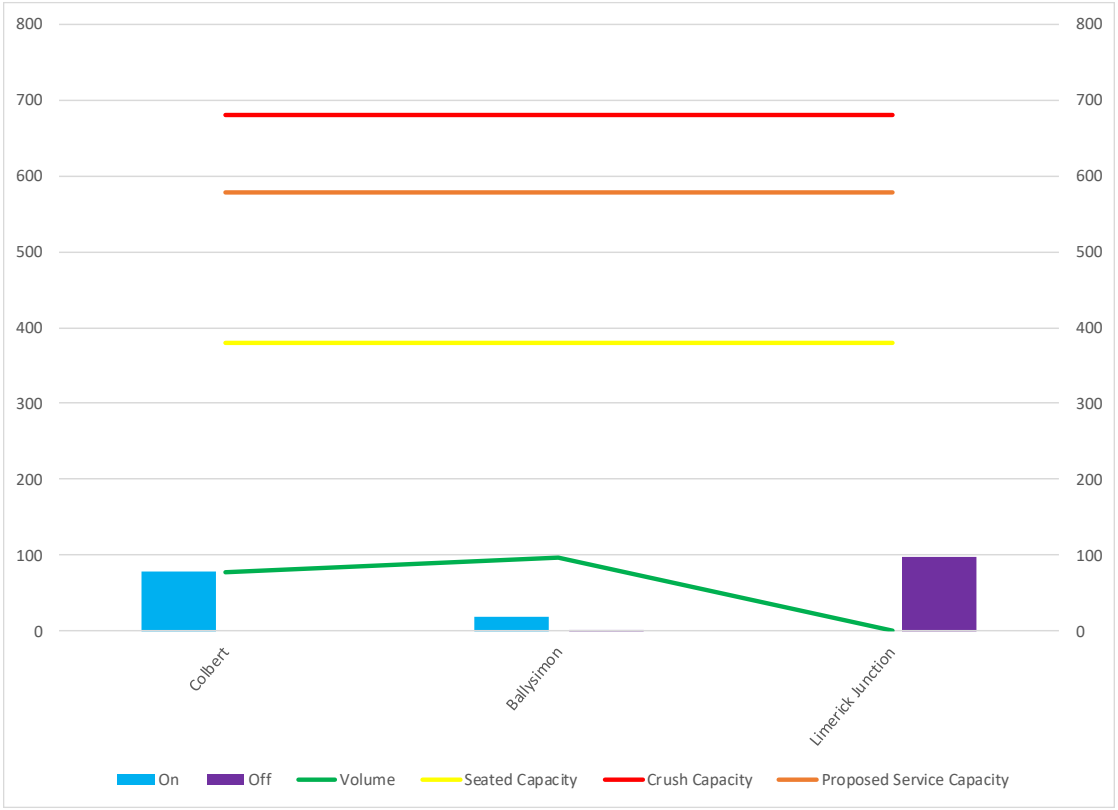
Limerick to Limerick Junction - 2040



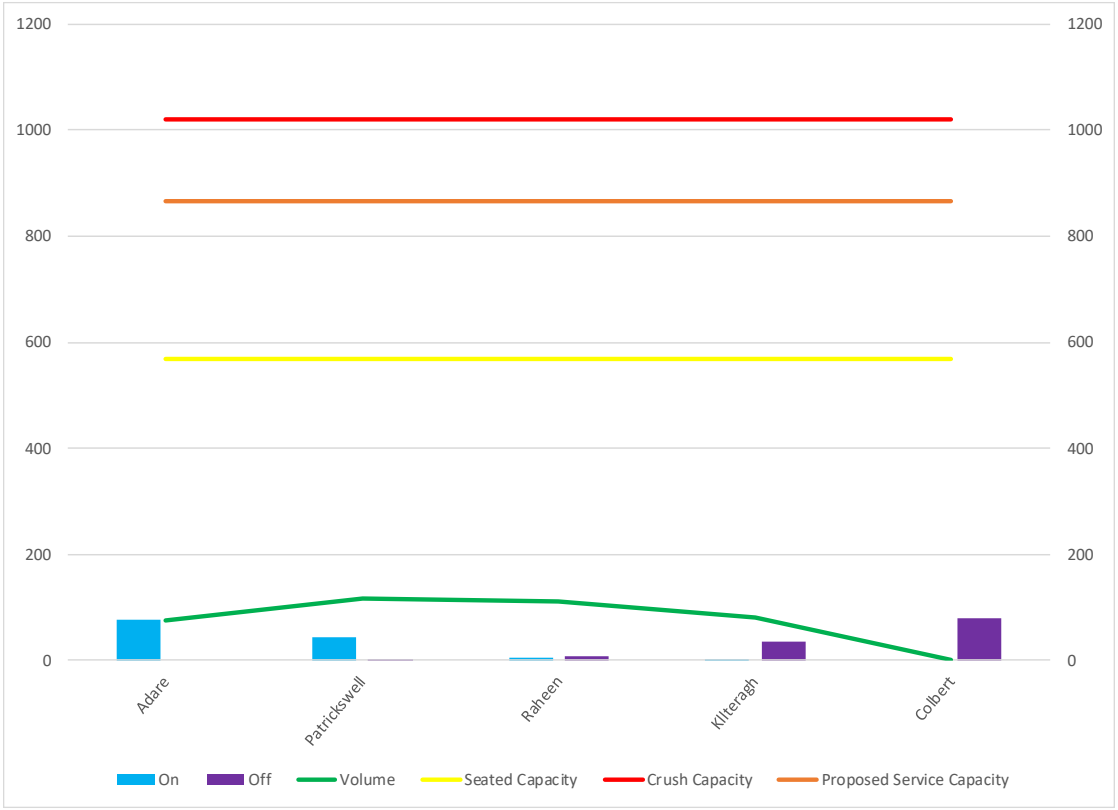
Limerick Junction to Limerick - 2070



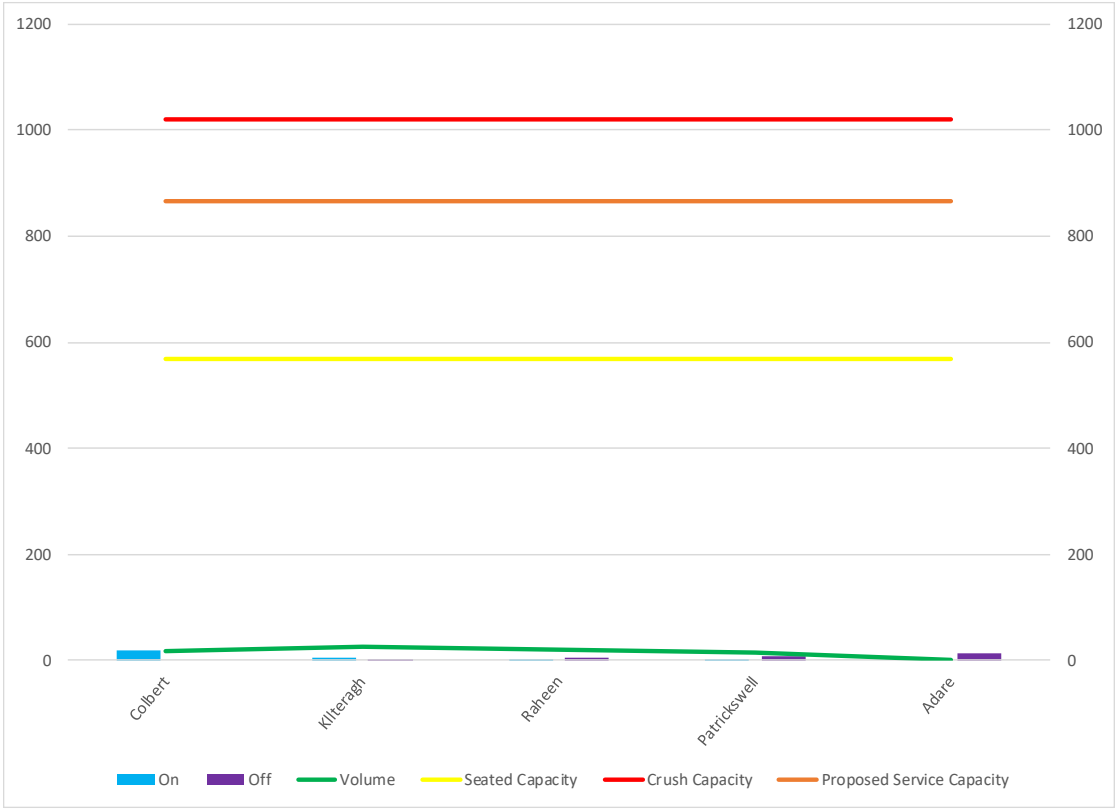
Limerick to Limerick Junction - 2070



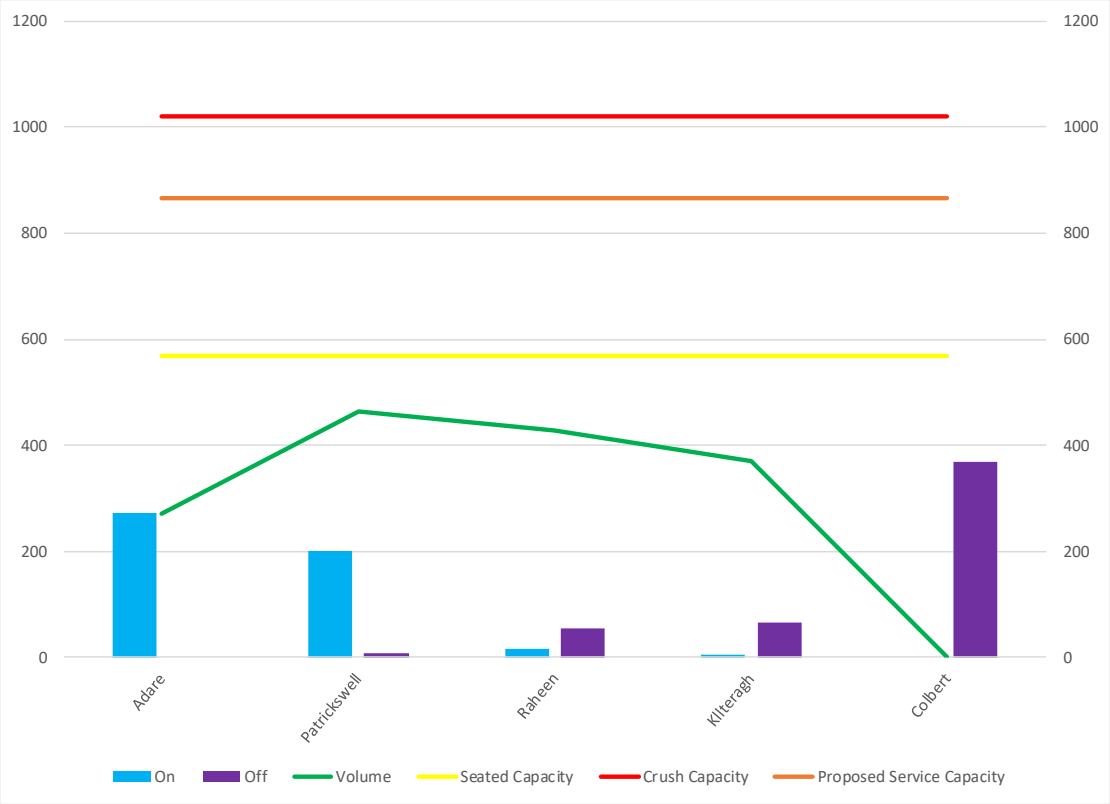
Adare to Limerick - 2040



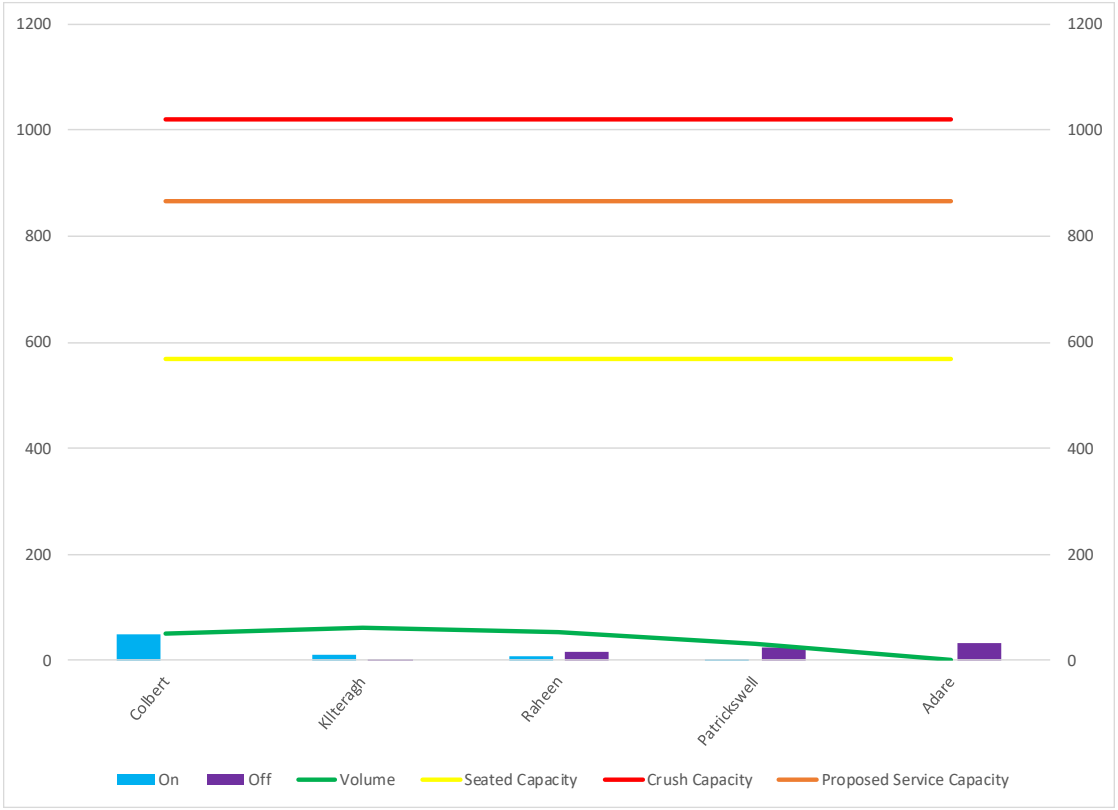
Limerick to Adare - 2040



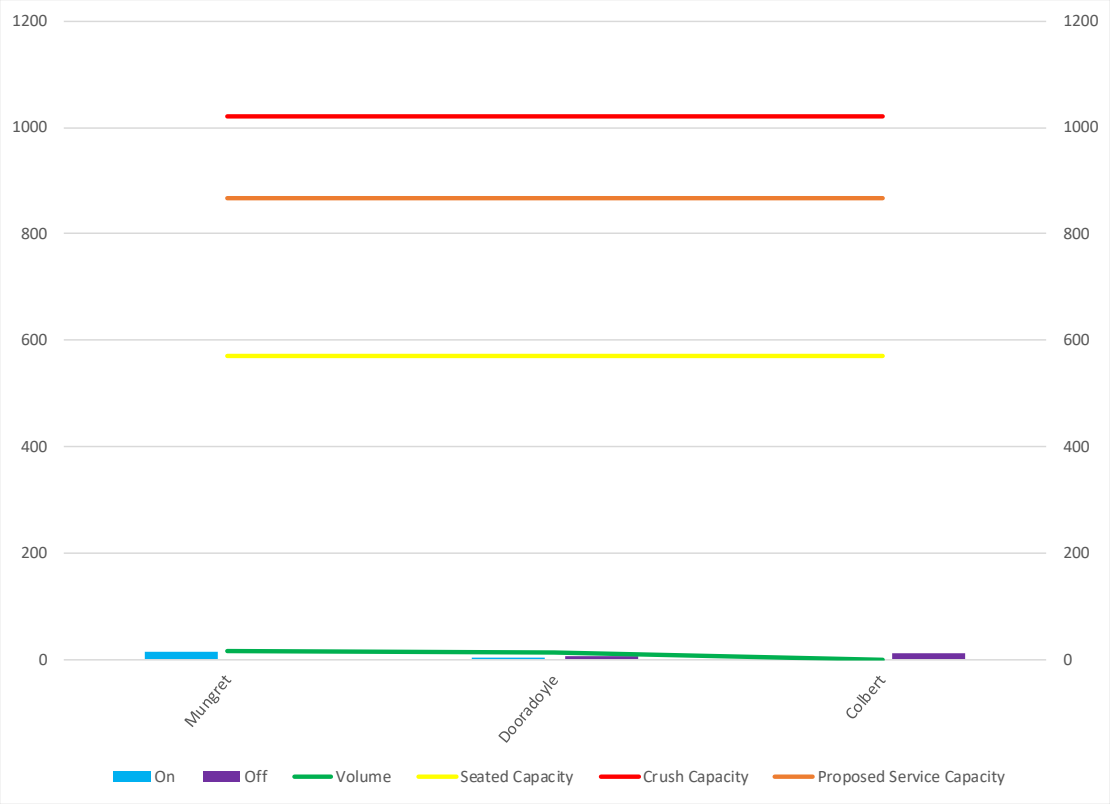
Adare to Limerick - 2070



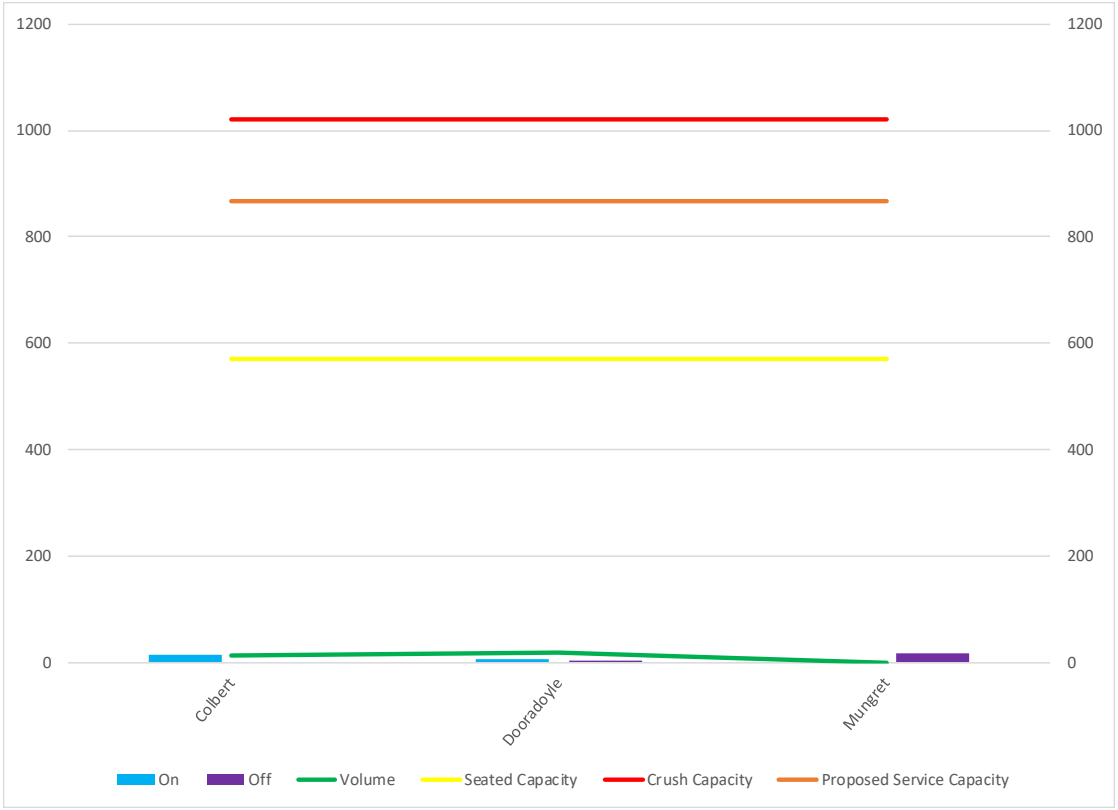
Limerick to Adare - 2070



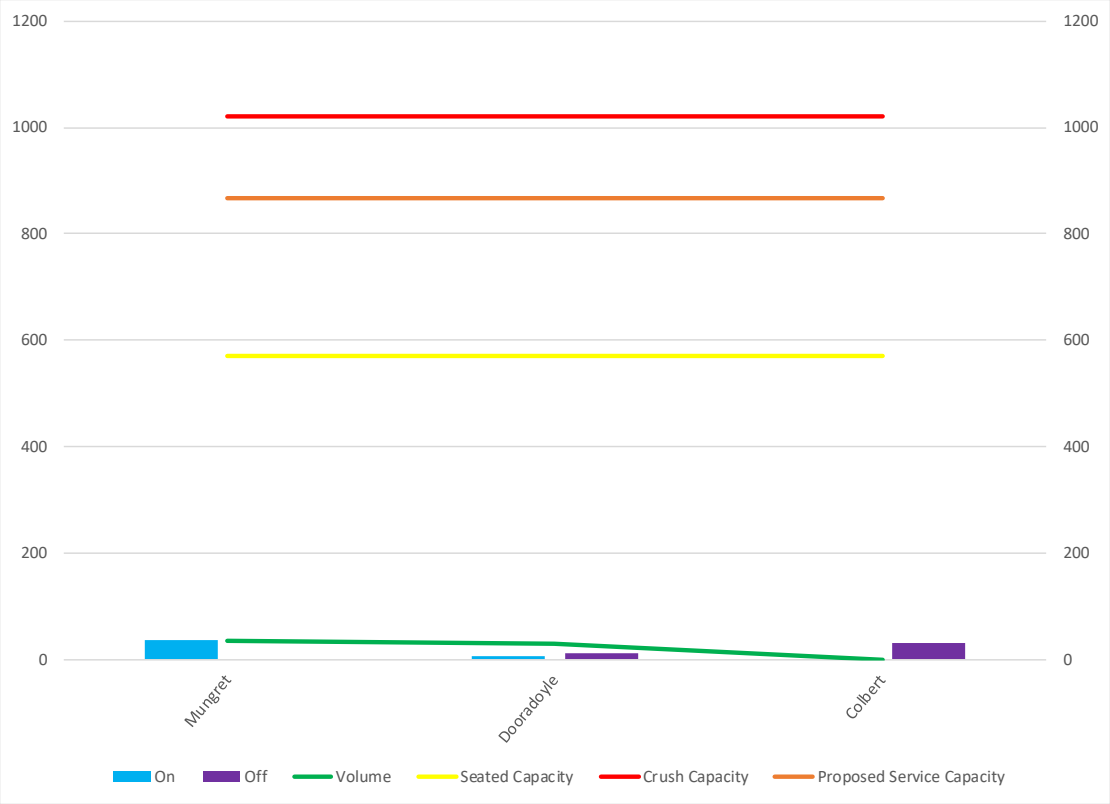
Mungret to Limerick - 2040



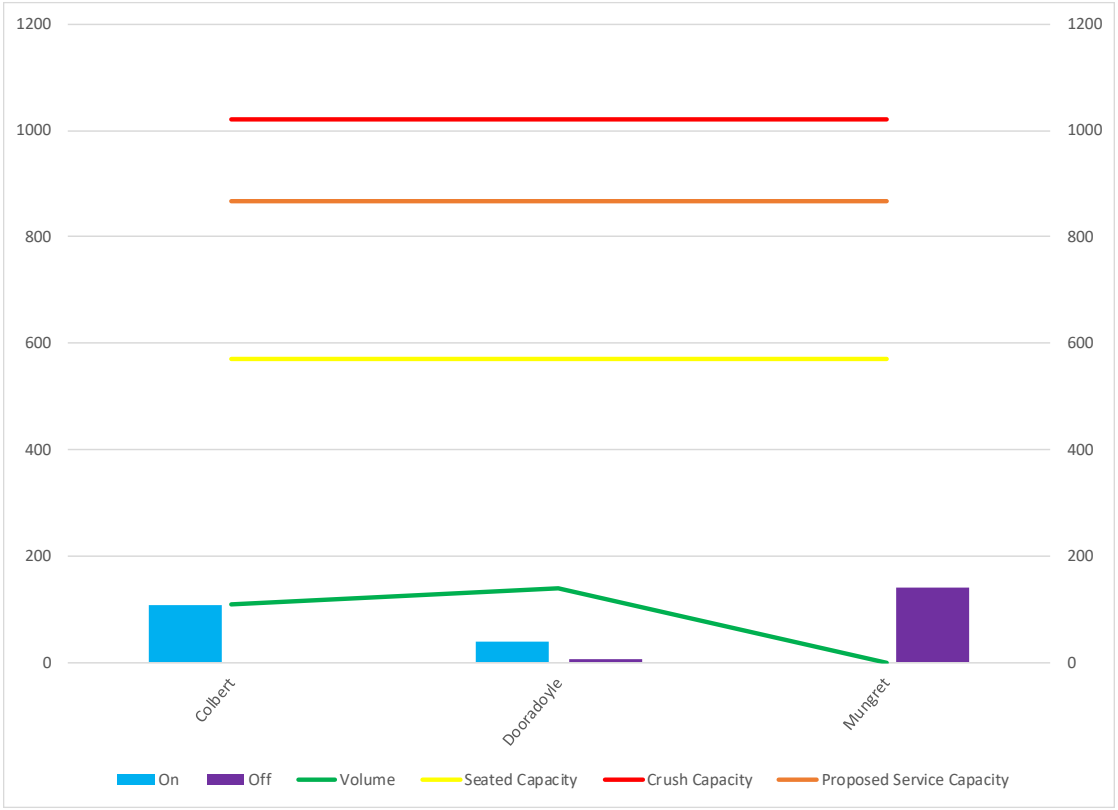
Limerick to Mungret - 2040



Mungret to Limerick - 2070

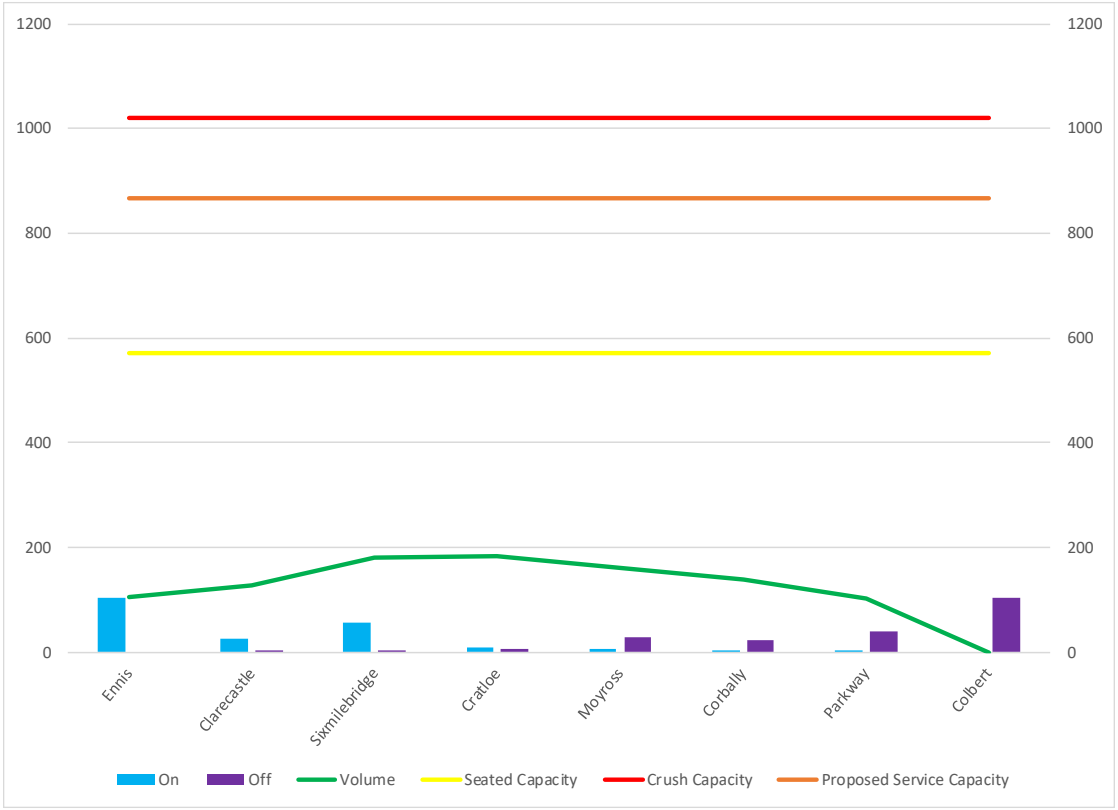


Limerick to Mungret - 2070

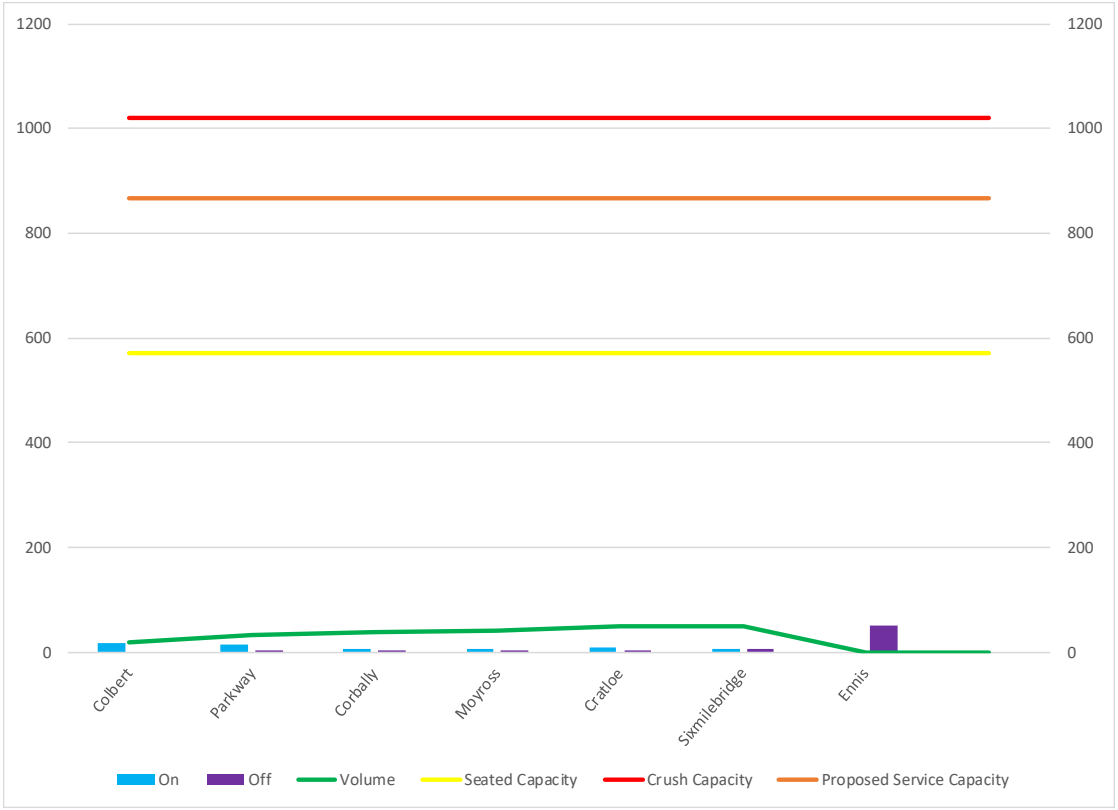


Option 4 B&A Graphs

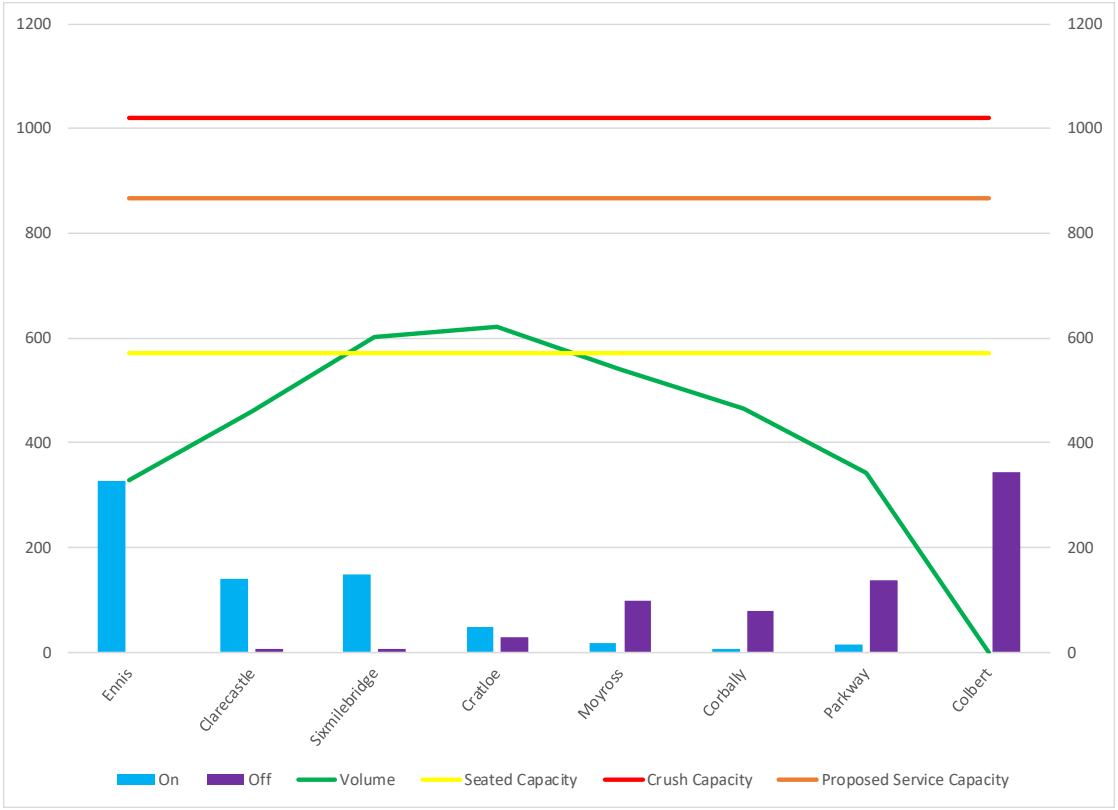
Ennis to Limerick - 2040



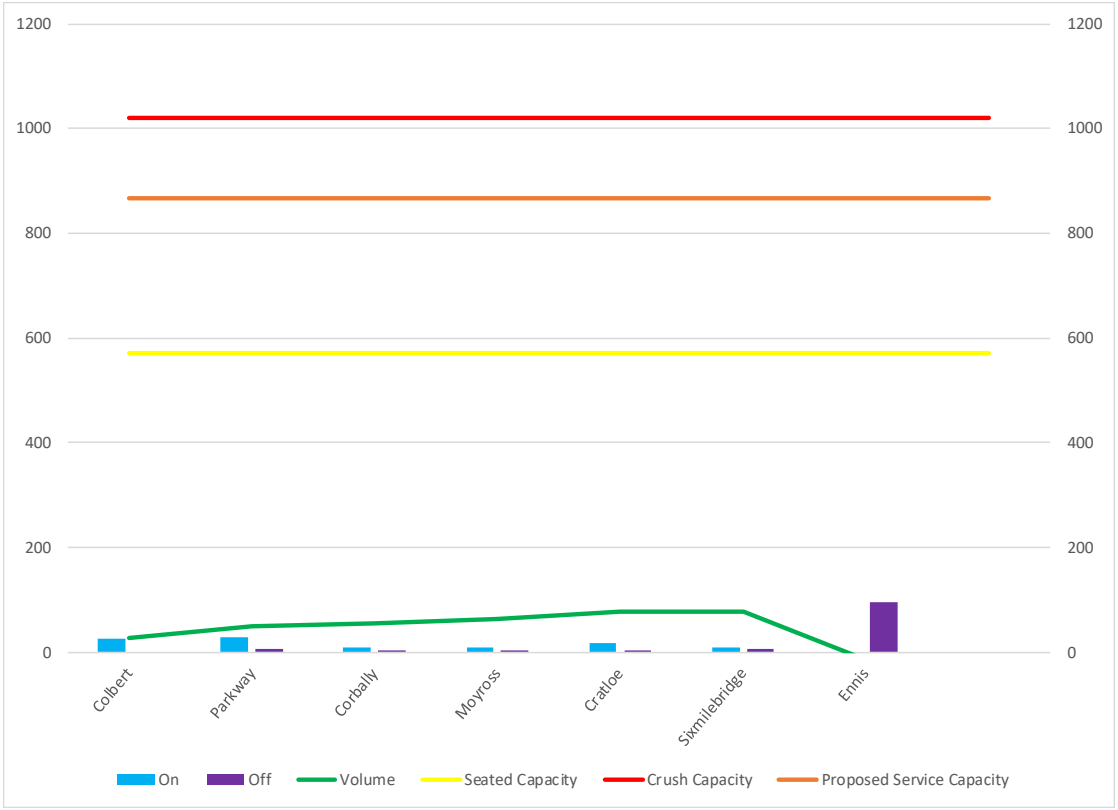
Limerick to Ennis - 2040



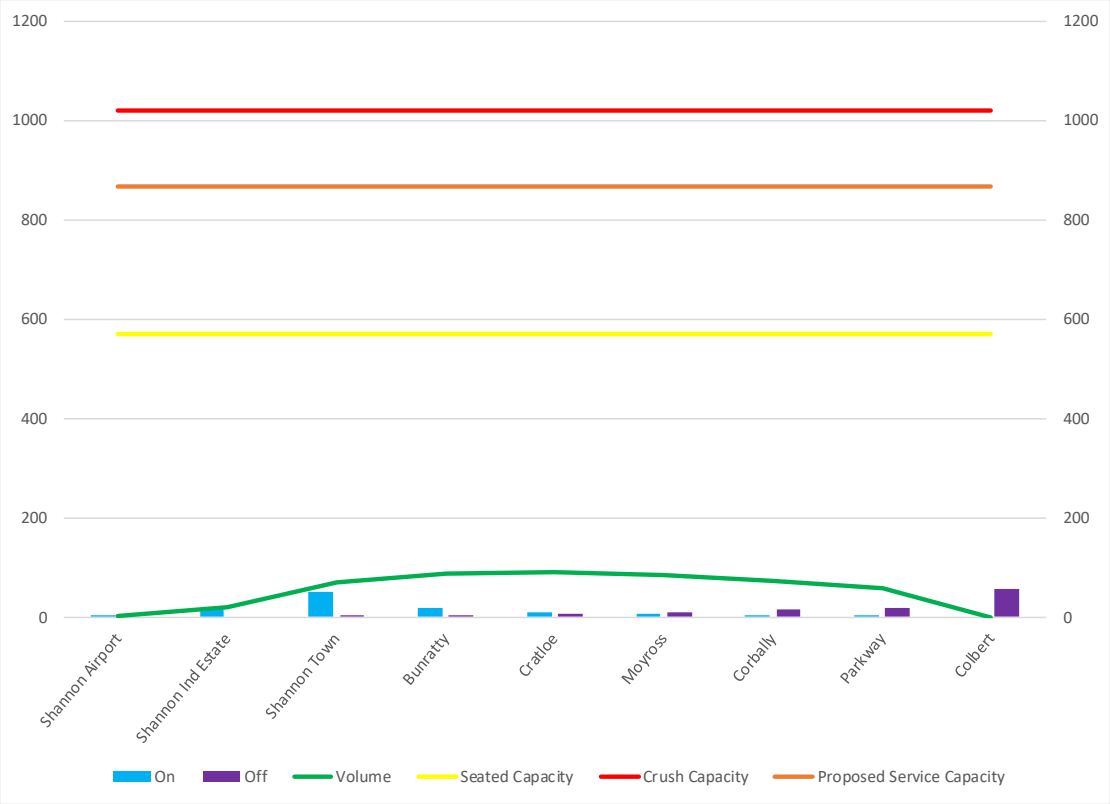
Ennis to Limerick - 2070



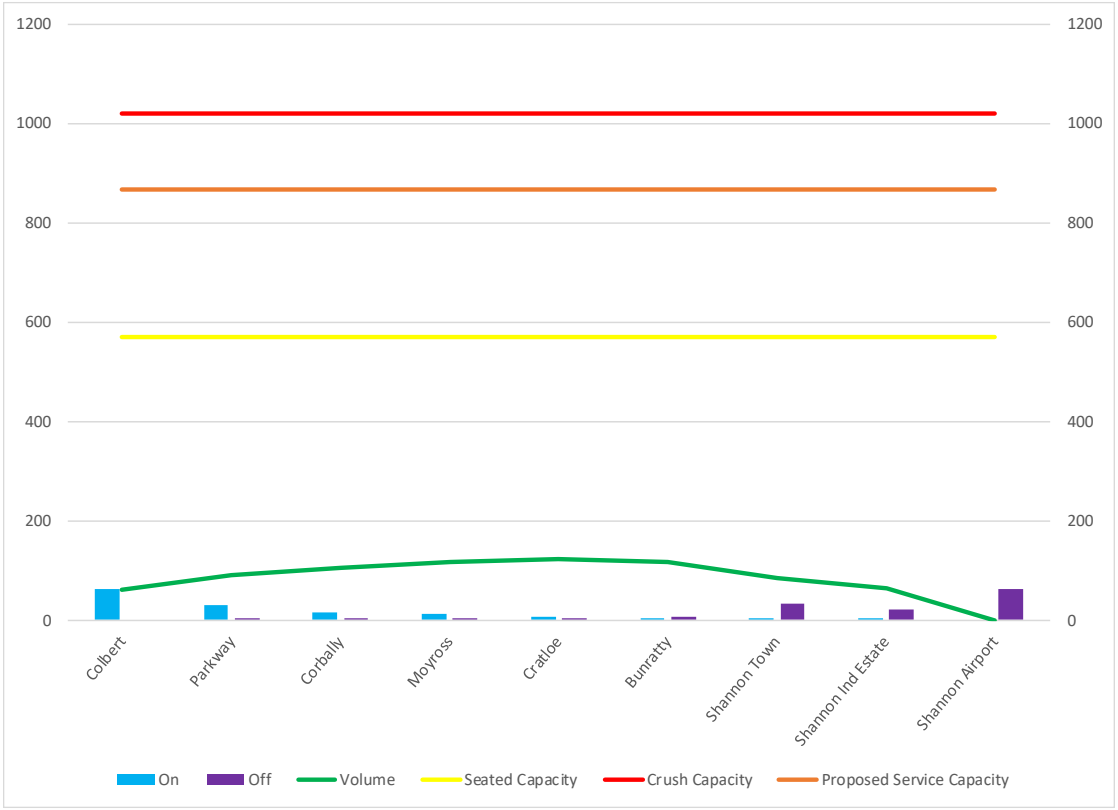
Limerick to Ennis - 2070



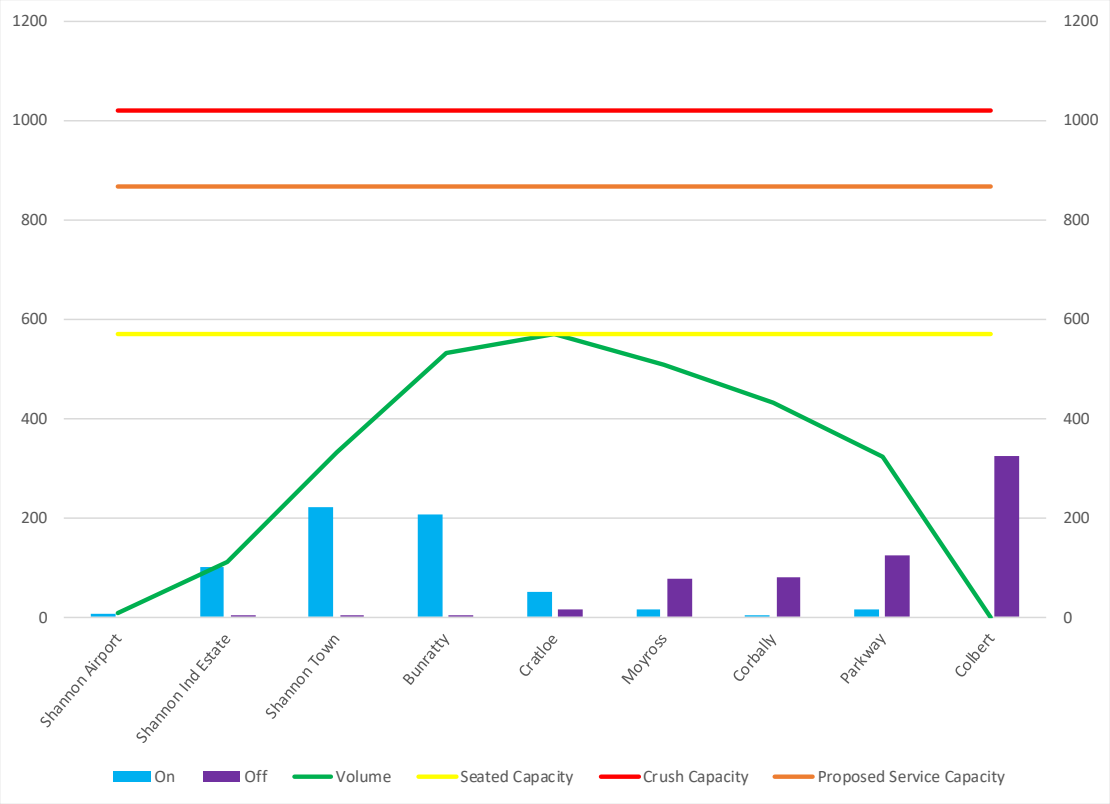
Shannon to Limerick - 2040



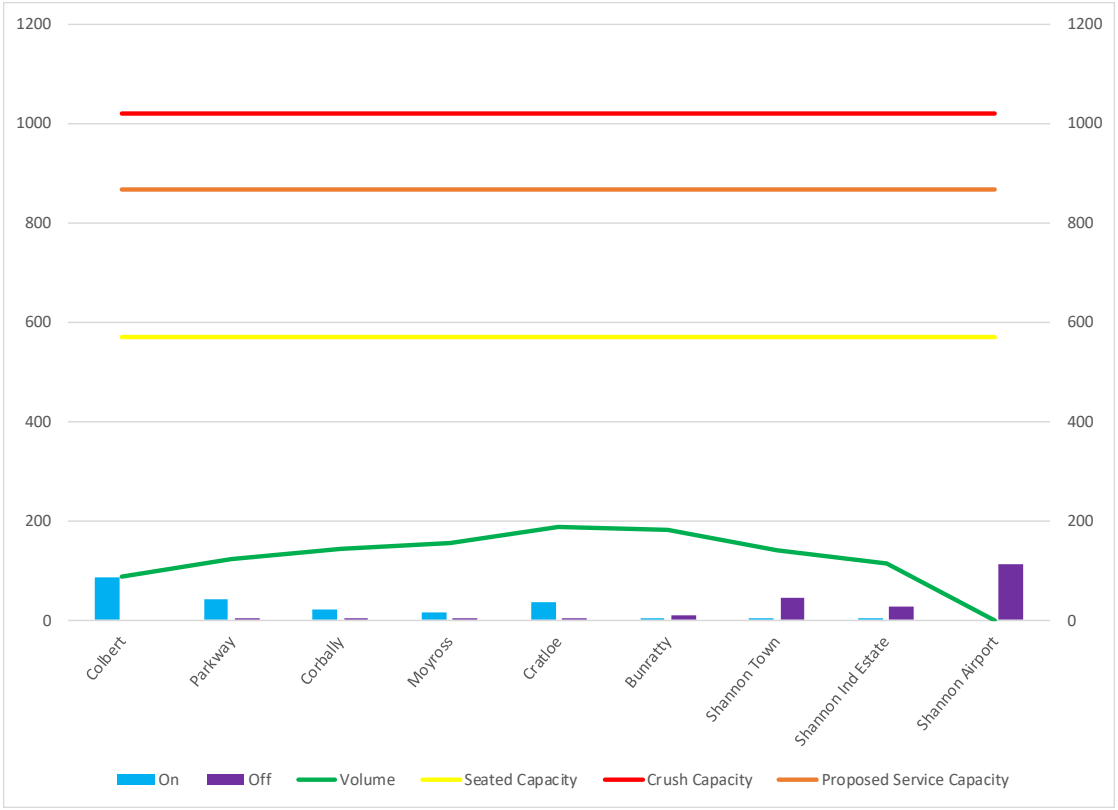
Limerick to Shannon - 2040



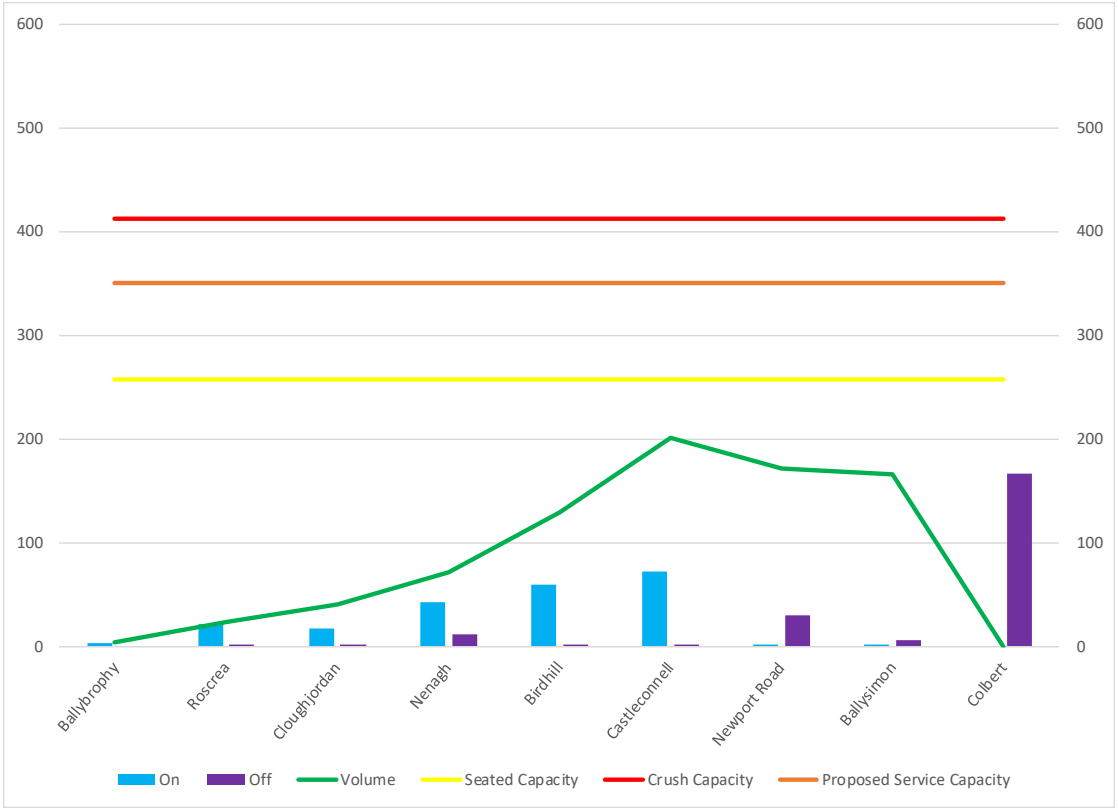
Shannon to Limerick - 2070



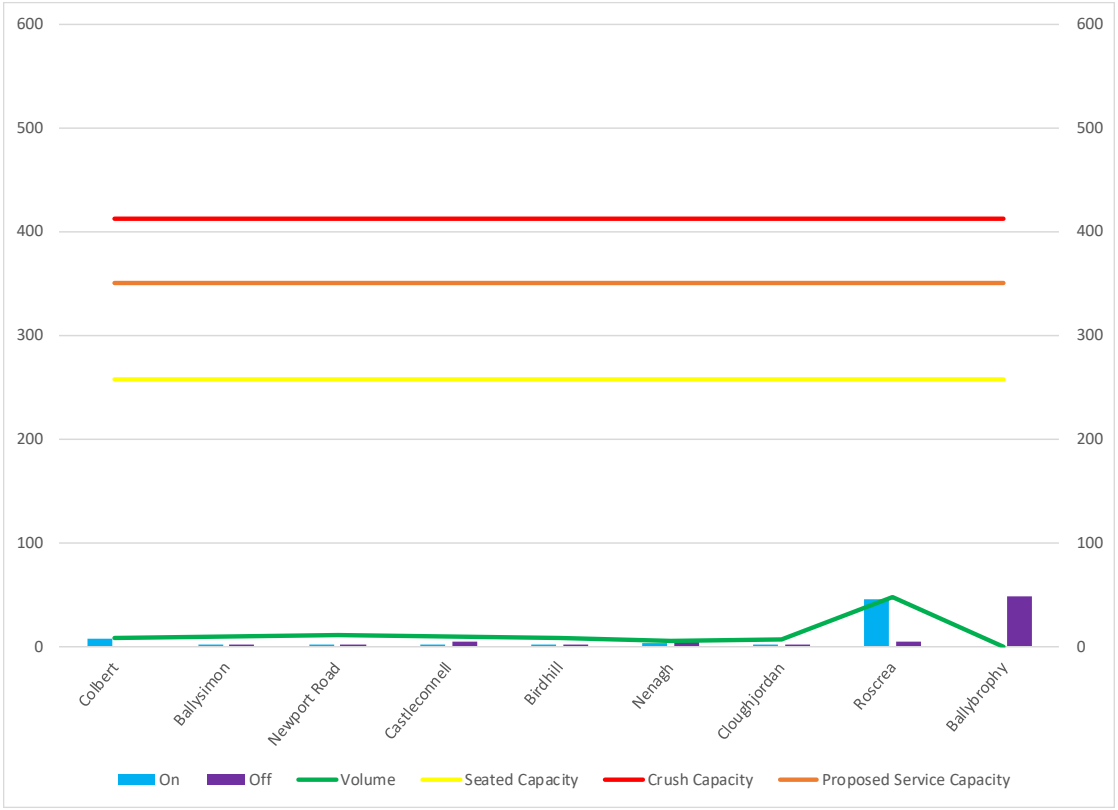
Limerick to Shannon - 2070



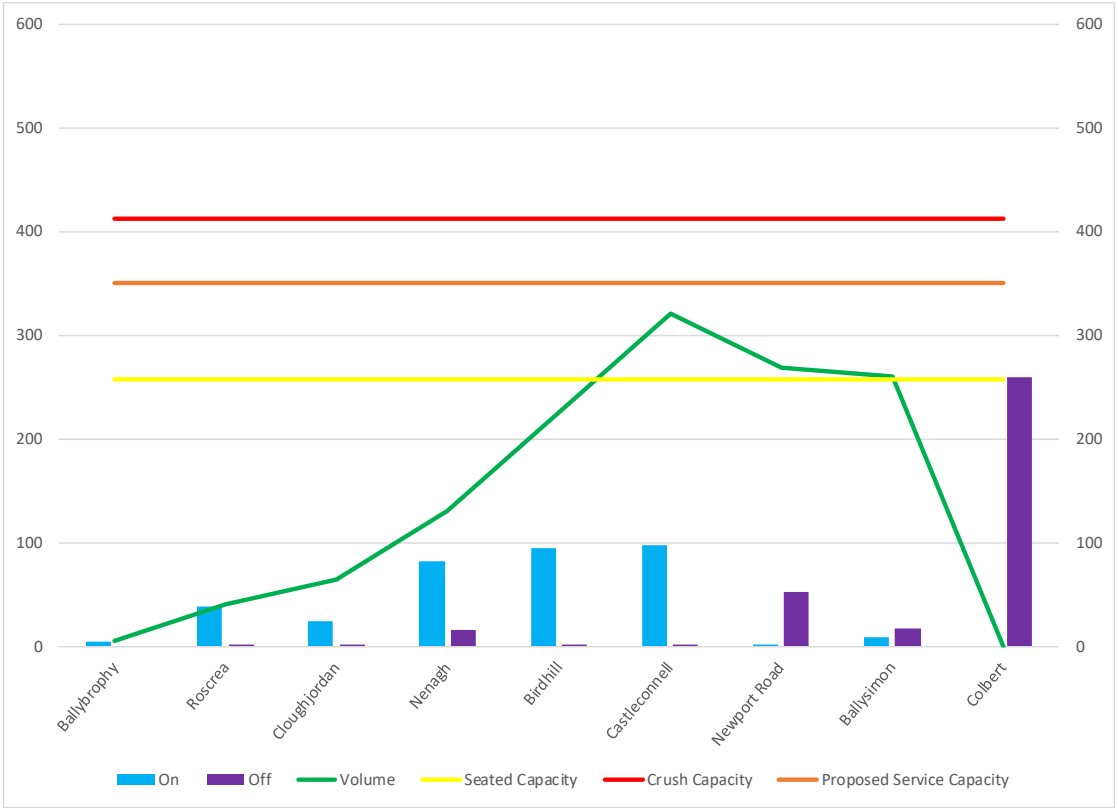
Ballybrophy to Limerick - 2040



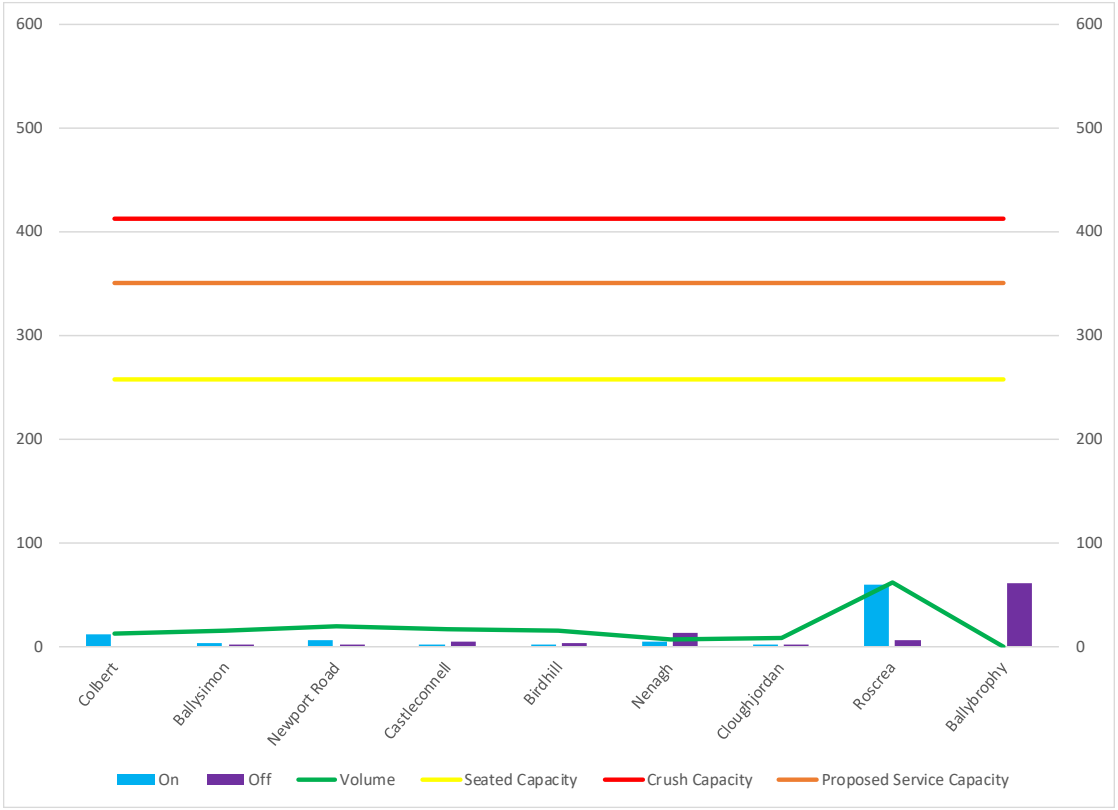
Limerick to Ballybrophy - 2040



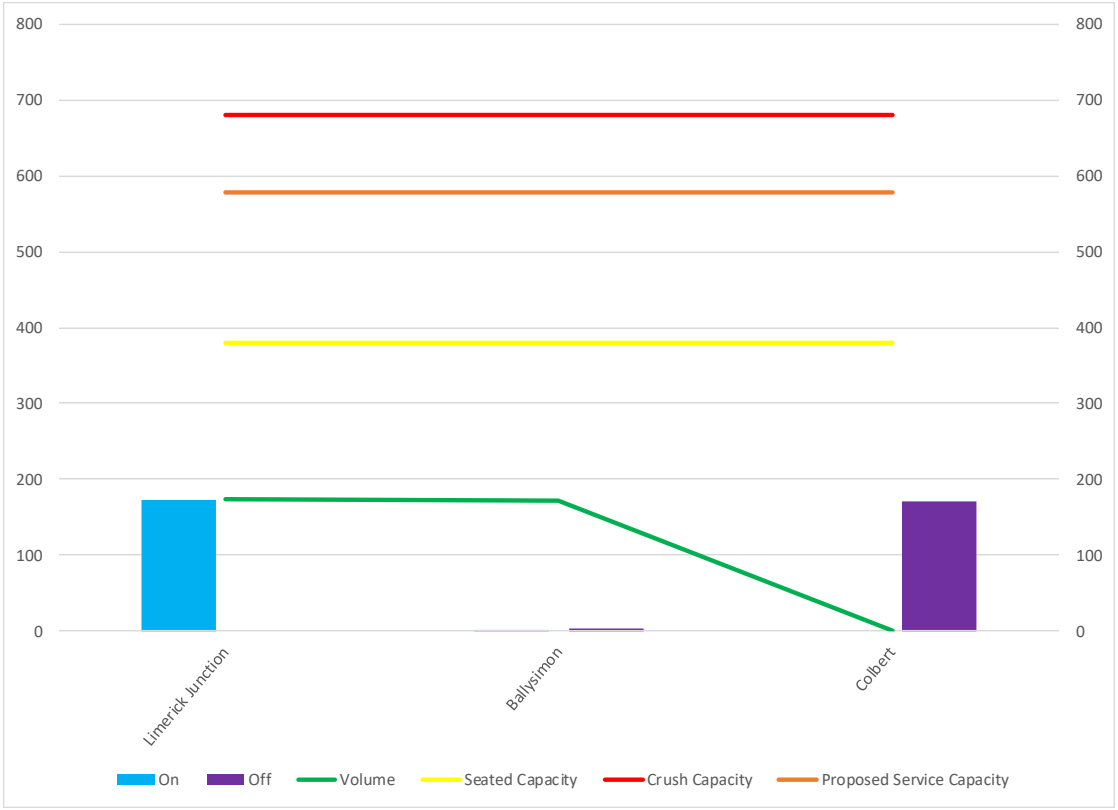
Ballybrophy to Limerick - 2070



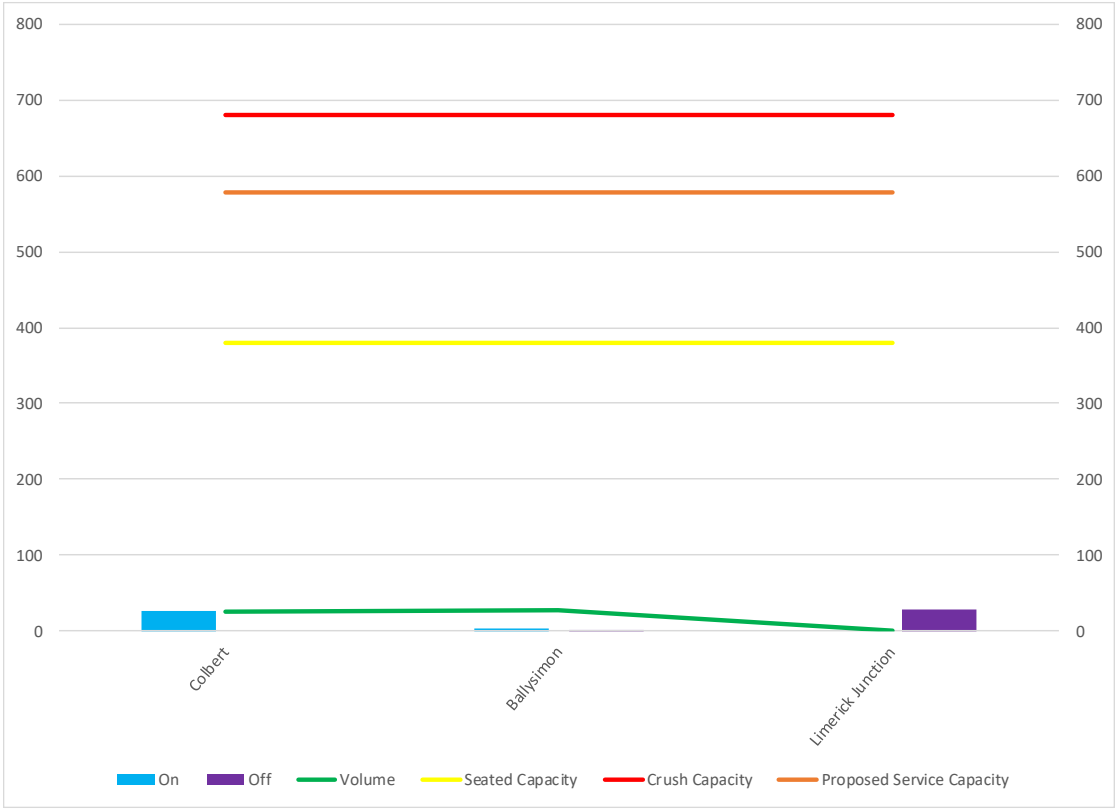
Limerick to Ballybrophy - 2070



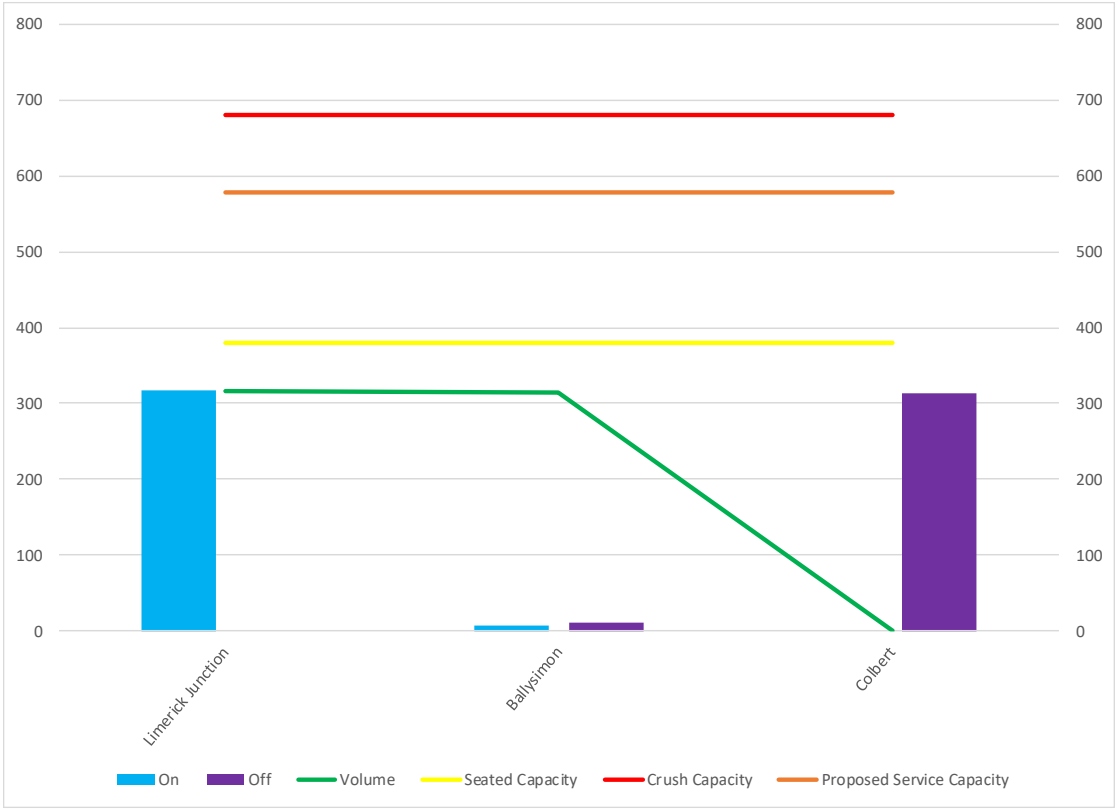
Limerick Junction to Limerick - 2040



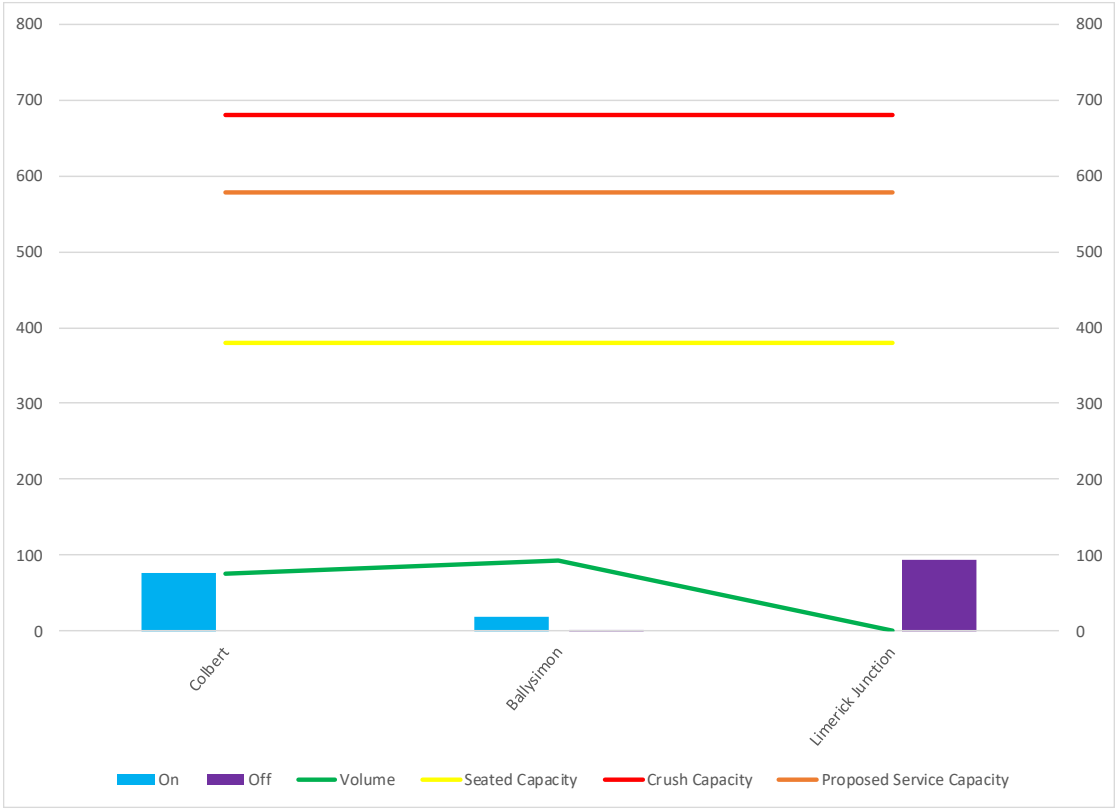
Limerick to Limerick Junction - 2040



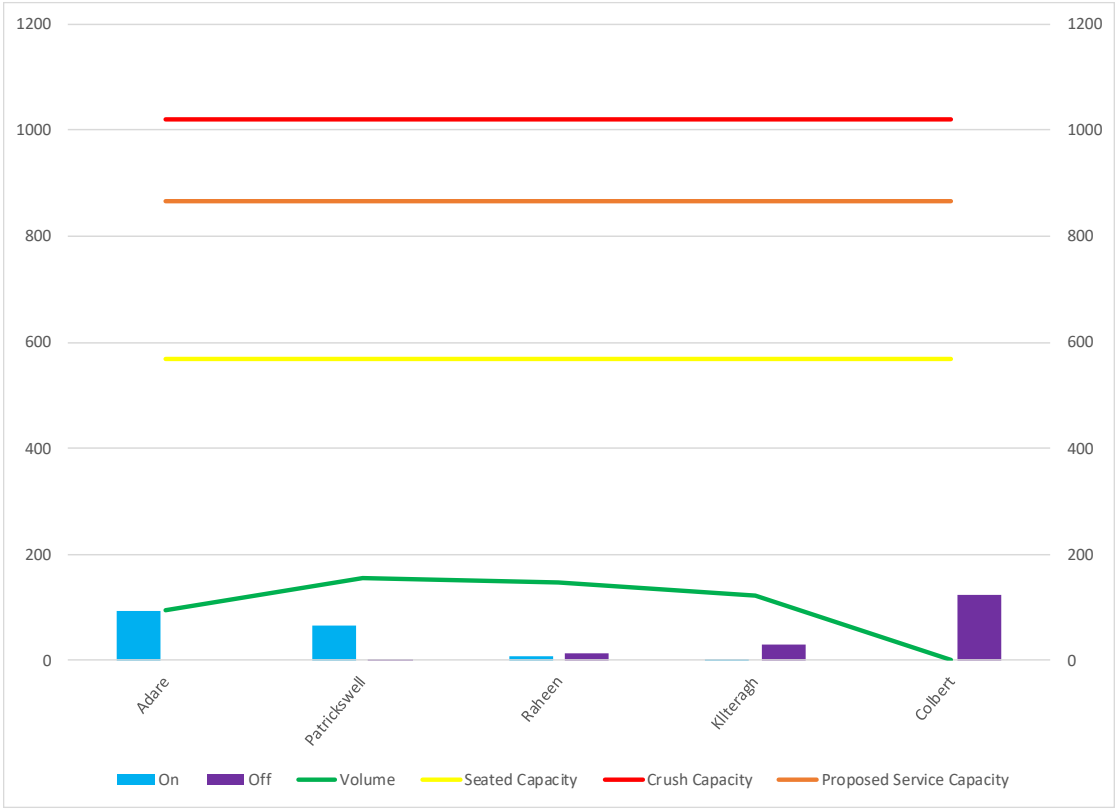
Limerick Junction to Limerick - 2070



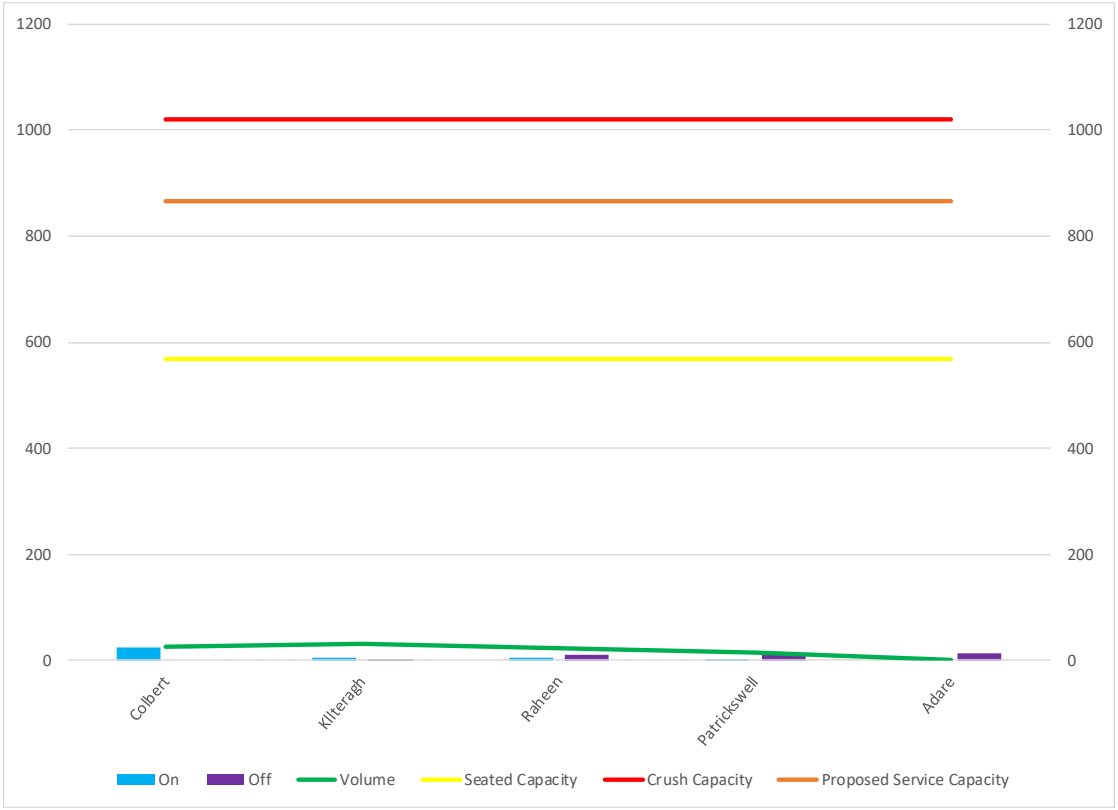
Limerick to Limerick Junction - 2070



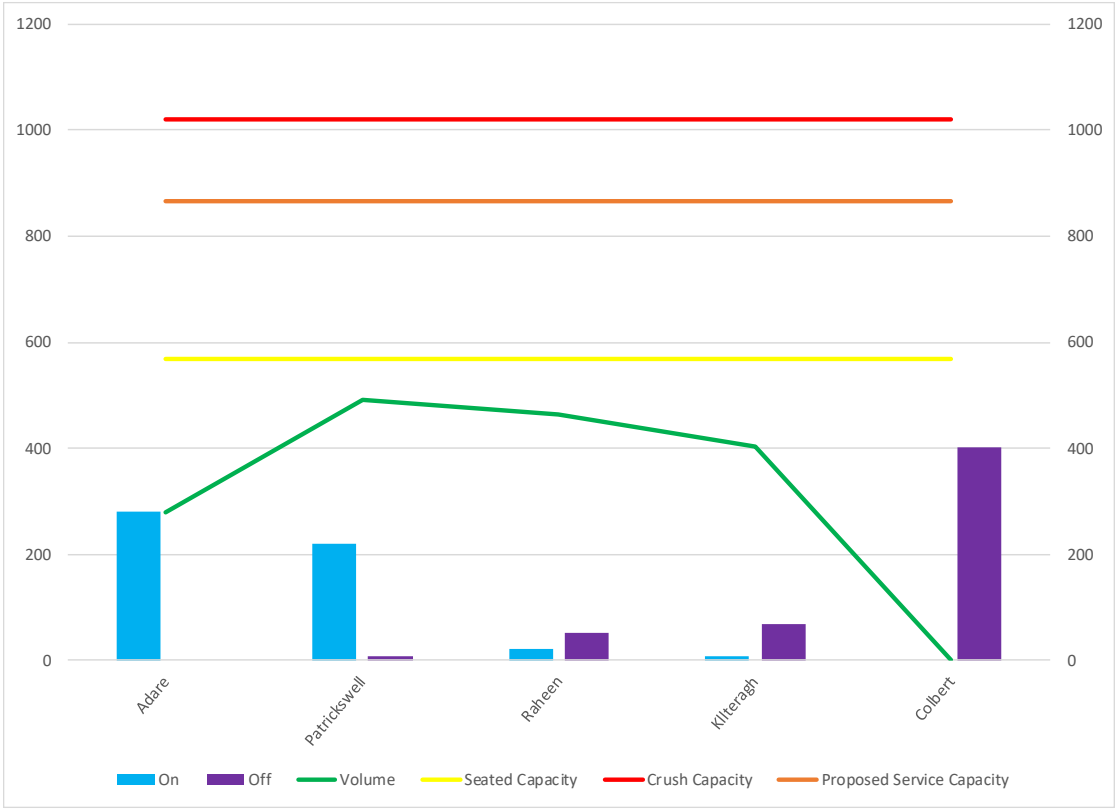
Adare to Limerick - 2040



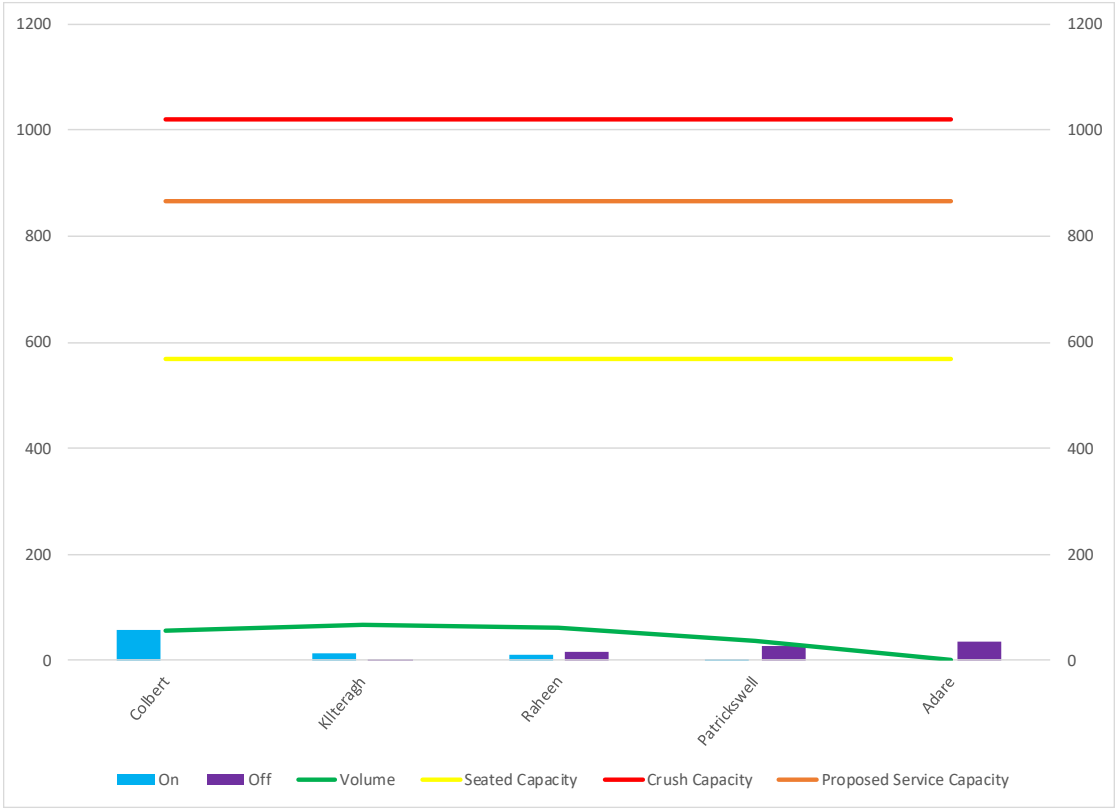
Limerick to Adare - 2040



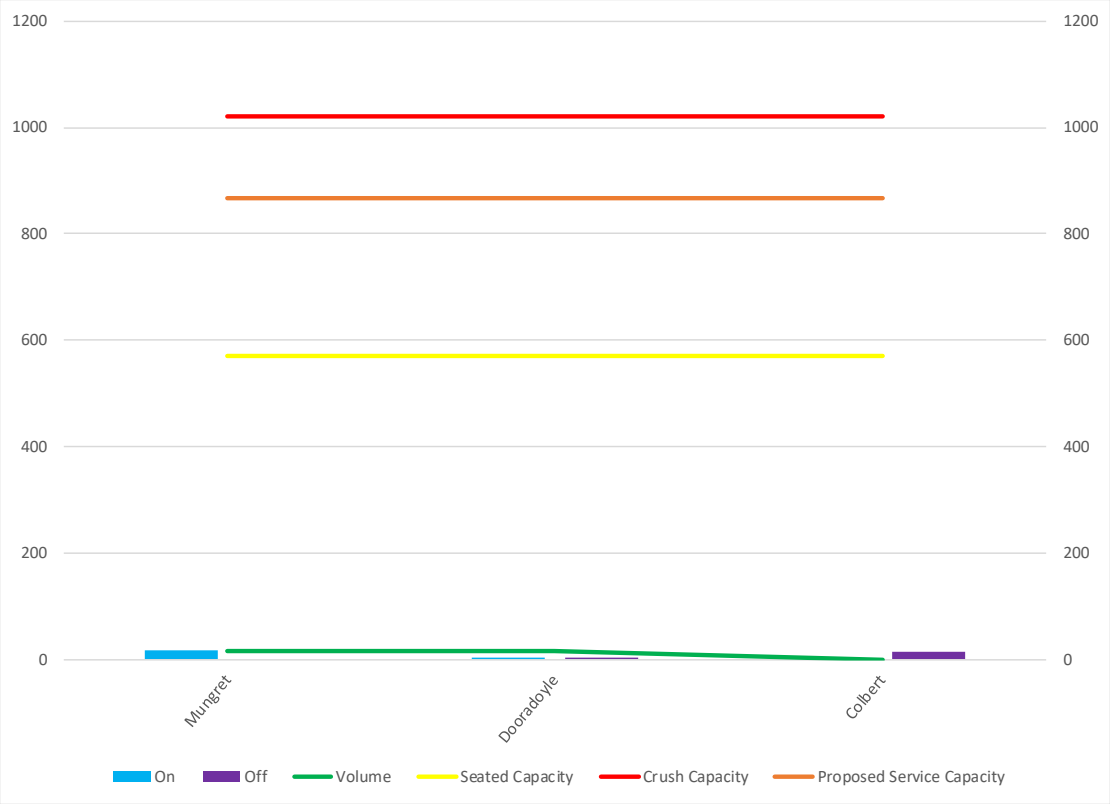
Adare to Limerick - 2070



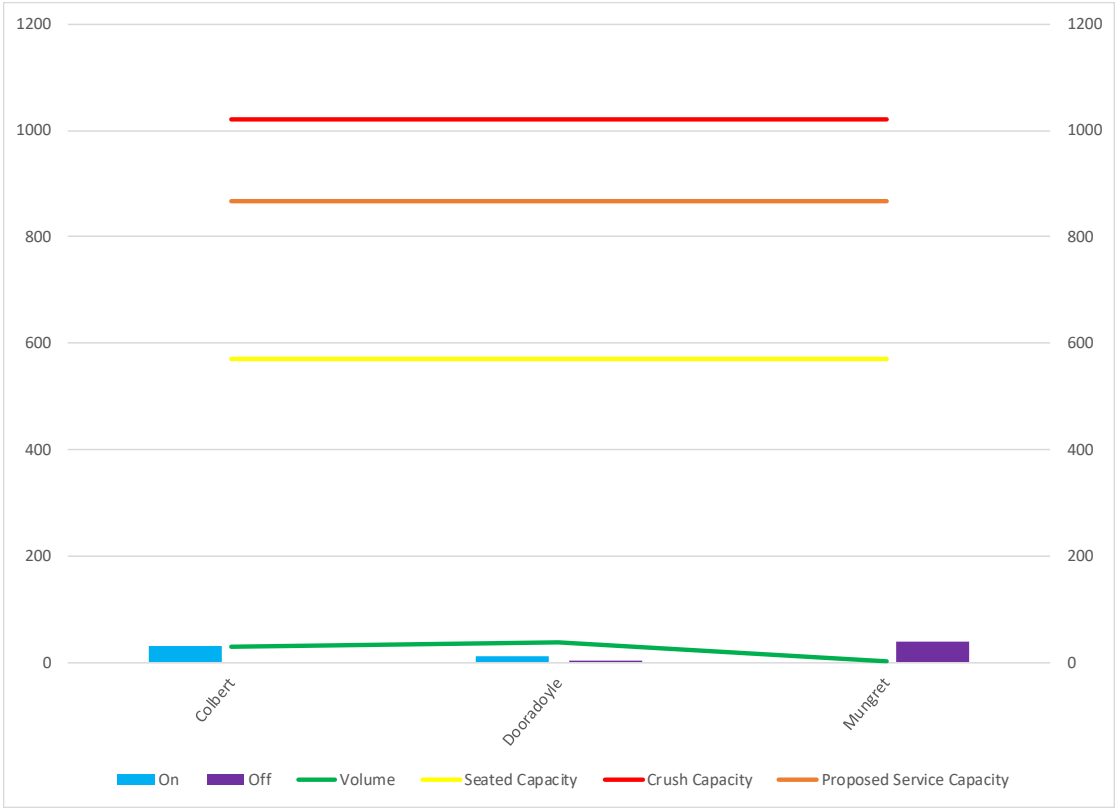
Limerick to Adare - 2070



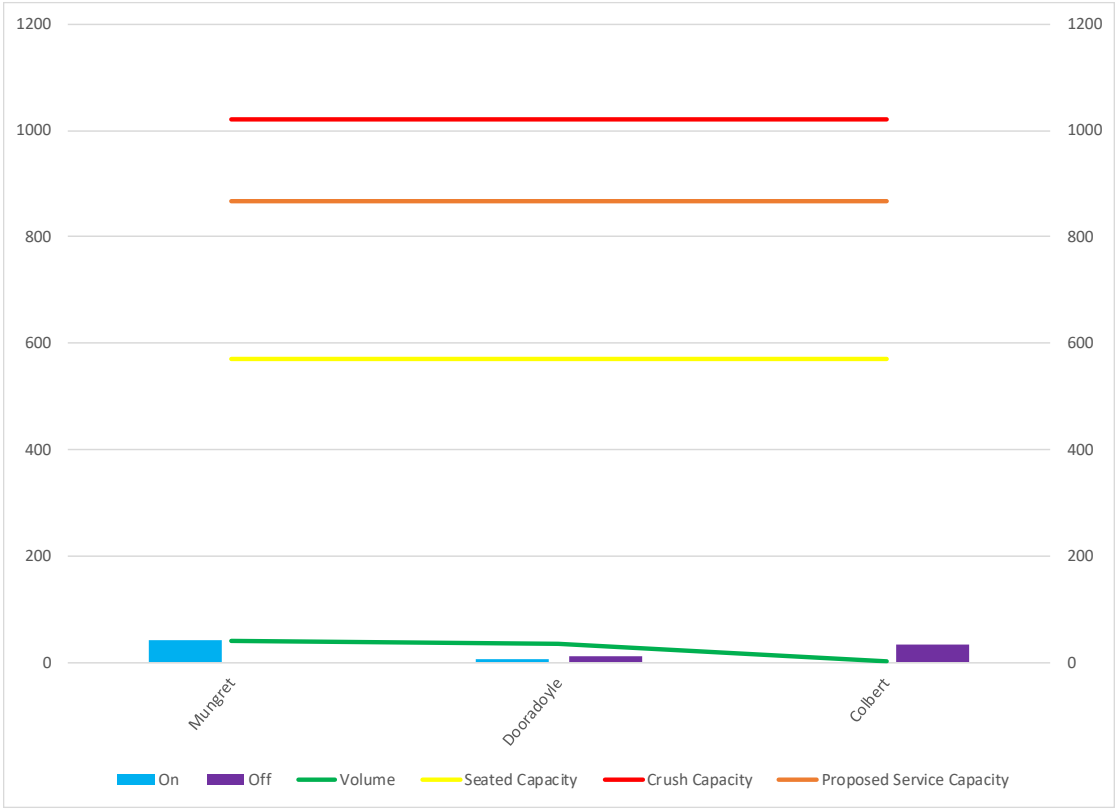
Mungret to Limerick - 2040



Limerick to Mungret - 2040



Mungret to Limerick - 2070



Limerick to Mungret - 2070