URBAN systems

KOOTENAY LAKE FERRY VEHICLE CAPACITY STUDY

PREPARED FOR THE MINISTRY OF TRANSPORTATION & INFRASTRUCTURE

FINAL REPORT

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1 INTRODUCTION

Urban Systems was retained by the BC Ministry of Transportation and Infrastructure (MoTI) to examine vehicle capacity requirements for a replacement of the MV Balfour ferry on Kootenay Lake. This report provides a review of current vehicle demands and load conditions at the ferry crossing during the winter, shoulder and summer service periods and estimated performance based on new 50 and 60 vehicle capacity vessels. 10, 20 and 40 year base growth scenarios are projected to reveal mid- and long-term vehicle demands, delays and overflow constraints.

1.1 Background

MoTI provides a toll free ferry service between Balfour and Kootenay Bay, as shown in **Figure 1.1**. The route serves 10 crossings daily from each origin most of the year. In the summer months (mid-June through early September), a secondary vessel adds an additional five crossings, increasing the total crossing number to 15 per direction. It takes 35 minutes to travel the 9 km route, with an additional 15 minutes required for loading / unloading vehicles, for a one-way cycle time of 50 minutes. Ferry service is provided by two ferries owned by MoTI and operated by Western Pacific Marine under a services contract with MoTI.

The MV Osprey 2000 was built in 2000 and serves as the primary vessel for the Kootenay Lake Ferry Route. It has a capacity of 80 automobile equivalent units (AEQ) and 250 passengers. However, based on a review of its traffic data, the Marine Branch has determined that the maximum capacity averages approximately 75 vehicle units.

Built in 1954, the MV Balfour is currently the secondary vessel servicing the Kootenay Lake Ferry Route. It has a vehicle capacity (AEQ) of 28 and a passenger capacity of 150 persons. The Balfour is in service during the summer period to increase the capacity of the Kootenay Lake Ferry route during the peak tourism season. It also relieves the Osprey 2000 for its scheduled maintenance and any unpredicted circumstances. The MV Balfour was not originally designed to meet the current federal regulatory safety requirements and, given its age, it is experiencing increasing operating costs. The MV Balfour is one of the oldest free run ferries operating in Western Canada and without significant refit, will likely need to be retired in the next few years.

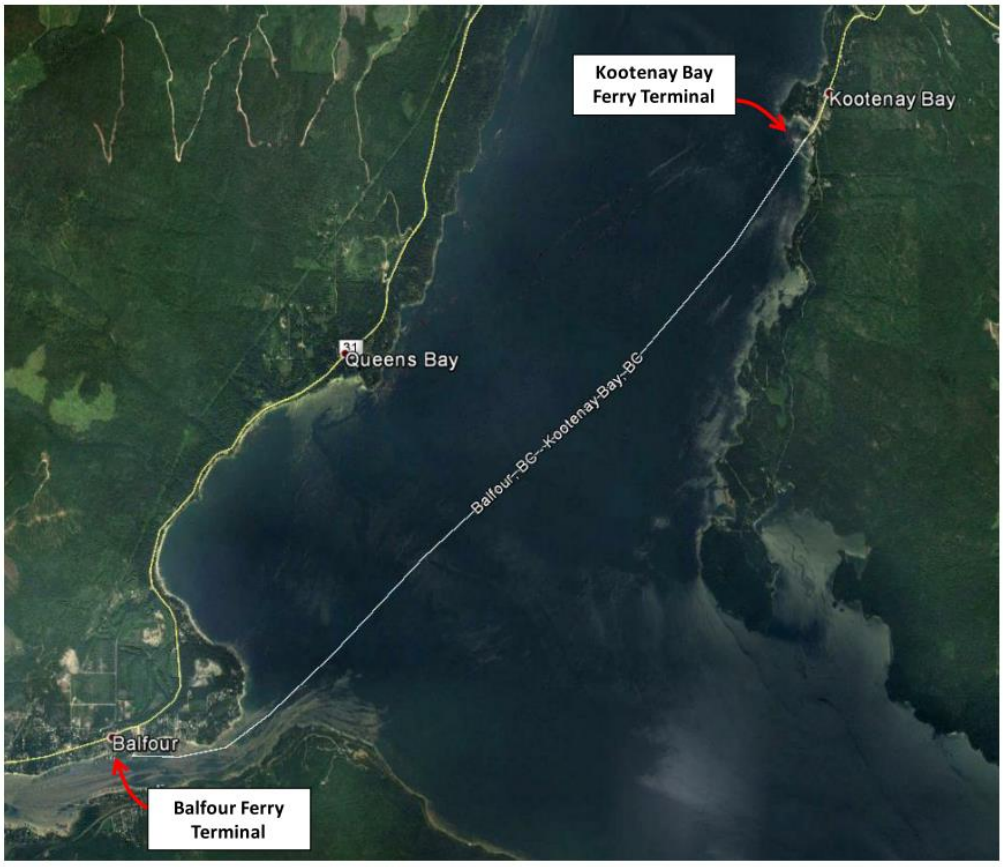

Figure 1.1: Balfour Terminal to Kootenay Bay Terminal Ferry Route

MoTI has been examining ways of improving the Kootenay Lake ferry route for over 25 years. Most recently, the *Balfour Ferry Terminal Relocation Project Technical Feasibility Study (2016),* conducted by SNC Lavalin, resulted in a recommendation to relocate the western terminal from Balfour to Queens Bay, which would have shortened crossing distances, enabling the Kootenay Lake ferry to operate with one vessel throughout the year. As a result of community feedback, a decision was made to concentrate on remaining at the western terminal at Balfour. Consequently, in order to maintain service levels in the event that the MV Balfour retires, MoTI is considering a new ferry to replace the aging MV Balfour.

2 PROBLEM IDENTIFICATION AND DEFINITION

This section summarizes traffic trends as well as current and future vehicle capacity constraints at the Kootenay Lake Ferry during the winter, shoulder and summer service periods. Results are derived from an in-depth analysis of January 2015 to October 2016 trip log data, provided by MoTI.

2.1 Existing Ferry Demand and Traffic Growth

The Kootenay Lake Ferry serves approximately 225,000 to 250,000 vehicles and 350,000 to 450,000 passengers annually. As displayed in **Figure 2.1**, the total number of passengers and vehicles that use the Kootenay Lake Ferry has declined between 2005 and 2015. Despite these trends, this study employs a 0.3% compound annual growth rate, which is reflective of BC Stats population projections for the Kootenays and past studies.

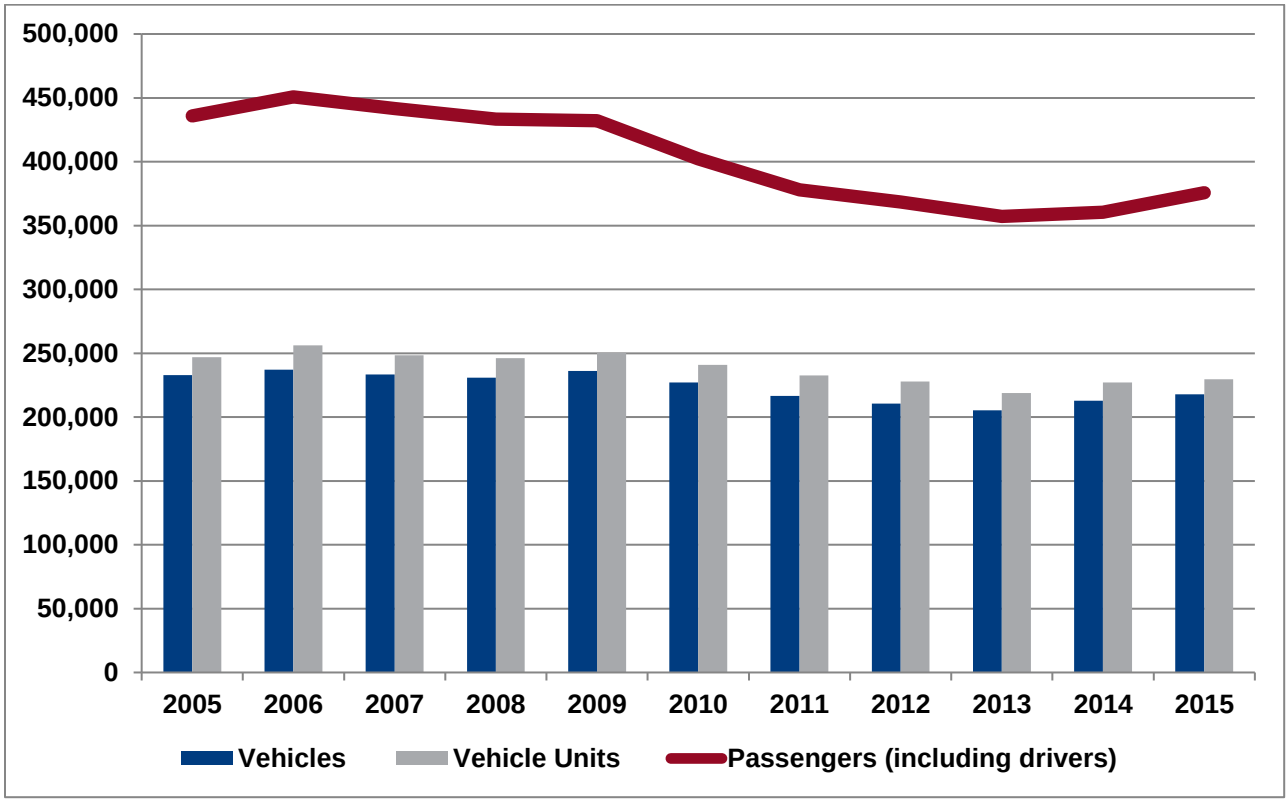

Figure 2.1: Kootenay Lake Ferry Route Traffic (2005 to 2015)

2.2 Seasonal Variation

Traffic volumes near central Kootenay Lake are very seasonal with much higher traffic through the region during the summer months due to tourism. As displayed in **Figure 2.2**, at almost 38,000 vehicles, total ferry traffic in August represents over three times January ferry traffic volumes (10,600). The Spring and Fall shoulder seasons experience intermediate volumes ranging between 15 and 20,000 trips per month.

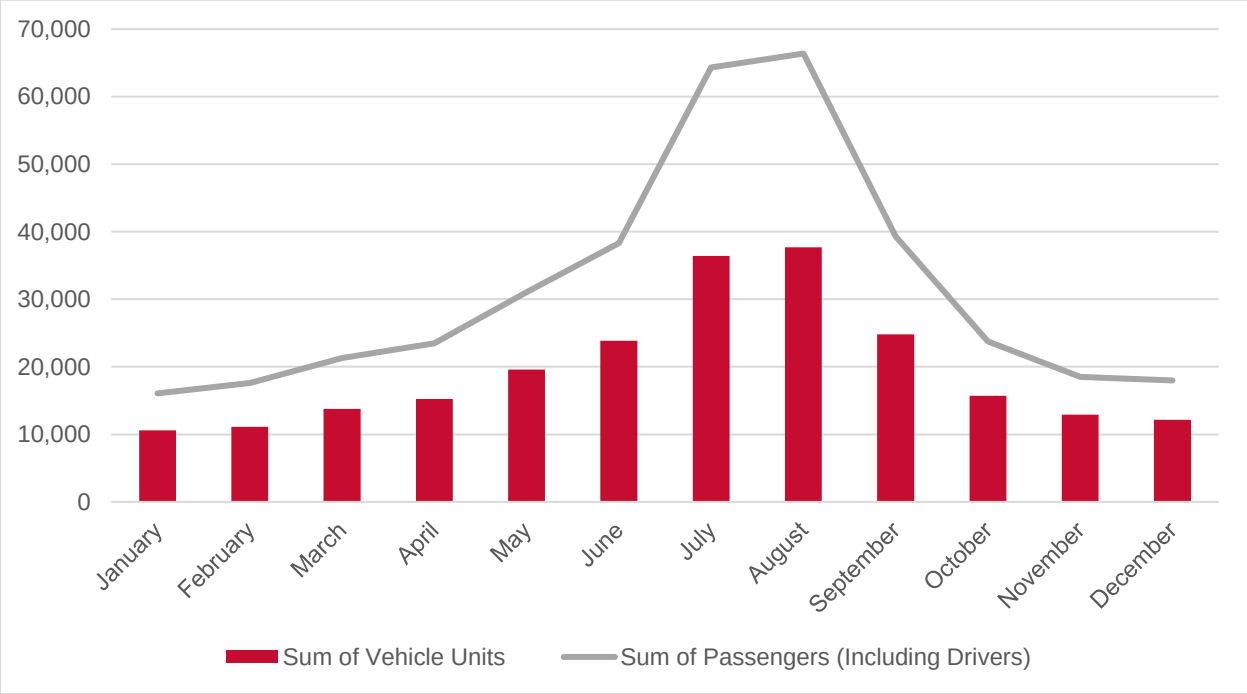

Figure 2.2: Total Monthly Vehicles and Passengers

2.3 Daily Demand and Capacity Analysis

Daily profiles of weekday and weekend vehicle demands at the Kootenay Lake Ferry were prepared for the existing, 10, 20 and 40 year horizons to determine queuing, overflow, and delay constraints. Average and 85th percentile demands are recorded to gain a broader understanding of constraints under both typical and heavy volume conditions. As ferry traffic volume is highly seasonal, separate profiles were prepared for the winter (January, February), shoulder (May, October) and summer (July, August) service periods.

MoTI's trip log registers total vehicles that board the ferry and, when overflows occur, provides estimates of total overflow vehicles on a trip by trip basis. The trip log converts vehicle type (autos, heavy vehicles, motorcycles, buses) to standard auto equivalents (AEQ). For analysis purposes, per sailing overflow vehicles are recalculated in this assessment to represent ideal loading conditions by the following equation:

Overflow Vehicles (per sailing) = Total Vehicle Demand – Vessel Vehicle Capacity

Overflows can occur because of insufficient space aboard a vessel or weight restrictions. 99.7% of sailings resulting in overflows on the MV Osprey 2000 occur because of insufficient space. This compares to 91% on the MV Balfour.

2.3.1 Current Conditions

Current horizon daily profiles are derived from January 2015 to October 2016 trip log data, provided by MoTI. Full demand-capacity tables for all current conditions are included in **Appendix A.**

WINTER

As displayed in **Table 2.1,** the Kootenay Lake Ferry typically transports approximately 190 vehicles per direction each weekday and 170 vehicles per direction each weekend day. 85th percentile volumes are approximately 1.3 times average volumes. Regular service is provided by the MV Osprey 2000 only.

Table 2.1: Winter Period Average and 85th% Daily Trips (Current Horizon)

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	193	255	181	239
Westbound	189	239	162	216
TOTAL	**382**	**494**	**343**	**455**

Eastbound and westbound average and 85th percentile vehicle demands by sailing are displayed in **Figure 2.3** and **Figure 2.4**, respectively. Eastbound average and 85th percentile vehicle demands peak at the 2:50 PM sailing at 32 and 43, respectively. Westbound average and 85th percentile vehicle demands peak at the 9:00 AM sailing at 39 and 46, respectively. All volumes are significantly below the Osprey's 75 vehicle practical capacity. All vehicles are able to be serviced by the next scheduled sailing and no overflows occur under typical or 85th% conditions. Of note, when the Osprey 2000 is out of service, the Balfour is unable to process typical weekday and weekend demands along the route. Average vehicle demands for 3 weekday sailings and 1 weekend sailing exceed the 28 vehicle capacity of the MV Balfour.

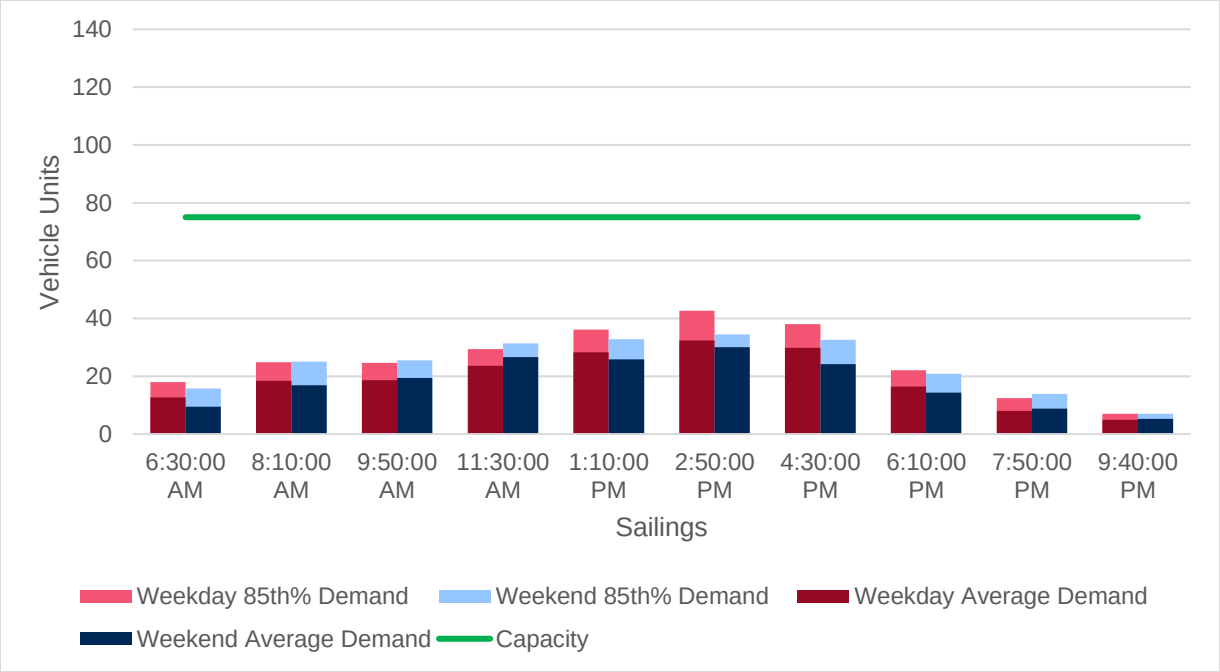

Figure 2.3: Current Eastbound Average and 85th Percentile Vehicle Demands (Winter)

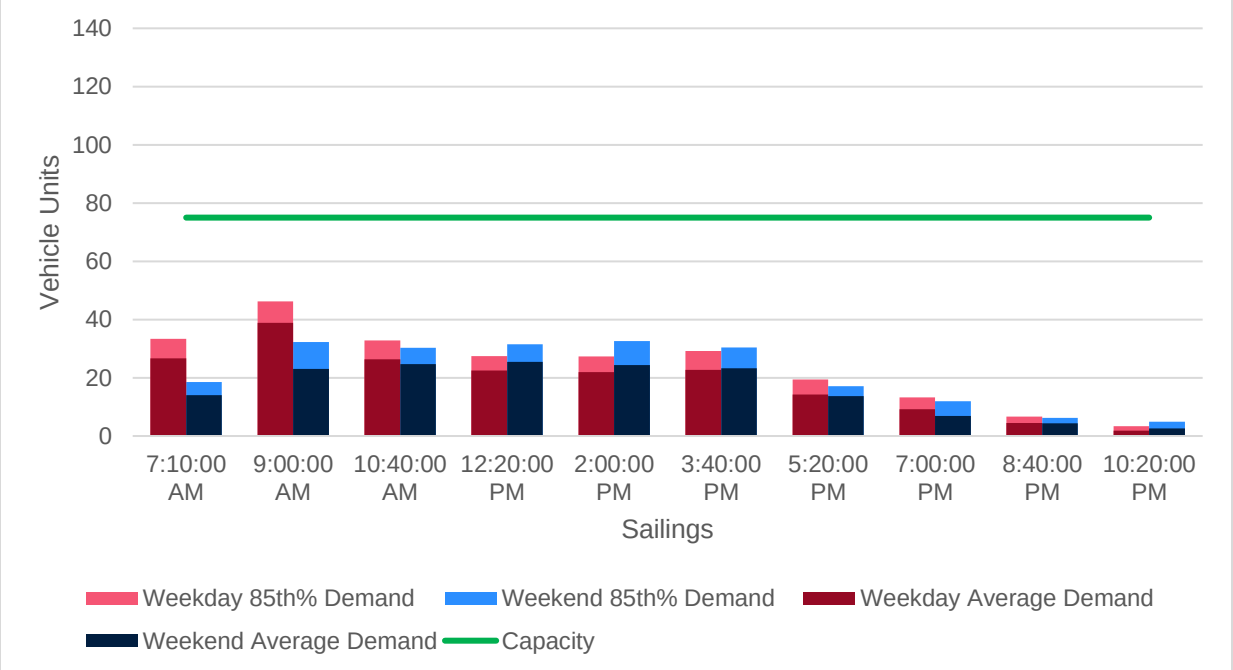

Figure 2.4: Current Westbound Average and 85th Percentile Vehicle Demands (Winter)

SHOULDER

May and October were analysed as the "shoulder" period which represents the travel expectations between the peak summer months and slower winter months. As displayed below in **Table 2.2,** the Kootenay Ferry route serves about 300 vehicles per direction per day. Under heavy traffic conditions, the route services approximately 380 trips daily, approximately 1.2 to 1.3 times that under normal conditions. Under normal operating conditions, all trips in this period are serviced by the Osprey 2000.

Table 2.2: Shoulder Period Average Trips

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	298	377	286	369
Westbound	317	410	285	356
TOTAL	**615**	**787**	**571**	**725**

Eastbound and westbound average and 85th percentile vehicle demands by sailing for May and October are displayed in **Figure 2.5** and **Figure 2.6**, respectively.

Eastbound weekday average and 85th percentile vehicle demands peak at the 4:30 PM sailing at 44 and 53, respectively. Eastbound weekend average vehicle demand peaks at the 1:10 PM sailing at 42 vehicles, and 85th percentile demand peaks at the 11:30 AM at 56 vehicles.

In general, westbound weekday vehicle demands are fairly consistent from the first sailing until the evening 5:20 PM sailing. Average and 85th percentile volumes peak at 46 and 54, respectively. Weekend westbound average and 85th percentile vehicle demand peak at the 12:20 PM sailing at 46 and 55, respectively.

Similar to the winter traffic volume, these peak volumes are below the Osprey's practical vehicle capacity of 75. All vehicles can be serviced by the next sailing and no overflow is anticipated under normal conditions. Of note, when the Osprey 2000 is out of service, the Balfour is unable to process typical weekday and weekend demands along the route. Average vehicle demands for 13 weekday sailings and 11 weekend sailings exceed the 28 vehicle capacity of the MV Balfour.

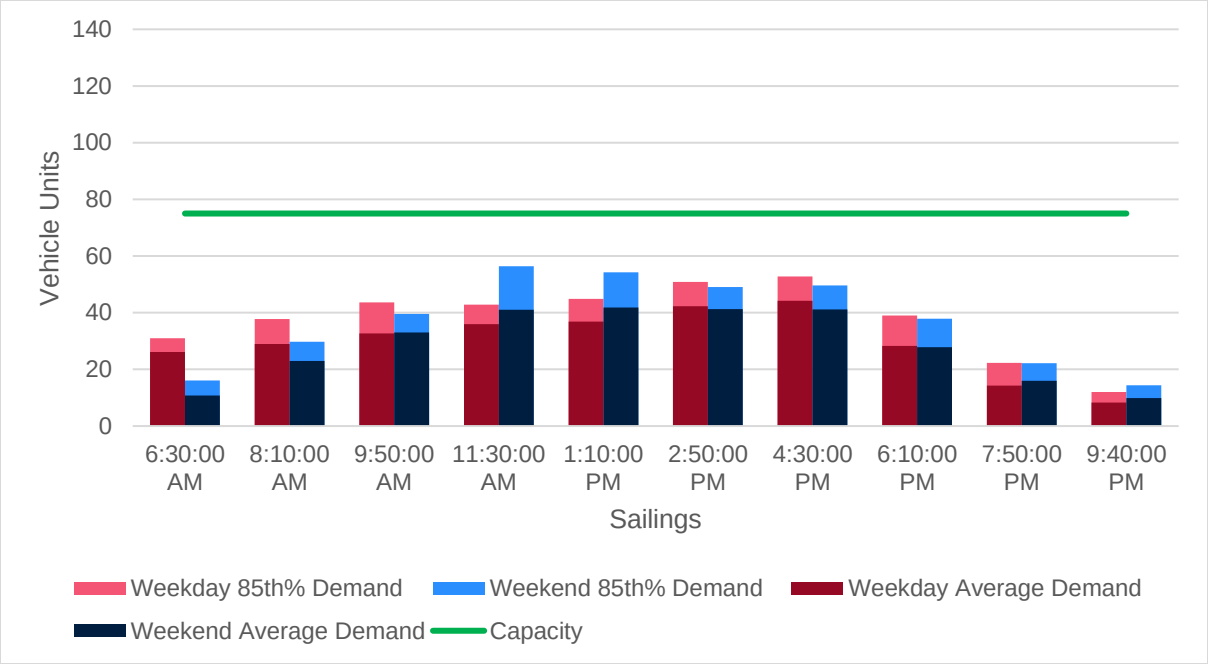

Figure 2.5: Current Eastbound Average and 85th Percentile Vehicle Demands (Shoulder)

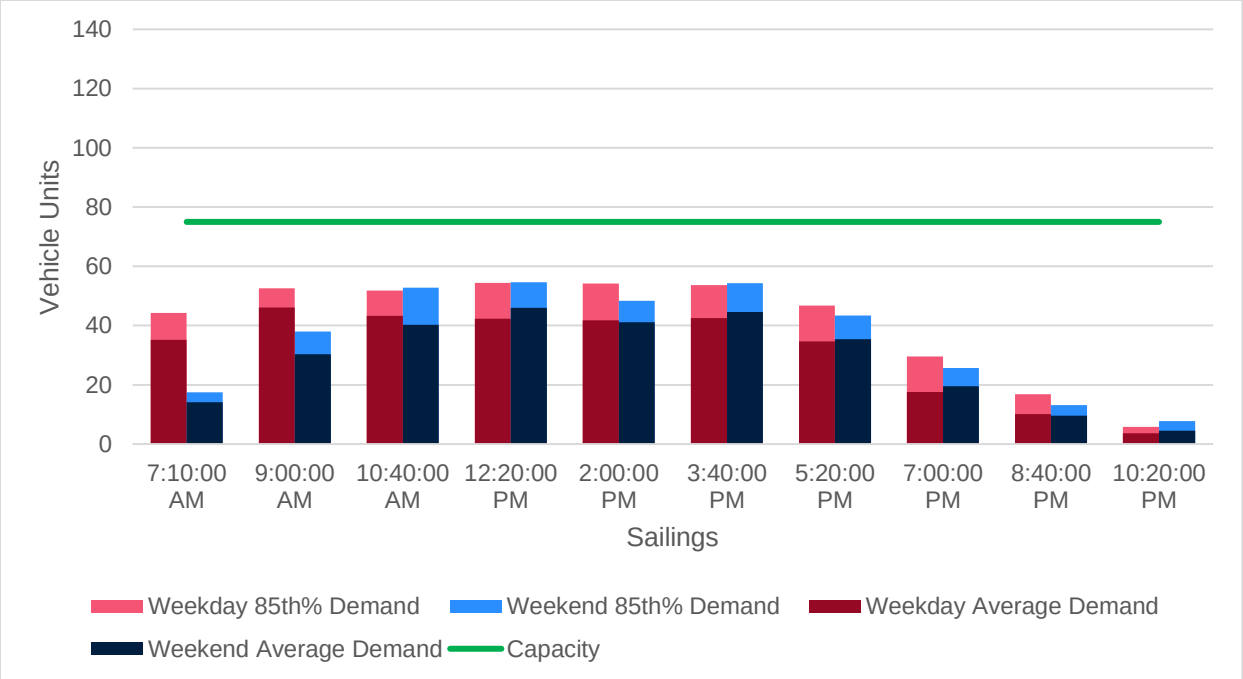

Figure 2.6: Current Westbound Average and 85th Percentile Vehicle Demands (Shoulder)

SUMMER

As displayed in **Table 2.3,** the Kootenay Lake Ferry typically transports around 675 trips per direction each weekday and 693 trips per direction each weekend day. 85th percentile volumes are approximately 1.1 times average volumes. Service is provided by the MV Osprey 2000 and MV Balfour.

Table 2.3: Summer Period Average and 85th% Daily Trips (Current Horizon)

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	652	834	663	825
Westbound	701	904	724	966
TOTAL	**1,353**	**1,738**	**1,387**	**1,791**

Eastbound and Westbound average and 85th percentile vehicle demands by sailing are displayed in **Figure 2.7** and **Figure 2.8**, respectively. To reflect typical weekend conditions, long weekends and the weekend of the "Starbelly Jam Music Festival" on the eastside of Kootenay Lake are excluded. These special case scenarios are addressed separately.

Eastbound weekday average and 85th percentile vehicle demands peak at the 11:30 AM sailing at 72 and 86, respectively. Weekend day average and 85th percentile vehicle demands also peak at the 11:30 AM sailing at 76 and 89, respectively.

Westbound weekday average and 85th percentile vehicle demands peak at the 12:20 PM sailing at 73 and 95, respectively. Weekend day average and 85th percentile vehicle demands peak at the 12:20 PM sailing at 76 and 109, respectively.

Average and 85th percentile vehicle demands frequently exceed ferry capacities, resulting in compounding demands and significant traveller delays. On a typical weekday, 118 vehicles (10% of total daily vehicles) experience a 1 sailing wait, resulting in 97.9 hours of aggregate traveller delay. On heavier volume weekdays, when 85th percentile demands are experienced, 323 vehicles (23% of total daily vehicles) experience a 1 sailing wait, resulting in 271.2 hours of aggregate traveller delay.

On a typical weekend day, 153 vehicles (12% of total daily vehicles) experience a 1 sailing wait, resulting in 127.2 hours of aggregate traveller delay. On heavier volume weekend days, when 85th percentile demands are experienced, 401 vehicles (22% of total daily vehicles) experience a 1 sailing wait, and 13 vehicles experience a 2 sailing wait, resulting in 356.4 hours of aggregate traveller delay.

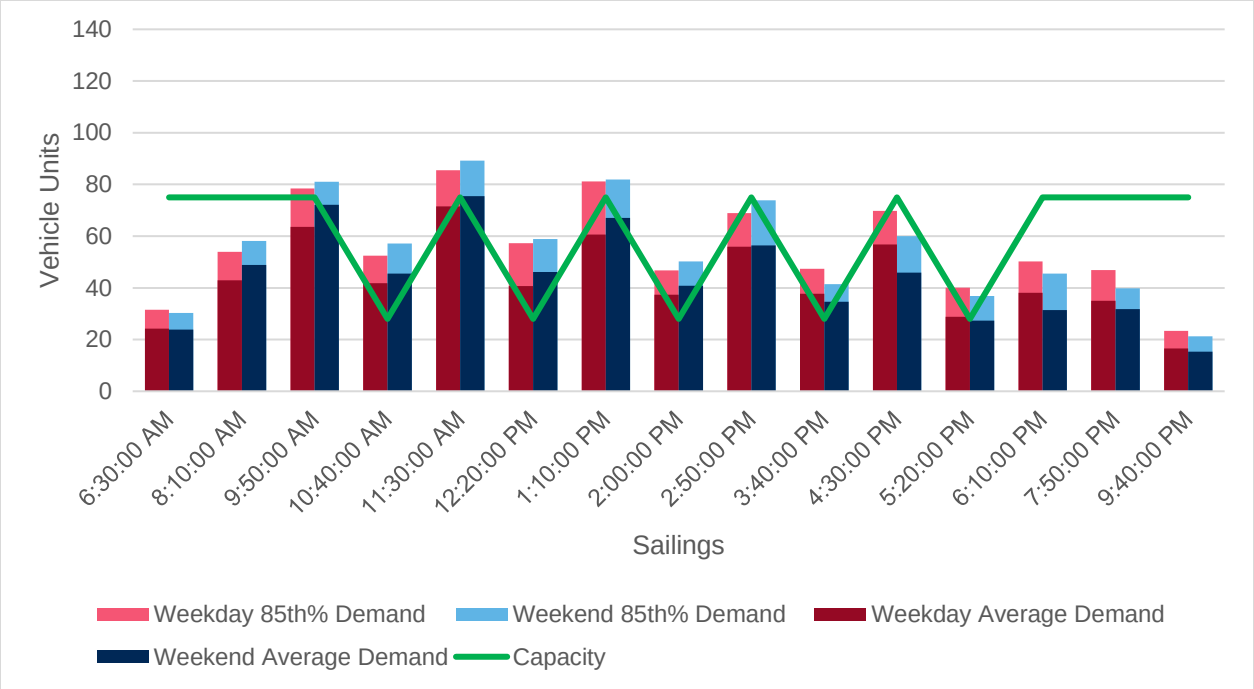

Figure 2.7: Current Eastbound Average and 85th Percentile Vehicle Demands (Summer)

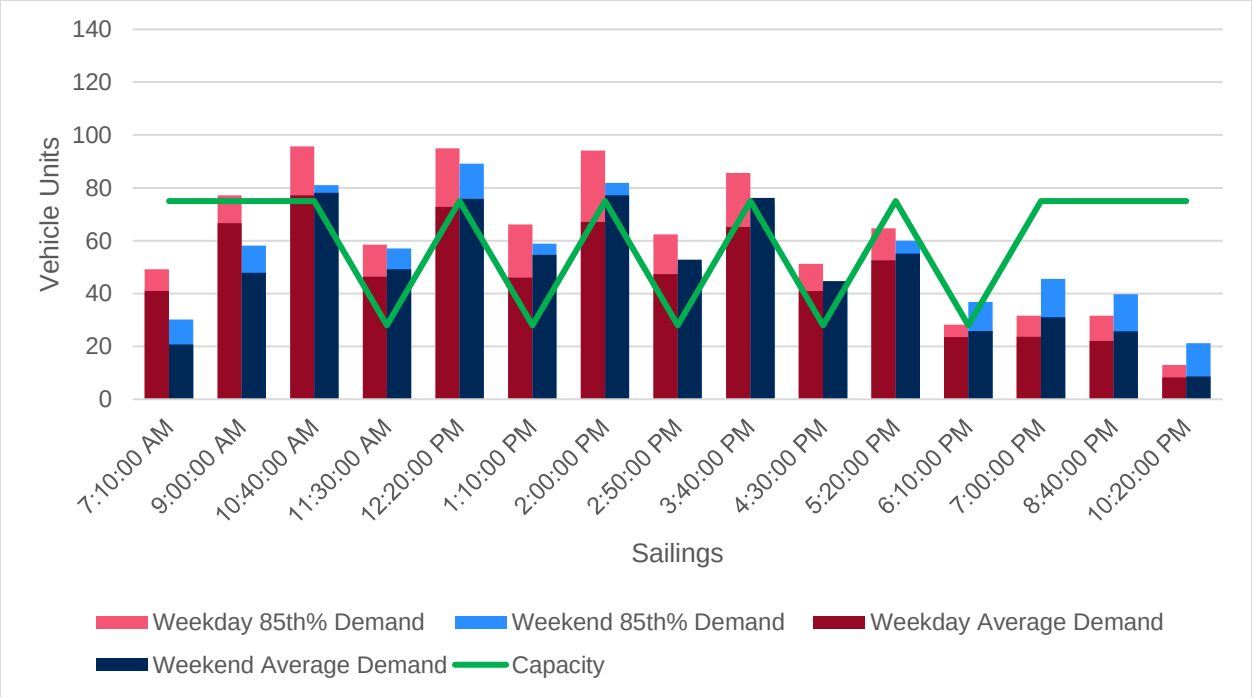

Figure 2.8: Current Westbound Average and 85th Percentile Vehicle Demands (Summer)

LONG WEEKENDS

Each long weekend in the summer and shoulder periods was analysed to highlight extreme demand cases. These weekends are briefly summarized below.

VICTORIA DAY

The Victoria Day long weekend occurs at the end of May when the Kootenay Lake Ferry route is serviced exclusively by the Osprey 2000. Vehicle demands for the Victoria Day weekend are shown below in **Figure 2.9.** Each day, traffic peaks at midday sailings with an overall peak on Friday at the 2:00 PM sailing (westbound) at 76 vehicle units. No other sailing during the Victoria Day weekend exceeded the capacity of the Osprey 2000.

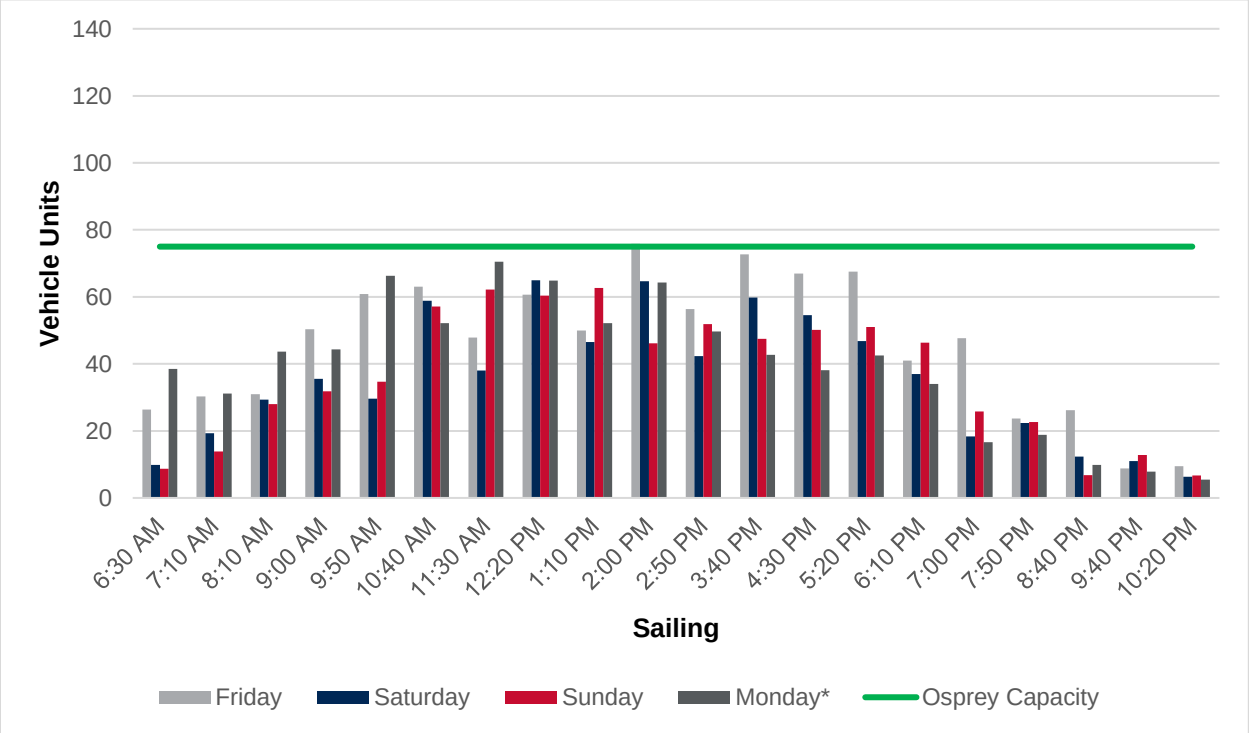

Figure 2.9: Victoria Day (2015 - 2016) Traffic Demand

CANADA DAY

Eastbound and westbound vehicle demand around the Canada Day Long weekend is shown in **Figure 2.10** and **Figure 2.11,** respectively. The Canada Day weekend occurs during the summer service period, which is serviced by both the Osprey 2000 and the MV Balfour.

Traffic demand on the Canada Day long weekend resulted in a total of 26 overloaded sailings. Overall, westbound traffic was much higher than eastbound traffic with Sunday being the busiest day in both directions. Eastbound traffic demand peaked at the Sunday 8:10 AM sailing at 74 vehicles, which is below the capacity of the Osprey 2000. Westbound traffic peaked at the Sunday 12:20 PM sailing at

137 vehicles. Of the total vehicle travellers on Canada Day weekend, 798 vehicles experienced a one sailing wait and 43 experienced a two sailing wait. Over all four days, Thursday through Sunday, 15 percent of all vehicles experienced at least a one sailing wait equating to 737 hours of aggregate delay.

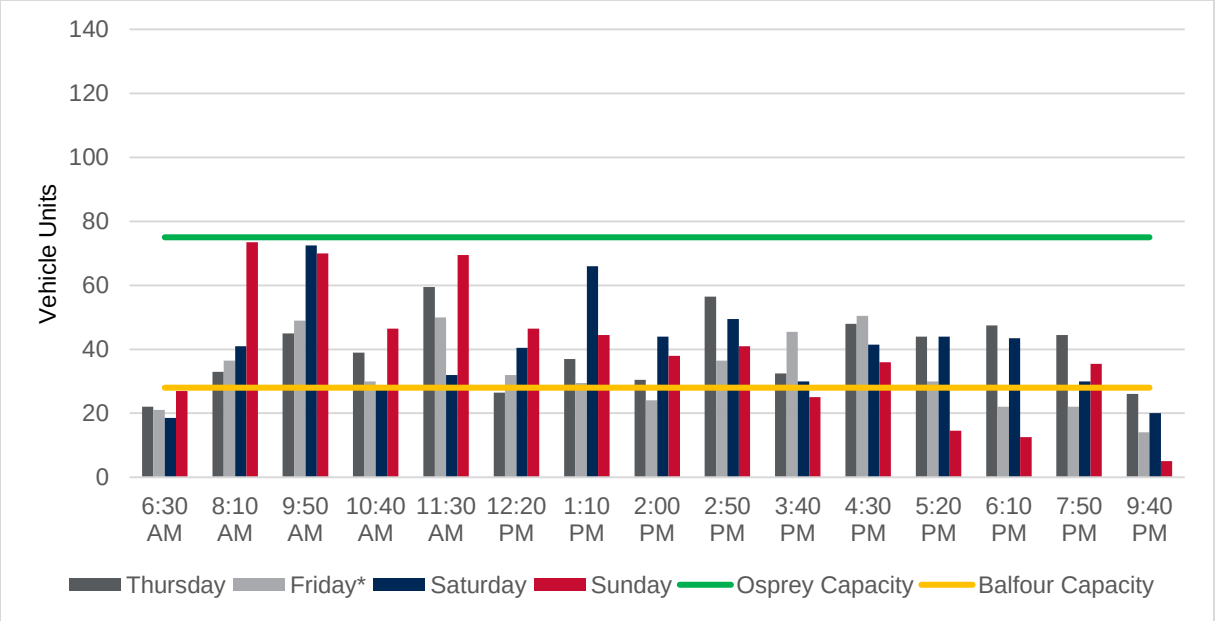

Figure 2.10: Canada Day (2016) Long Weekend Traffic Demand - Eastbound

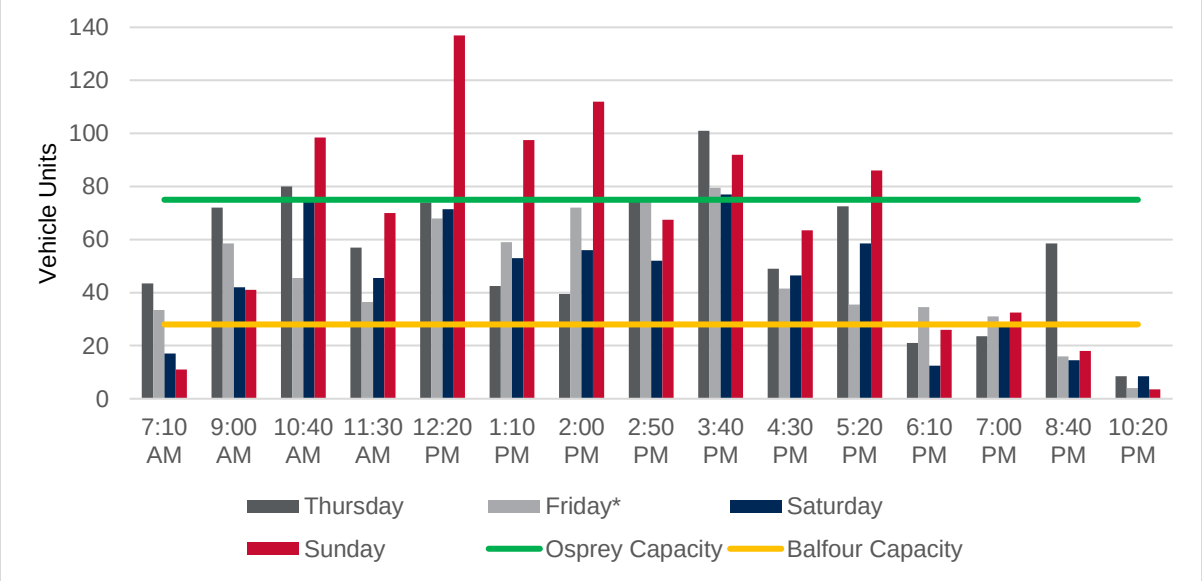

Figure 2.11: Canada Day (2016) Long Weekend Traffic Demand - Westbound

BC DAY

The BC Day Long Weekend occurs on the first Monday in August and represents one of the highest demand periods for the Kootenay Lake Ferry. Eastbound and Westbound vehicle demands on the BC Day weekend by sailing are displayed in **Figure 2.12** and **Figure 2.13**, respectively.

Eastbound vehicle demands peak on Monday at 130 vehicles at the 11:30 AM and 1:10 PM sailings. Westbound vehicle demands peak on Friday at 160 vehicles at the 3:40 PM and 5:20 PM sailings. Demands frequently exceed capacities, resulting in compounding queuing and significant traveller delays. The data for 2015 and 2016 shows that an average of 1,965 vehicles experienced a one sailing wait and 538 vehicles experienced a two sailing wait, resulting in over 2,500 hours of aggregate traveller delay over all four days of the BC Day weekend (Friday to Monday). Of the total vehicles travelling on the BC Day long weekend, over 31 percent experienced at least a one sailing wait.[1]

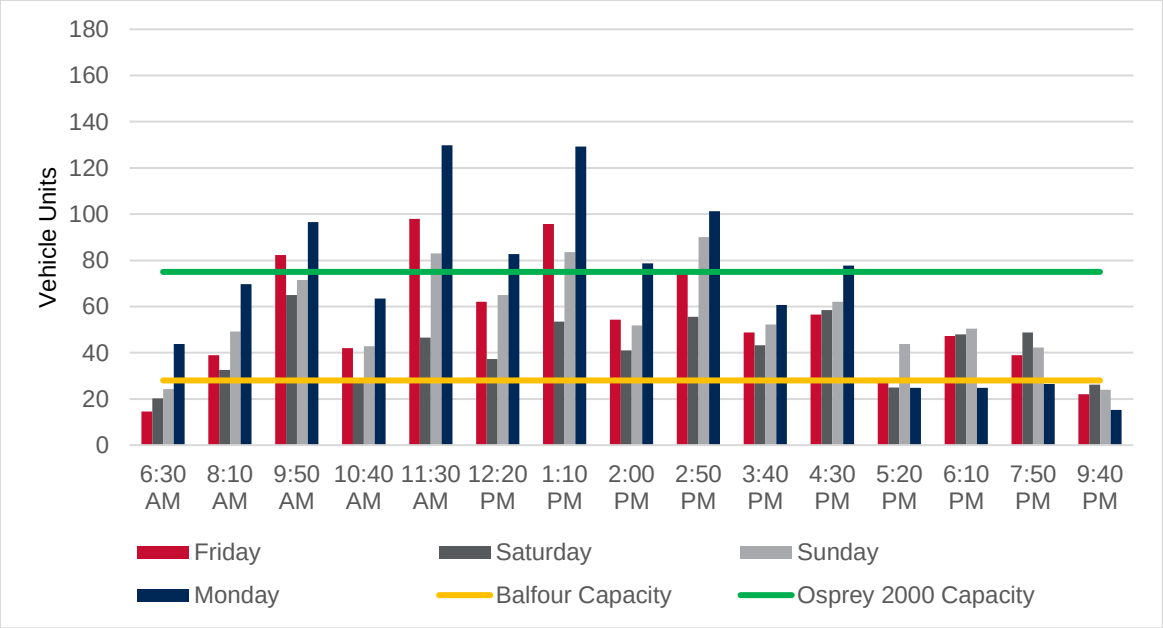

Figure 2.12: Eastbound BC Day Weekend Vehicle Demands

[1] *Average of 2015 and 2016 BC Day weekend data.*

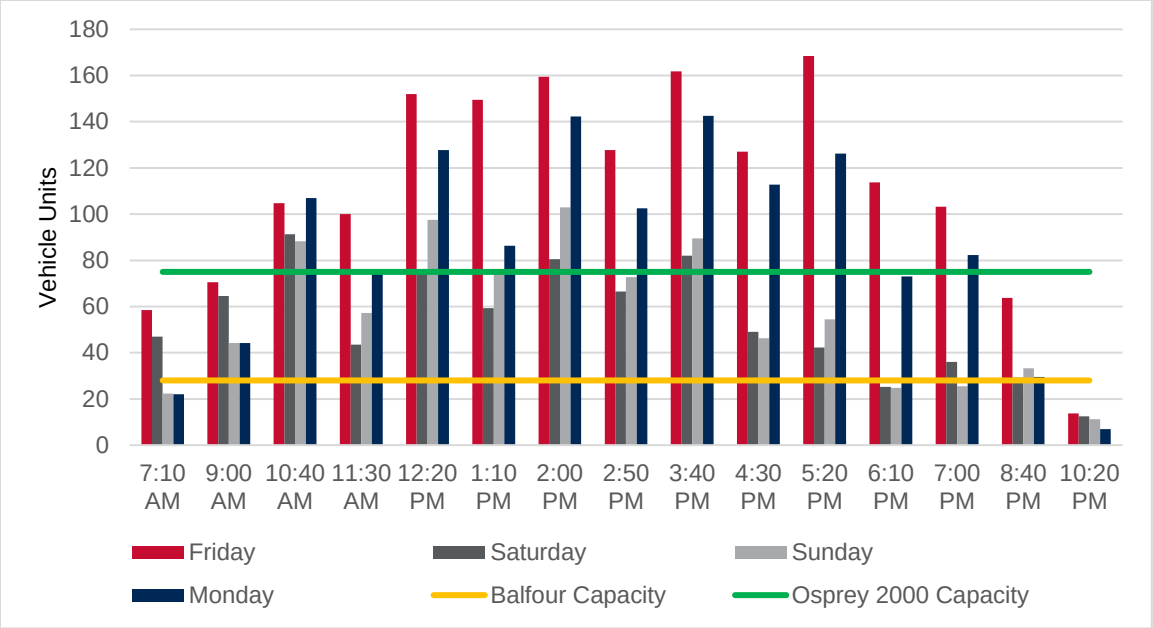

Figure 2.13: Westbound BC Day Weekend Vehicle Demands

LABOUR DAY

Labour Day occurs on the first Monday in September and is the last weekend of the summer service period with both vessels in operation. Average traffic demand by sailing, based on 2015 and 2016 data, is depicted below in **Figure 2.14** and **Figure 2.15** for eastbound and westbound traffic, respectively.

Traffic trends in 2015 and 2016 show the eastbound leg peaking on Sunday and Monday with a total 574 travellers per day. Westbound traffic overall is fairly consistent across all days, peaking on Friday with 612 vehicles. Traffic demand per trip peaks at 82 and 73 vehicle units for eastbound and westbound traffic, respectively. Altogether between Friday and Monday, a total of 226 vehicles experience a one sailing wait resulting in 188 hours of aggregate delay.

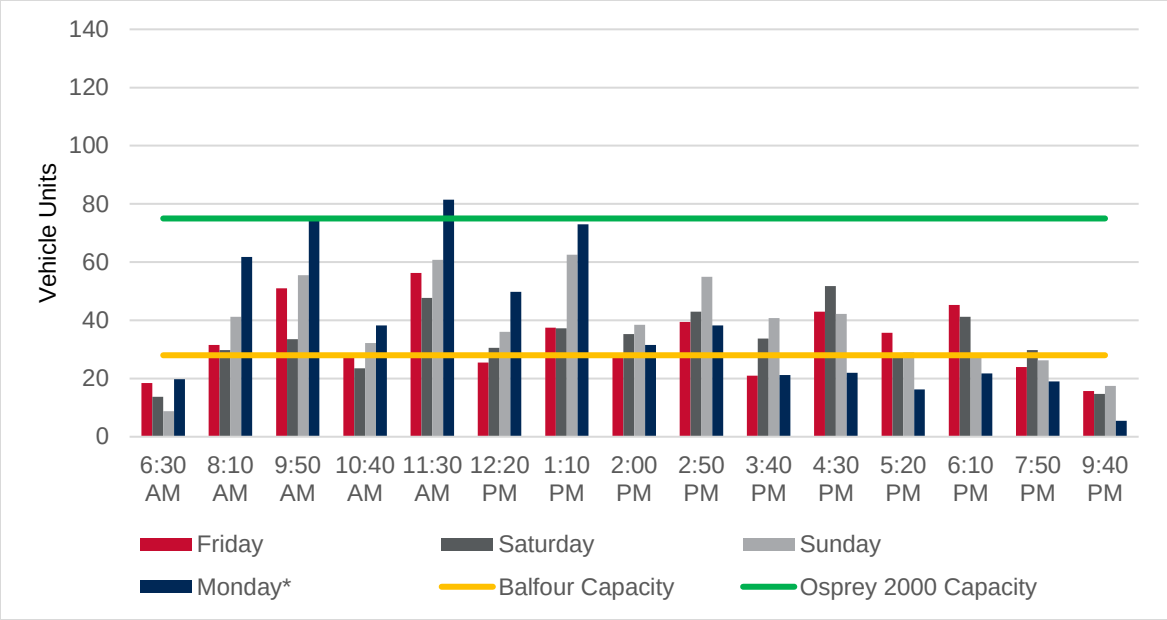

Figure 2.14: Eastbound Labour Day Weekend Vehicle Demands

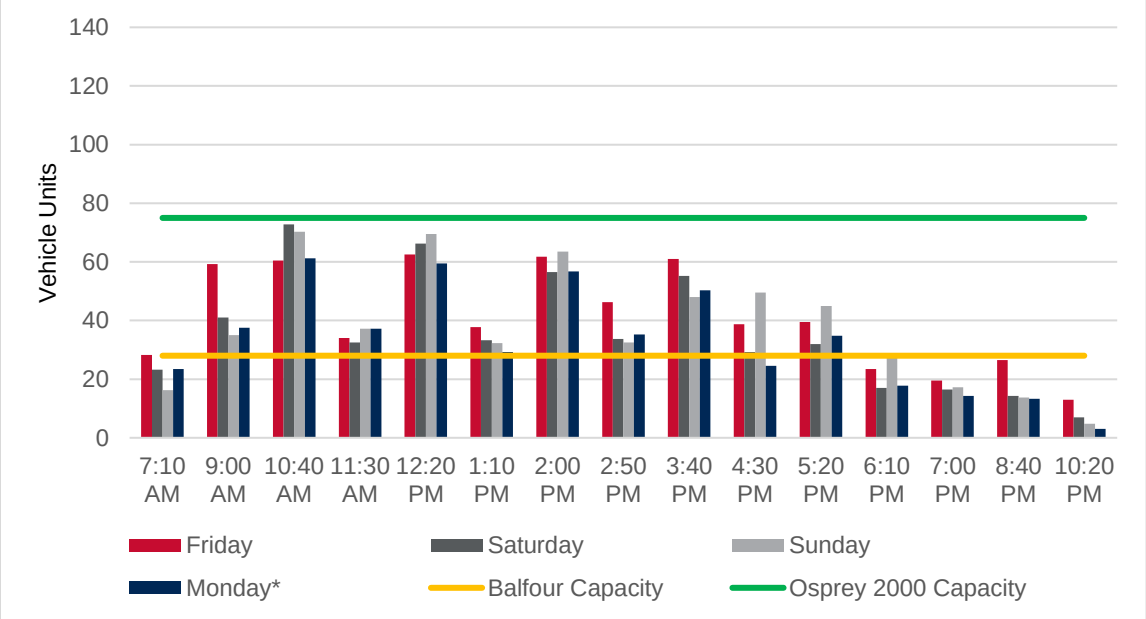

Figure 2.15: Westbound Labour Day Weekend Vehicle Demands

THANKSGIVING

The 2015 Thanksgiving weekend was analysed to identify the peak scenario in the shoulder season. The Osprey 2000 was in service this weekend (Friday through Monday) with no sailings exceeding capacity on these days. However, the Balfour served the route on Tuesday when demand exceeded the 28 vehicle unit capacity, resulting in delays.

KOOTENAY PASS HIGHWAY CLOSURE

The Kootenay Pass, along Highway 3 (the Crowsnest Highway), experiences planned closures in winter and spring for avalanche control or due to poor driving conditions. During a closure, highway traffic is rerouted to the Kootenay Lake Ferry, resulting in increased demand on those days. Data was obtained for the closures that occurred between January 2015 and October 2016 and analysed to determine inflated demand due to rerouted traffic.

Heaviest demand sailings on days when the Kootenay Pass was closed are displayed in **Table 2.4**. Demand for those sailings are juxtaposed alongside winter average and 85th percentile vehicle demands for that sailing for context.

Table 2.4: Kootenay Pass Avalanche Closures (January, 2015 - October, 2016)

Leg	Day of the Week	Length of Pass Closure (hh:mm)	Sailing	Demand	Average Sailing Demand	85th Percentile Sailing Demand	% Above 85th Percentile
Westbound	Friday	1:10	9:00 AM	65	39	46	41%
	Monday	1:32	9:00 AM	62	39	46	35%
	Saturday	0:45	12:20 PM	60	25	31	94%
	Friday	1:15	3:40 PM	56	23	29	93%
	Monday	12:25	7:10 AM	55	27	33	67%
	Tuesday	0:37	3:40 PM	55	23	29	90%
	Tuesday	8:40	7:10 AM	54	27	33	64%
	Friday	1:15	5:20 PM	54	14	19	184%
Eastbound	Saturday	0:45	2:50 PM	57	30	35	63%
	Friday	1:15	4:30 PM	52	30	38	37%
	Tuesday	0:37	4:30 PM	49	30	38	29%
	Wednesday	5:30	4:30 PM	49	30	38	29%
	Wednesday	5:30	1:10 PM	49	28	36	36%
	Tuesday	0:37	2:50 PM	48	32	43	12%
	Tuesday	0:37	6:10 PM	47	16	22	114%

Although traffic demand never exceeded the capacity of the Osprey 2000 during a pass closure, there are clear spikes in traffic due to travellers rerouting. Interestingly, these spikes do not seem to follow a clear pattern in the percent of vehicle unit increase over expected traffic demand. The sailings that tend to be most affected, independent of the length of the pass closure, are weekday morning (7:10 and 9:00 AM) and later afternoon sailings (3:40 and 4:30 PM). Sunday pass closures result in marginal increases in ferry demand.

Highway pass closures due to avalanche control or poor road conditions are scheduled and advance warning of the closure times is given to the public. This could explain why pass closures on Sundays do not significantly increase ferry traffic volume, as fewer people tend to make essential trips on Sundays. Closures at busier weekday periods result in higher spikes in demand. In some cases, demand increases for sailings before the beginning of the closure, which is likely due to forewarning of the closure.

Kootenay Pass highway closures also occur unexpectedly for mudslides. No data was available to analyse the effects of these closures.

2.3.2 Future Base Conditions

Consistent with long-term growth projections for the Kootenays and SNC Lavalin's *Balfour Ferry Terminal Relocation Study*, current traffic volumes are grown at a compound annual growth rate of 0.3% to the 10, 20, and 40 year horizons. Future base conditions represent a hypothetical scenario where no additional vehicle capacity is added to the Kootenay Lake Ferry system.

While this section addresses future base capacity conditions at the 40 year horizon only, full demand-capacity tables representing the 10, 20, and 40 year horizons are included in **Appendices B, C, and D,** respectively.

WINTER

2057 winter period average and 85th percentile daily vehicle volumes are summarized in **Table 2.5**. On average, 431 vehicles are projected to use the Kootenay Ferry System on weekdays and 387 on weekend days.

Table 2.5: Winter Period Average and 85th% Daily Trips (2057 Horizon)

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	218	288	204	270
Westbound	213	269	183	243
TOTAL	**431**	**557**	**387**	**513**

2057 winter period traffic demands for eastbound and westbound sailings are shown in **Figure 2.16** and **Figure 2.17**. Traffic volumes for all sailings remain well below the Osprey's 75 vehicle practical capacity with average (85th percentile) demands peaking at 36 (48) in the eastbound direction and 44 (52) in the westbound direction.

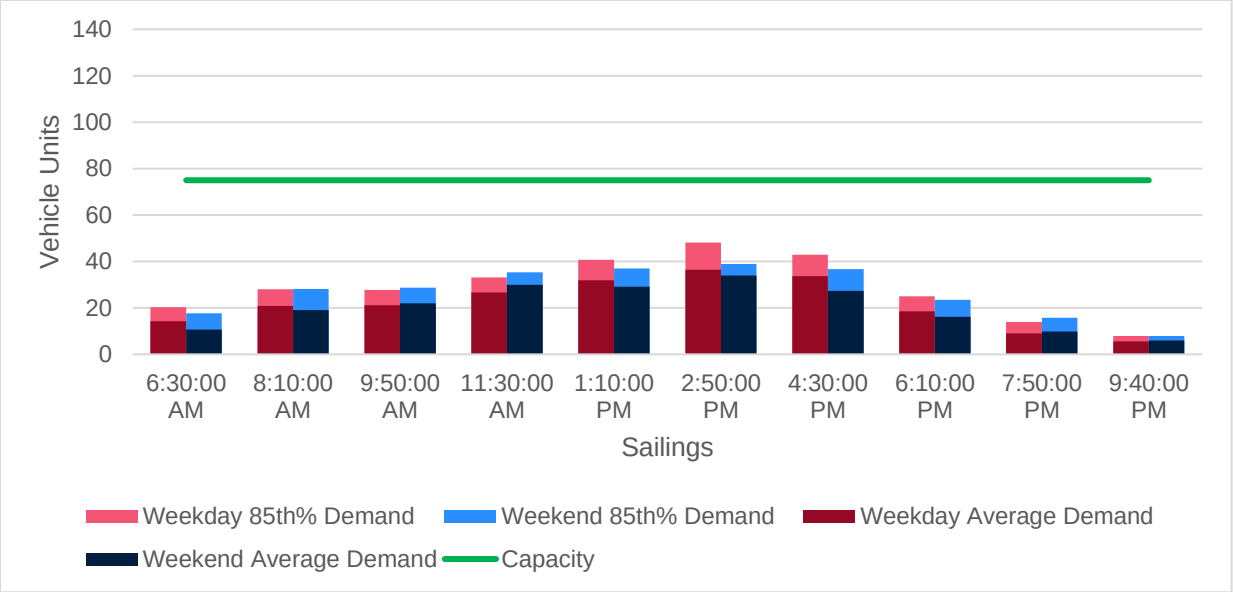

Figure 2.16: 2057 Horizon Eastbound Average and 85th Percentile Vehicle Demands (Winter)

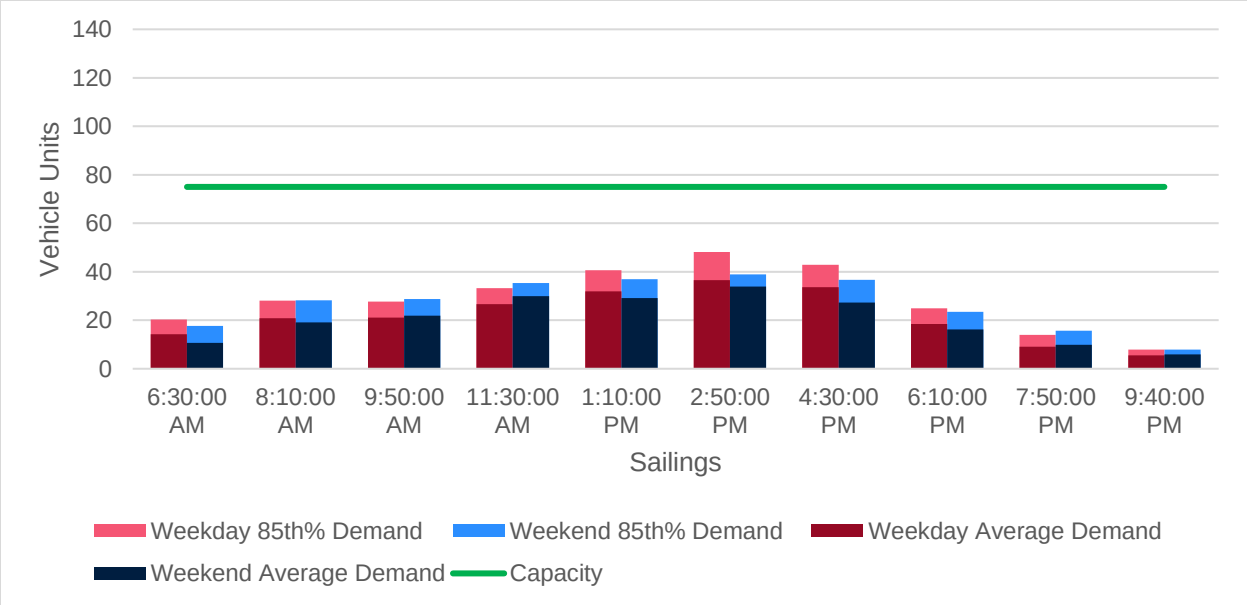

Figure 2.17: 2057 Horizon Westbound Average and 85th Percentile Vehicle Demands (Winter)

SHOULDER

2057 shoulder period average and 85th percentile daily vehicle volumes are summarized in **Table 2.6**. On average, 693 vehicles are projected to use the Kootenay Ferry System on weekdays and 644 on weekend days.

Table 2.6: Shoulder Period Average and 85th% Daily Trips (2057 Horizon)

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	336	425	322	416
Westbound	358	462	322	401
TOTAL	**693**	**887**	**644**	**817**

2057 shoulder period traffic demands for eastbound and westbound sailings are shown in **Figure 2.18** and **Figure 2.19.** Traffic volumes for all sailings remain below the Osprey's 75 vehicle practical capacity with average (85th percentile) demands peaking at 50 (64) in the eastbound direction and 52 (62) in the westbound direction.

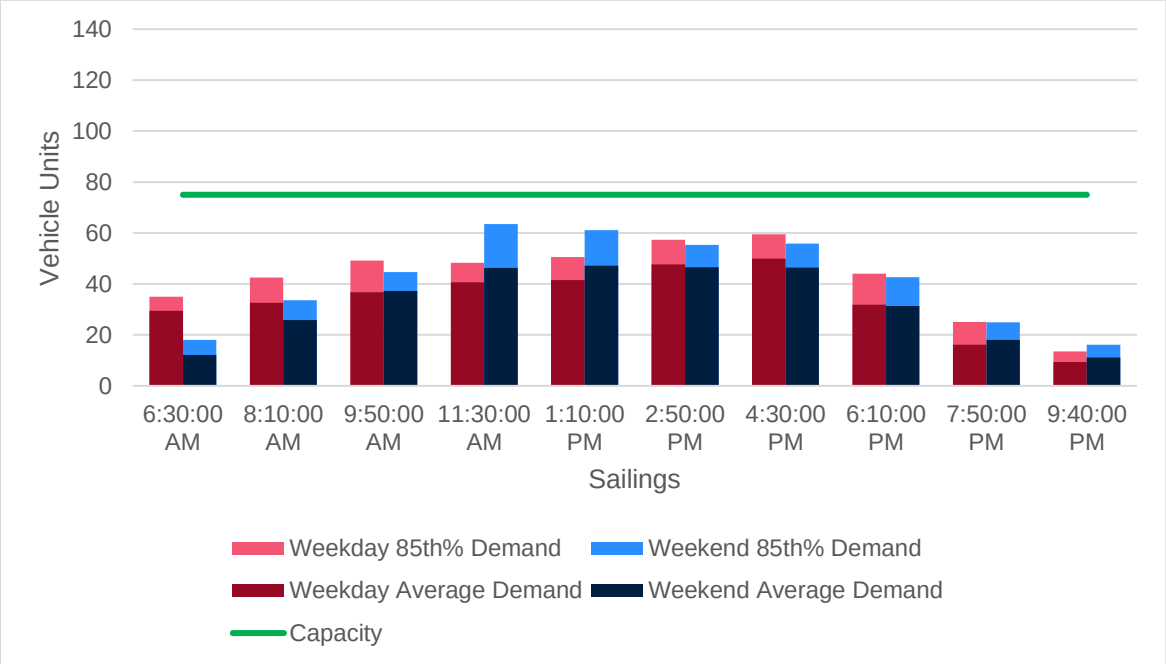

Figure 2.18: 2057 Horizon Eastbound Average and 85th Percentile Vehicle Demands (Shoulder)

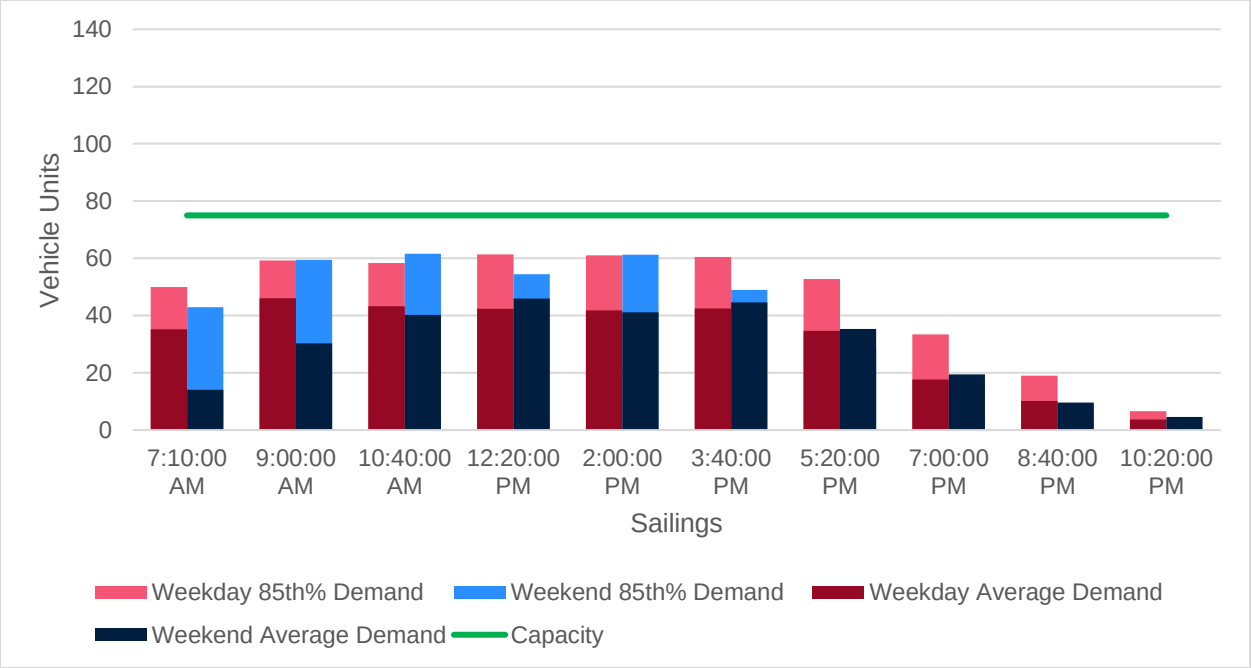

Figure 2.19: 2057 Horizon Westbound Average and 85th Percentile Vehicle Demands (Shoulder)

SUMMER

2057 summer period average and 85th percentile daily vehicle volumes are summarized in **Table 2.7**. On average, 1,525 vehicles are projected to use the Kootenay Ferry System on weekdays and 1,563 on weekend days. On heavily trafficked days, approximately 2,000 vehicles are projected to use the ferry.

Table 2.7: Summer Period Average and 85th% Daily Trips (2057 Horizon)

	Average Weekday Trips	85th% Weekday Trips	Average Weekend Day Trips	85th% Weekend Day Trips
Eastbound	735	940	747	930
Westbound	790	1019	816	1089
TOTAL	**1525**	**1959**	**1563**	**2020**

2057 summer period traffic demands for eastbound and westbound sailings are shown in **Figure 2.20** and **Figure 2.21.** To reflect typical weekend conditions, long weekends are excluded from the analysis.

Eastbound weekday average and 85th percentile vehicle demands peak at the 11:30 AM sailing at 81 and 96, respectively. Weekend day average and 85th percentile vehicle demands also peak the 11:30 AM sailing at 85 and 101, respectively.

Westbound weekday average and 85th percentile vehicle demands peak at the 10:40 AM sailing at 87 and 108, respectively. Weekend day average vehicle demand peaks at the 10:40 AM sailing at 88. At the 85th percentile, westbound weekend day vehicle demands peak at the 12:20 sailing at 123.

Average and 85th percentile vehicle demands will frequently exceed ferry capacities, resulting in compounding demands and significant traveller delays. On a typical summer weekday in 2057, 188 vehicles (12 % of total daily vehicles) will experience a 1 sailing wait, resulting in 156.5 hours of aggregate traveller delay. On heavier volume weekdays, when 85th percentile demands are experienced, 471 vehicles (24 % of total daily vehicles) will experience a 1 sailing wait, and 12 vehicles will experience a 2 sailing wait, resulting in 422.4 hours of aggregate traveller delay.

On a typical summer weekend day in 2057, 259 vehicles (17% of total daily vehicles) will experience a 1 sailing wait, resulting in 215.9 hours of aggregate traveller delay. On heavier volume weekend days, when 85th percentile demands are experienced, 531 vehicles (26% of total daily vehicles) will experience a 1 sailing wait, and 56 vehicles will experience a 2 sailing wait, resulting in 536.4 hours of aggregate traveller delay.

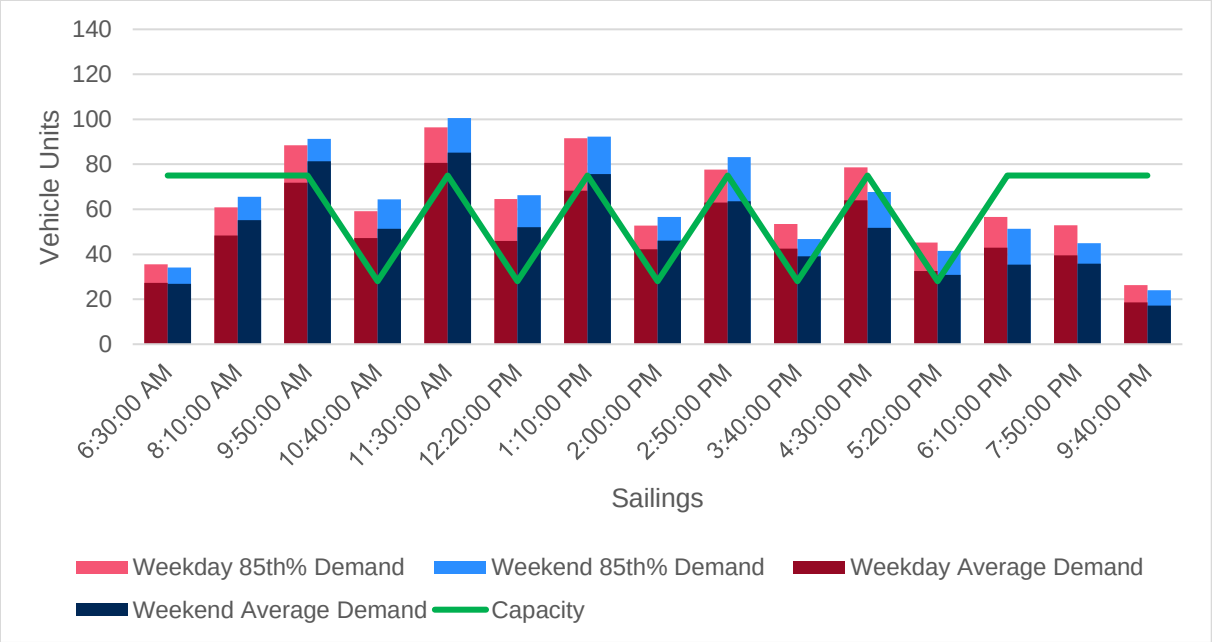

Figure 2.20: 2057 Horizon Eastbound Average and 85th Percentile Vehicle Demands (Summer)

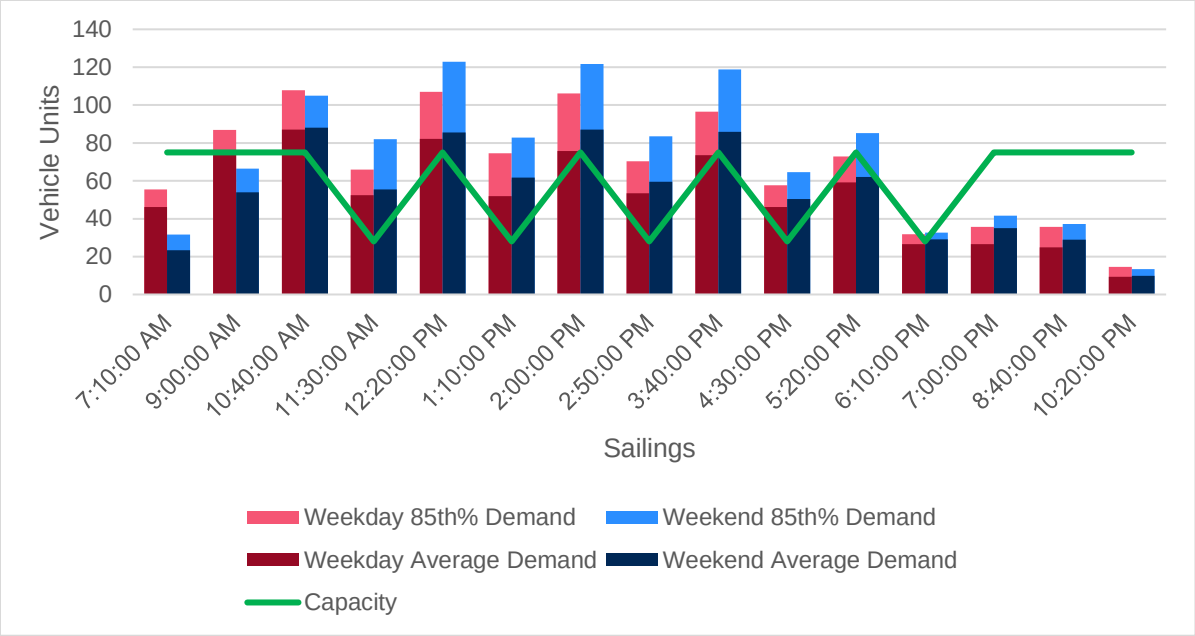

Figure 2.21: 2057 Horizon Eastbound Average and 85th Percentile Vehicle Demands (Summer)

2.4 Base Condition Annualized Vehicle Overflows and Delays

Aggregate annual overflows at the current and 40-year horizon are estimated from daily calculations and are summarized in **Table 2.8** below. Assuming regular operating conditions, all overflows occur during summer months only. Altogether over 13,800 vehicle trip overflows occur each year, which results in 11,700 hours of aggregate delay. This is anticipated to increase to over 20,200 vehicle trips and 17,300 hours of aggregate delay by 2057.

Table 2.8: Total Vehicle Overflows and Delays (Current and 2057)

	2017		2057	
	Vehicle Overflows (1 sailing wait equivalents)	Delay (hrs)	Vehicle Overflows (1 sailing wait equivalents)	Delay (hrs)
Weekdays	3,894	3,231	6,204	5,165
Weekend Days	1,530	1,272	2,590	2,159
Long Weekend Days	8,395	7,209	11,454	9,980
TOTAL	**13,819**	**11,711**	**20,248**	**17,303**

2.5 Problem Definition Summary

The MV Balfour is nearing the end of its service life and in order to maintain service levels needs to be replaced within the next few years. In response, current and future base operating conditions at the Kootenay Lake Ferry have been assessed in the winter, shoulder and summer service periods to ensure the capacity of the replacement vessel is appropriately matched with existing and projected demands.

Under its current operating scheme, the Kootenay Lake Ferry has adequate capacity to process demand for all regularly scheduled weekday and weekend sailings to the 2057 horizon in the winter and shoulder operating periods. Current average and 85th percentile traffic volumes peak at 46 and 55 vehicles per trip, respectively, and are projected to peak at 52 and 64 vehicles per trip in 2057. These volumes are all well below the 75 vehicle practical capacity of the *MV Osprey 2000.*

During the summer months ferry demand can more than triple, resulting in significant volume pressure on the ferry route. Despite the additional capacity provided by the *MV Balfour* which supplements the *MV Osprey 2000* during the summer months, vehicle demand often exceeds capacity, resulting in significant traveller delays. Current average and 85th percentile traffic volumes peak at 78 and 109 vehicles per trip, respectively, and are projected to peak at 88 and 123 vehicles per trip in 2057. Hyper-demands are experienced on select weekends such as the Canada Day and BC Day long weekends and the weekend of the *Starbelly Jam Music Festival* on the eastside of Kootenay Lake.

Currently, average summer traffic demands result in 10 percent of all travellers experiencing at least a one sailing wait. This increases on long weekends when up to 31 percent of travellers experience at least a one sailing wait. Altogether, these waits amount to 11,700 hours of traveller delay annually. Assuming no change in cross-lake vehicle capacity, steadily increasing demands will result in projected annual delays of 17,300 hours in 2057.

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3 RIGHT-SIZING THE NEW BALFOUR VESSEL

MoTI intends to replace the aging MV Balfour with a new vessel that is appropriately sized to accommodate existing and future travel demands. To ensure the vessel is right-sized, both a 50 and 60 Automobile Equivalent Unit (AEQ) capacity vessel are investigated in this exercise. To minimize the negative impacts associated with operating a larger vessel like the Osprey 2000 and to reduce operating costs, the Ministry intends to operate the new vessel in the winter and shoulder periods in lieu of the Osprey 2000. Both vessels would be in service during the busy summer period.

Traveller impacts of replacing the existing 28 vehicle Balfour with a new 50 or 60 vehicle vessel are examined for the winter, shoulder and summer service periods.

3.1 Assumptions & Results

Alternative 50 and 60 vehicle capacity replacement vessels were modelled using the same methodology that was employed in the existing and future base conditions assessments. Results are presented using the following measures on a per day basis to illustrate the following:

- Number of sailings that result in overflows,
- Percent of total daily sailings that result in overflows,
- Number of overflow vehicles, and
- Total hours of aggregate vehicle delay.

Results are shown for average and 85th percentile demands on weekdays and weekend days. The busiest long weekend in each applicable season is also shown to provide an extreme demand scenario comparison.

The new vessel is assumed to function as the sole service vessel during the winter and shoulder periods, replacing the *Osprey 2000.* In the summer service period, the *Osprey 2000* is assumed to retain its current schedule with the new vessel replacing *MV Balfour* sailings.

Of note, the current data reveals that summer demand distributions tend to correspond to the vessel capacity of each sailing. In other words, demand is typically greater at the sailings that the *Osprey 2000* services as compared to *Balfour* sailings. It is worth noting that this trend in traffic demand is likely due to traveller awareness of the service vessel capacity. While summertime demand patterns are not adjusted in this assessment, it is likely that demands will flatten to a degree to reflect the additional capacity provided by the new vessel.

3.1.1 50 Vehicle Capacity Replacement Vessel

The estimated performance results of a 50 vehicle capacity vessel are displayed for each season in **Table 3.1, Table 3.2,** and **Table 3.3**.

In the winter season, a 50 vehicle capacity vessel was found to be adequate with no overloaded sailings in the current year and only one overloaded sailing affecting two vehicles per day under 85th percentile volume conditions at the 2057 horizon. Winter season spikes in demand occur when Highway 3 through the Kootenay Pass closes for avalanche control or poor conditions. While pass closure-related sailings can at times exceed 50, a 50 vehicle capacity vessel should be able to accommodate demand for most sailings during road closure events.

During the shoulder season, a 50 vehicle capacity vessel would result in modest delays under 85th percentile conditions at current traffic levels. No overfilled sailings are anticipated under average conditions. At the 2057 horizon, a 50 vehicle capacity vessel results in 1 to 2 overfilled sailings per day under average conditions with modest delays to travellers and 8 to 9 overfilled sailings per day under 85th percentile conditions, with approximately 70 vehicles facing one sailing waits.

With a 50 vehicle capacity vessel, summer 2017 conditions improve considerably compared to base conditions, with the total number of weekday (weekend day) vehicles experiencing a one sailing wait reducing from 118 (153) to 2 (15). At the 2057 horizon, summer average conditions result in slightly less delay than existing base 2017 conditions, but it is estimated that at the 85th percentile over half of daily sailings will still result in overflows.

The heaviest weekend during the summer, BC Day, experiences reduced overloaded sailings with a 50 AEQ vessel compared to the existing service, however, significant overflow is still expected. Total delay at the 2057 horizon is slightly more than 2017 delays under existing base operations.

Table 3.1: 50 AEQ Capacity Analysis Results (Winter)

Winter		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
	Weekend	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
85th Percentile	Weekday	0	0%	0	0.0	0	0%	0	0.0	1	5%	2	3.5
	Weekend	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0

Table 3.2: 50 AEQ Capacity Analysis Results (Shoulder)

Shoulder		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	0	0%	0	0.0	0	0%	0	0.0	1	5%	2	3.3
	Weekend	0	0%	0	0.0	0	0%	0	0.0	2	10%	2	3.5
85th Percentile	Weekday	0	0%	0	0.0	7	35%	20	33.7	9	45%	71	117.9
	Weekend	0	0%	0	0.0	5	25%	22	37.3	8	40%	73	121.2
Thanksgiving Weekend*		0	0%	0	0.0	6	30%	76	127.1	10	50%	142	236.5

Table 3.3: 50 AEQ Capacity Analysis Results (Summer)

Summer		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	10	33%	118	97.9	1	3%	2	1.8	8	27%	33	27.7
	Weekend	13	43%	153	127.2	7	23%	15	12.9	13	43%	94	78.4
85th Percentile	Weekday	18	60%	323	271.2	14	47%	141	119.1	18	60%	286	248.1
	Weekend	18	60%	414	345.2	15	50%	237	197.5	16	53%	396	330.2
BC Day Weekend*		19	63%	1031	1176.3	17	57%	842	870.2	19	63%	1099	1216.6

3.1.2 60 Vehicle Capacity Replacement Vessel

The estimated performance results of a 60 vehicle capacity vessel are displayed for each season in **Table 3.4, Table 3.5,** and **Table 3.6.**

In the winter season, a 60 vehicle capacity vessel satisfies average and 85th percentile traffic demand with no overloaded sailings anticipated to the 2057 horizon.

In the shoulder season, no overfilled sailings are anticipated at the 2017 horizon under either average or 85th percentile conditions. By 2057, a 60 vehicle capacity vessel will result in very modest delays to travellers under 85th percentile conditions. No delays are anticipated under average demand conditions.

Summer 2017 estimated delays are significantly reduced with a 60 vehicle capacity vessel with the total number of weekday (weekend day) vehicles experiencing a one sailing wait reduced from 118 (153) to 2 (8). By 2057, the number of weekday (weekend day) vehicles delayed under average conditions is projected to mount to a mere 26 (65), which is significantly lower than existing base conditions. Marked improvements are additionally noted under 85th percentile demand conditions, with the total number of weekday (weekend day) vehicles experiencing one sailing waits reduced from 323 (414) to 101 (184) at the 2017 horizon and 223 (330) at the 2057 horizon.

The heaviest weekend during the summer, BC Day, experiences reduced overloaded sailings with a 60 AEQ vessel compared to the existing service, however, significant overflow is still expected. Total delay at the 2057 horizon is similar to 2017 delays under existing base operations.

Table 3.4: 60 AEQ Capacity Analysis Results (Winter)

Winter		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
	Weekend	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
85th Percentile	Weekday	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
	Weekend	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0

Table 3.5: 60 AEQ Capacity Analysis Results (Shoulder)

Shoulder		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
	Weekend	0	0%	0	0.0	0	0%	0	0.0	0	0%	0	0.0
85th Percentile	Weekday	0	0%	0	0.0	0	0%	0	0.0	3	15%	3	4.9
	Weekend	0	0%	0	0.0	0	0%	0	0.0	4	20%	8	12.6
Thanksgiving Weekend*		0	0%	0	0	4	20%	27	44.3	6	30%	64	106.9

Table 3.6: 60 AEQ Capacity Analysis Results (Summer)

Summer													
		Modeled Existing - 2017				New Vessel - 2017				New Vessel - 2057			
		Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours	Daily Overloaded Sailings	% Overloaded Sailings	# Overflow Vehicles	Total Overflow Delay Hours
Average	Weekday	10	33%	118	97.9	1	3%	2	1.8	5	17%	26	21.4
	Weekend	13	43%	153	127.2	5	17%	8	6.6	8	27%	65	54.3
85th Percentile	Weekday	18	60%	323	271.2	10	33%	101	86.2	14	47%	223	195.6
	Weekend	18	60%	414	345.2	11	37%	184	153.0	15	50%	330	274.7
BC Day Weekend*		19	63%	1031	1176.3	16	53%	777	770.3	18	60%	1023	1089.6

3.2 Improved Condition Annualized Vehicle Overflows and Delays

Aggregate annual vehicle overflows at the 2017 and 2057 horizons are calculated for both the 50 and 60 vehicle capacity vessels from average daily values and are contrasted against the base condition in **Table 3.7**. Assuming regular operating conditions, almost all vehicle overflows occur during the summer operating period.

Replacing the 28 vehicle *MV Balfour* with a 50 or 60 AEQ capacity vessel results in considerable delay gains to the travelling public over the next 40 years. A 50 vehicle capacity vessel eliminates 8,699 one sailing waits each year (63% of total waits) at the current horizon and 11,478 one sailing waits (57%) by 2057. This is equivalent to 6,618 hours of delay in 2017 and 8,396 hours of delay in 2057. A 60 vehicle capacity vessel eliminates 9,283 one sailing waits each year (67% of total waits) at the current horizon and 12,609 one sailing waits (63%) by 2057. This is equivalent to 7,340 hours of delay in 2017 and 9,684 hours of delay in 2057.

Table 3.7: New Balfour Capacity Aggregate Delay Summary

	50 AEQ				60 AEQ			
	2017		2057		2017		2057	
	Vehicle Overflows (1 sailing wait equivalents)	Delay (hrs)	Vehicle Overflows (1 sailing wait equivalents)	Delay (hrs)	Vehicle Overflows (1 sailing wait equivalents)	Delay (hrs)	Vehicle Overflows (1 sailing wait equivalents)	Delay hrs)
Weekdays	66	59	1,089	914	66	59	858	706
Weekend Days	150	129	940	784	80	66	650	543
Long Weekend Days	4,904	4,904	6,741	7,209	4,390	4,245	6,131	6,370
TOTAL	**5,120**	**5,093**	**8,770**	**8,907**	**4,536**	**4,371**	**7,639**	**7,619**
Change from Baseline	***↓8,699***	***↓6,618***	***↓11,478***	***↓8,396***	***↓9,283***	***↓7,340***	***↓12,609***	***↓9,684***

4 SUMMARY AND POTENTIAL SERVICE STRATEGY

The Kootenay Lake Ferry system is served by the *Osprey 2000,* a 75 vehicle capacity vessel, and the *MV Balfour,* a 28 vehicle capacity vessel. The larger *Osprey 2000* is used year-round on the route. In the busy summer period, the *MV Balfour* supplements the service providing additional capacity. The MV Balfour is nearing the end of its service life and needs to be replaced within the next few years. In response, current and future base operating conditions at the Kootenay Lake Ferry have been assessed in the winter, shoulder and summer service periods to ensure the capacity of the replacement vessel is appropriately matched with existing and projected demands.

Under its current operating scheme, the Kootenay Lake Ferry has adequate capacity to process demand for all regularly scheduled weekday and weekend sailings to the 2057 horizon in the winter and shoulder operating periods. During the summer months ferry demand can more than triple, resulting in significant volume pressure on the ferry route. Summer current average and 85th percentile traffic volumes peak at 78 and 109 vehicles per trip, respectively, and are projected to peak at 88 and 123 vehicles per trip in 2057. Hyper-demands are experienced on select weekends such as the Canada Day and BC Day long weekends and the weekend of the *Starbelly Jam Music Festival* on the eastside of Kootenay Lake.

Currently, average summer traffic demands result in 10 percent of all travellers experiencing at least a one sailing wait. This increases on long weekends when up to 31 percent of travellers experience at least a one sailing wait. Altogether, these waits amount to 11,700 hours of traveller delay annually. Assuming no change in cross-lake vehicle capacity, steadily increasing demands will result in projected annual delays of 17,300 hours in 2057.

Either a 50 or a 60 vehicle capacity replacement vessel will significantly relieve demand pressures along the route over the next 40 years. A 50 vehicle capacity replacement vessel will reduce annual vehicle overflows by 63% in 2017 and 57% in 2057, resulting in average delay reductions of 6,618 hours in 2017 and 8,396 hours in 2057. A 60 vehicle capacity replacement vessel will reduce annual vehicle overflows by 67% in 2017 and 63% in 2057, resulting in average delay reductions of 7,340 hours in 2017 and 9,684 hours in 2057.

A 50 or a 60 vehicle capacity vessel could accommodate demands in the winter period under average and 85th percentile traffic conditions up to the 2057 horizon. During the shoulder season, a 50 vehicle capacity vessel would result in modest delays under 85th percentile conditions at current traffic levels. At the 2057 horizon, a 50 vehicle capacity vessel results in 1 to 2 overfilled sailings per day under average conditions with modest delays to travellers and 8 to 9 overfilled sailings per day under 85th percentile conditions, with approximately 70 vehicles facing one sailing waits. By contrast, no overfilled sailings are anticipated at the 2017 horizon under either average or 85th% conditions for a 60 vehicle capacity vessel during the shoulder season, and only modest delays are projected by 2057 under 85th

percentile conditions. In the summer season, a 50 vehicle capacity vessel results in an average of 1 weekday and 7 weekend day overfilled sailings at the 2017 horizon and 8 weekday and 13 weekend day overfilled sailings at the 2057 horizon, down from 10 weekday and 13 weekend day sailings currently. By contrast, a 60 vehicle capacity vessel results in an average of 1 weekday and 5 weekend day overfilled sailings at the 2017 horizon and 5 weekday and 8 weekend day overfilled sailings at the 2057 horizon.

4.1 Potential Service Strategy

The most efficient and economic vessel for the Kootenay Lake Ferry route will be determined by balancing overflow and under-capacity sailings.

In addition to assessing the capacity of the vessel, other opportunities to improve service efficiency may be considered. If a 50 vehicle capacity vessel presents significant capital and operation cost advantages over a 60 vehicle capacity vessel, alterations to the service schedule could be considered to best utilize resources. Over time, as shoulder season vehicle demands approach vessel capacities, a third operating season could be introduced that would see the larger *Osprey 2000* vessel serve the route in the late Spring and early Fall periods in lieu of the replacement vessel, as outlined in **Table 4.1**. The shoulder period could easily be extended as demand warrants. This approach would provide a dedicated time for annual servicing and retrofits without affecting service provision as each vessel would be out of service for a specified period each year. Alternately, the summer service period could be lengthened, extending the season when both vessels service the route.

Table 4.1: Optimized Service Schedule

Season	Date Range	Current Service	Future Service
Winter	Oct 15 – Apr 30	Osprey	New Balfour
Shoulder	May 1 – Jun 19	Osprey	Osprey
Summer	Jun 20 – Sep 10	Osprey + Balfour	Osprey + New Balfour
Shoulder	Sep 11 – Oct 14	Osprey	Osprey