BRTPlan
BRT Planning International

Borgarlína: A Review

October 2020

BRT Planning International, LLC

Contents

Executive Summary

The Borgarlína BRT project is a forward-thinking project which, once built, will demonstrate to Icelanders the commitment of the government to environmentally-friendly, people-oriented transportation. Through its system design, Borgarlína will take travelers in the Capital Area where they want to go, far quicker than ever before. Through its architecture and integration into the urban form, Borgarlína will communicate that the Capital Area is changing for the better, opening up new possibilities for transit-oriented development and tourism.

This report is a summary of BRTPlan's evaluation of the *Phase I Borgarlína Conceptual Design: Ártúnshöfði -Hamraborg*, and Strætó's Bus Network Restructuring Plan as of March/April 2020. The report, based on a series of memos and presentations given by BRTPlan to the Borgarlína and Strætó teams since early 2019, evaluates both the Conceptual Design and the Bus Network Restructuring from the perspective of international best practice, and identifies any areas of inconsistency between these two closely-associated plans. Finally, it rates the Borgarlína project using *The BRT Standard*.

Evaluation of the proposed Strætó network restructuring

Strætó has been working on bus route network restructuring for several years and has been coordinating these efforts with the Borgarlína team and other stakeholders. BRTPlan has been involved in these efforts since mid-2019, so the network evaluated here has already incorporated several rounds of input from stakeholders and BRTPlan. This document clarifies the reasoning behind what has already been done and suggests a few modifications based on recent infrastructure decisions and recently available data.

The report first evaluates the existing Strætó bus network from the perspective of best practice. It concludes the following:

- **Today's network is not a 'frequent' network:** Strætó should define a network of 'frequent' routes where passengers need not rely on a schedule. Today, only 2 routes qualify as 'frequent.'
- **Today's routes are largely indirect:** Passengers prefer to travel in straight lines. Strætó should straighten these out.
- **No grid in today's network:** Today's routes do not form a grid in the dense area. They should form more of a grid of services so anywhere can be reached with a maximum of one transfer.
- **Too many of today's routes terminate downtown** at Hlemmur and other sub-centers. Routes should pass through, rather than terminate, in centers and sub-centers to minimize transfers, reduce fleet requirements through interlining, and avoid buses idling downtown on valuable real estate.
- **Today's routes are already relatively direct between most popular trip origins and destinations**, so caution should be used before severing these routes and creating needless transfers and increased fleet requirements.

The proposed Strætó network addresses most of these concerns and additionally takes into consideration the planned BRT infrastructure. Specifically, the proposed bus route restructuring:

- **Frequent network:** Creates a network of 7 high frequency services

- **Mostly straight routes:** Most of the new services are very straight. However, some proposed routes are made needlessly circuitous to terminate at BSÍ despite low projected transfer volumes there. We suggest terminating fewer routes at BSÍ and straightening out these routes. This would allow the services to create more of a grid through the built-up areas of Reykjavík.
- **Routes pass through centers and sub-centers:** Most new routes pass through Hlemmur, downtown, and the sub-centers of Mjódd and Hamraborg without terminating there. This clears the way to turn Hlemmur into a world class public square.
- **Proposed routes are relatively direct between most popular trip origins and destinations** with the exception of:
    - Direct connections to the University of Iceland, particularly from Karsnes/Kopovogur.
    - Old Downtown Reykjavík to destinations along Bústaðavegur
- **Third-Generation BRT service plan:** Borgarlína has state-of-the-art 'third generation' service plans. Most of the routes make good use of the Borgarlína BRT infrastructure and continue beyond the BRT infrastructure where appropriate. We recommend branding Routes A and B as 'Borgarlína' routes, and Route E as a Borgarlína route when the full infrastructure is complete, while allowing, as proposed, several other routes to use the BRT infrastructure for shorter sections. This maximizes the number of passengers who will benefit from the infrastructure investment. However, the recent decision to build the Borgarlína BRT infrastructure in a loop through the University had not, as of yet, led to changes in the service plan, so currently there are no services using much of this infrastructure.

The Service Planning chapter of the report concludes with an endorsement of many of the proposed routes but recommends a few specific changes to reduce the indirectness of route caused by the decision to terminate so many routes at BSÍ. It also makes a few specific suggestions that would take better advantage of the proposed loop of Borgarlína infrastructure through the University. BRTPlan's proposed changes are shown in Figure 1 below.

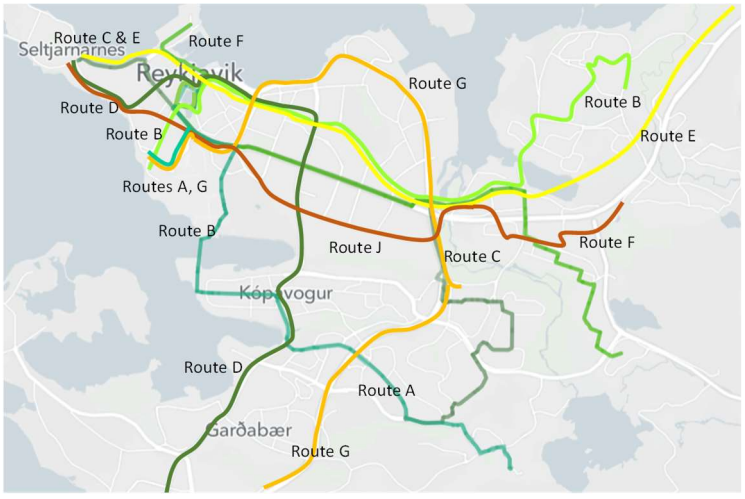

Figure 1. BRTPlan proposed minor modification of Strætó restructured network

Evaluation of Borgarlína Conceptual Design

BRTPlan endorses the Design Guidelines articulated in the Conceptual Design report as consistent with best practice. The standard cross section calls for a central-median aligned busway with stations to the

right of the bus as shown in Figure 2 below. Station sizing is generally a minimum of 3.5 meters wide by 26 meters in length. The standard design also calls for the station platforms to be level with the bus floor, for ease of entry. It calls for restricting left turning movements across the busway where possible, and it calls for bike lanes throughout the corridor on both sides of the road. This is all consistent with BRT best practice.

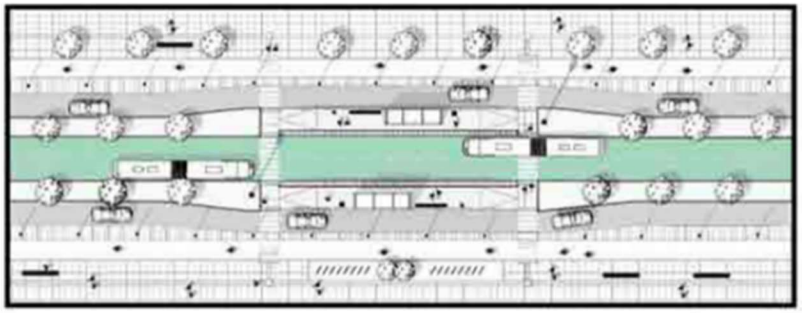

Figure 2. Borgarlína aerial view

The design guidance would benefit from further clarification on the intended fare collection mechanism. Best practice is to collect or validate fares off-board the bus in a pre-paid zone at the entrance to the bus station. This allows for high-speed boarding through all doors simultaneously. The fare payment/validation procedure must be decided on as it significantly affects bus delay and station design decisions.

A few more detailed recommendations are worth highlighting here:

- **Need to streamline the transfer at Vogabyggð** is the most important transfer point in the system with Routes B, C, E, F, G and J connecting there. Getting all of these routes to have a fast and convenient at-grade transfer in a location that minimizes diversion of the route and integrates with the planned surrounding development is critical. Currently only limited guidance is provided.
- **Off-board fare collection** is critical to speeding up buses and avoiding station saturation at Hlemmur, Lækjartorg and the Hospital. Otherwise, passing lanes will be needed at these stations. The method should be clarified in the Conceptual Design report.
- **Design Hverfisgata as a bus-only street.** Borgarlína would be faster and more reliable if Hverfisgata were designed as a bus-only street rather than as a one-way busway and one-way mixed traffic. Specific exceptions could be made for parking garage access.
- **Dedicated busway around Lake Tjörnin.** A dedicated busway should be possible in a one-way loop around Lake Tjörnin with innovative traffic management and would save time for buses.
- **Geirsgata spur.** A spur of Borgarlína infrastructure along Geirsgata, which has an accommodating cross section for upgrading to BRT, would complement the new development and touristic emphasis in the port area.
- **Re-evaluate the Suðurgata and Hringbraut intersection.** The Suðurgata and Hringbraut intersection may saturate if converted from a roundabout to a four-phase signal. We suggest a detailed evaluation and an alternative of retaining the roundabout.
- **Consider alternatives to the 5-phase signal at Njarðargata and Hringbraut**. The Njarðargata and Hringbraut intersection is very irregular and may saturate if converted to a five-phase signal. We

suggest a careful evaluation and a possible bus-only flyover of Hringbraut between BSÍ and Njarðargata.

- **Shift the Hospital station closer to Snorrabraut.** The Hospital station is an important transfer point and would be best located as close as possible to Snorrabraut to avoid indirectness of route. It has much higher transfer volumes than BSÍ so it is a higher priority station.
- **Offset stations where right-of-way is limited.** In general, if right of way is constrained, or communities are protesting loss of parking or traffic lanes, etc. it would be possible to regain right of way by offsetting the stations (i.e., they do not need to be directly across from one another). There is no particular downside of offsetting the stations.

BRT Silver or BRT Gold

While there is not enough detail to provide a definitive gold scoring for Borgarlína, from the decisions already taken a minimum silver rating is likely. To reach silver, there must be:

- Off-board fare collection in pre-paid zones at the stations or proof of payment;
- A clean bus specification with a sufficient number of wide doors;
- A state-of-the-art operational control system;
- Stations set back at least 26 meters from intersections where blocks are long enough; and
- Bicycle parking and ideally bike sharing integrated into bus station design.

These factors are likely to bring Borgarlína to BRT Silver. To reach BRT Gold, several additional easily-achievable features are needed, as specified in the conclusion.

Introduction

In 2017, the municipalities which make up the Icelandic Capital Area made the forward-thinking decision to invest in a BRT network for the region. The idea was to create a high-capacity public transport spine which would prioritize moving people over moving cars. Such a system would also help to improve streetscapes and attract new development.

In the summer of 2019, the Borgarlína team asked BRT Planning International, LLC (BRTPlan) to provide ongoing guidance and feedback throughout the conceptual development stages of Borgarlína. BRTPlan has worked on many of the most well-known BRT systems throughout the world and has brought its wealth of experience and technical expertise to the project.

What has resulted is a conceptual design and service for a Gold-Standard BRT corridor, the first in a network which will be transformative for the Capital Area.

Chapter 1. What is BRT?

Bus Rapid Transit (BRT) is a rapid transit system that provides fast and reliable travel to its riders. This service is achieved through a combination of measures, including dedicated bus lanes, off-board fare collection, level boarding, priority at intersections, and other elements such as operational control, real-time information technology and strong branding. Special vehicles and iconic full-featured stations can help make a good BRT system great.

BRT systems have been implemented in many cities around the world. Starting in 2010, a committee composed of the world's leading BRT experts came together to define the common elements of the best BRT systems. The result of this effort, first codified in 2012, is a rating system known as *The BRT Standard.*

Similar to environmental building standards like LEED, *The BRT Standard* scores the quality of BRT. It lays out the essential elements of BRT and provides a framework for engineers, decision makers, and community leaders to compare their own system or plans against best practices. *The BRT Standard* uses design characteristics that have been proven to correlate with enhanced performance and superior customer experience in a wide variety of circumstances.

A bus corridor must have most of the basic BRT elements illustrated in Figure 1 to qualify as a 'basic' BRT; however, the highest quality BRT systems also have a host of other elements, such as cycling paths along the BRT corridor, bike parking and bike sharing at BRT stations, modern and clean buses, and other elements listed in Figure 2. *The BRT Standard* provides a scorecard and ranks the quality of a BRT corridor using tiers, with gold-standard as the highest quality BRT and silver, bronze, and basic BRT representing successively lower quality.

Figure 3: Five key elements essential for BRT

Chapter 2. What is Borgarlína?

Borgarlína aims to become a gold-standard Bus Rapid Transit (BRT) system that will be the backbone of the Capital Area's urban transport system.

Borgarlína's iconic stations, buses, and service maps will constitute an immediately recognizable brand and will become a permanent part of the Capital Area's identity.

Borgarlína will serve as the catalyst to strategically transform the Capital Area into a sustainable carbon-free urban community, where young and old can embrace lively transit-, walking-, and cycling-oriented lifestyles. It will be a permanent fixture of the region, around which sustainability-focused new neighborhoods can develop.

Its rapid, high quality services will be the chain which links the Capital Area together. Borgarlína's beautiful stations will provide a safe and comfortable experience for waiting passengers in any weather. They will create a sense of place for the surrounding neighborhood, integrating seamlessly into the Capital Area's urban form, while projecting a sense of excitement and newness, a feeling that "something big has arrived".

As a gold-standard BRT, Borgarlína will include fully dedicated lanes, designed in a way that minimizes delay to passengers. It will operate on bus-only streets, creating new urban spaces elevating the importance of the bus in Iceland. It will include off-board fare collection, so that passengers can board quickly, and platform-level boarding so that passengers can board easily. Borgarlína will be accessible to everyone. Buses will run on clean, domestic fuel (electricity, methane or hydrogen). Bicycling will be integrated into Borgarlína stations and corridors, providing a clean, green option for last mile connectivity.

Borgarlína's 'third-generation BRT' services will provide direct connectivity to most key destinations in the Capital Area. Borgarlína vehicles will have the look and feel of light rail on the trunk corridor, then enter mixed traffic to continue to key destinations on or beyond the Borgarlína corridor. For many Icelanders, this will create a seamless, one-seat ride from home to destination.

Borgarlína: 3rd Generation BRT

Since its invention, BRT has been evolving. Before there was something known as BRT, there were bus lanes. These bus lanes lacked most of the features associated with BRT, such as weather-protected stations that one pays to enter, platform-level boarding, and physical barriers protecting the right-of-way. Routes using these bus lanes tended to be which bus routes were already operating there.

First Generation BRT

The first generation of BRT in Brazil, which began in Curitiba in the 1970s, essentially replicated some of the advantages of rail-based systems but using buses. A dedicated corridor was built in the median of the road, protected from mixed traffic by a concrete barrier. Like a metro, passengers entered an enclosed tubular BRT station through a turnstile where they validated their fare payment. Like a metro, the bus pulled up to a platform and passengers entered the bus at-level. At first, there was only one trunk service that ran up and down the BRT corridor. Also, like rail, passengers had to get to and from the BRT station – usually on foot – because the buses only operated on the BRT corridor.

In the United States, the first generation of BRT systems were little more than a limited stop bus route. Due to the availability of federal government funds for BRT projects, many cities began to call bus routes with articulated buses and fewer stops "BRT routes", without making any significant investments in the trunk corridor. This confused people about whether "BRT" was a route designation or a special set of investments in trunk bus corridor infrastructure.

Second Generation BRT

Then, in the early years of the 21st century, a second-generation of BRT systems developed. Trunk-only BRT systems like Curitiba began to include feeder bus routes which brought passengers to new transfer terminals, where they would board the BRT trunk buses. This helped to expand the BRT system's service area. This was similar to what metro systems did when they restructured bus routes to channel more passengers to metro stations. Curitiba evolved to have an extensive network of trunk, feeder, and circumferential routes.

Third Generation BRT

Starting in 2010, a third-generation of BRT systems were developed. BRT system designers realized that unlike a metro that can only operate on tracks, a bus can go on any street. Under third-generation BRT systems, the BRT trunk corridors have all the elements of second-generation BRT, dramatically increasing trunk bus speeds. However, by simply allowing the trunk buses to enter and exit the BRT corridor, third-generation BRT provides a one-seat bus ride to far more passengers and removes the need for expensive transfer terminals. Today's third-generation BRT systems feature multiple bus routes which can enter and leave the corridor at a variety of locations. Special buses must sometimes be procured that can operate effectively both on the BRT trunk corridor and in standard mixed traffic conditions.

Third-generation BRT systems, by greatly expanding the service area of the BRT system without forcing transfers, maximize the number of passengers who will benefit from the trunk corridor investments, while minimizing the infrastructure costs. As such, they are considered the state-of-the-art in BRT planning.

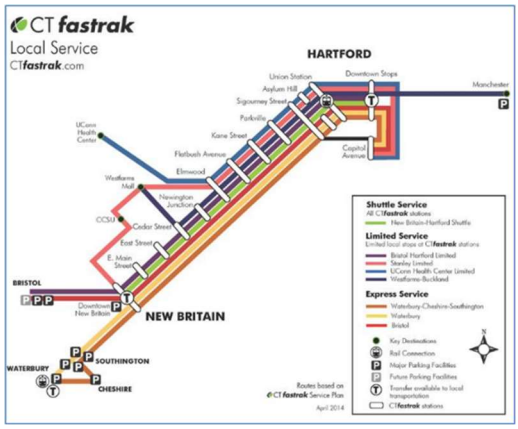

Figure 4. Example of Hartford, Connecticut's third-generation BRT service map

As third-generation BRT systems deliver more value for money, the Borgarlína BRT has been designed as a 3rd generation BRT.

Chapter 3. The Borgarlína Route Plan

As part of the design of Borgarlína Phase 1, the Borgarlína Team, together with Strætó, has redesigned the Strætó network. The goal, as we understand it, was twofold:

1. To bring as many routes as possible onto portions of the Borgarlína Phase 1 corridor so as to increase the number of beneficiaries; and
2. To use the opportunity created by Borgarlína Phase 1 to restructure the rest of the network.

BRTPlan was asked to review and comment on the new bus network plan proposed by Strætó, specifically as it relates to the Borgarlína Phase 1 corridor.

We endorse the approach taken by Strætó which makes needed changes to their entire network, while taking the maximum advantage of the planned new Borgarlína infrastructure, using third-generation BRT service planning. This will allow many riders, with many destinations, to benefit from Borgarlína, rather than just those who have origins and destinations along the Borgarlína corridor.

As there has been ongoing dialog with Strætó, many of our suggested minor modifications have already been addressed. This report contains both a summary of our more significant comments – some of which have been addressed and others of which have not – as well as a few additional new suggestions that were only possible after the receipt of some additional information.

In the sections to follow, we describe our process for analyzing each proposed route, as well as our proposed modifications.

Analysis of the existing network

In order to assess the proposed services, we start by analyzing the existing network. Our analysis is based on both the existing structure of the routes and the ridership and origin-destination data made available to us. This included:

- Existing boarding and alighting data per station (Strætó)
- Estimated 2019 daily demand per route, boarding and alighting per route per bus stop
- Estimated 2024 daily demand per route boarding and alighting per bus route per bus stop
- Estimated 2024 Transit OD Matrix (daily volumes)

To analyze origin-destination data, we used the 2024 modeled data provided by COWI (as above), which aggregates trips into zones as shown in the map below:

Figure 5: Detail of model analysis zones used by COWI in BRTPlan-analyzed 2024 OD Matrix

Since some of the zones had zero or near-zero trips, we aggregated numerous zones into districts and neighborhoods to manually assign them to routes. The areas which were aggregated to serve as our principal focal points of the OD matrix were:

- Hlemmur
- Downtown / Lækjartorg
- Kopavogúr / Hamraborg
- University of Iceland (HÍ)
- Seltjarnarnes and Grandar
- Port District

From this data, we were able to provide a diagnosis of the existing network.

Why start with an evaluation of the existing route network

While it is often a useful exercise to develop a new route network based on a 'clean slate', it is equally, if not more, important to fully understand the existing route network, what works well and what doesn't. People are familiar with the existing route structure, for better or worse. Changes should not be made unless they are going to bring large enough benefits to justify the effort required to change them and the confusion it will cause among the public. For this reason, we generally start a route restructuring with an evaluation of the strengths and weaknesses of the existing route network. Therefore, as a precursor to reviewing Strætó's proposed bus network, we first evaluated the existing Strætó network.

Today's network is radial in nature, roughly oriented towards four main areas: Hlemmur, Hamraborg, Mjódd, and Artun.

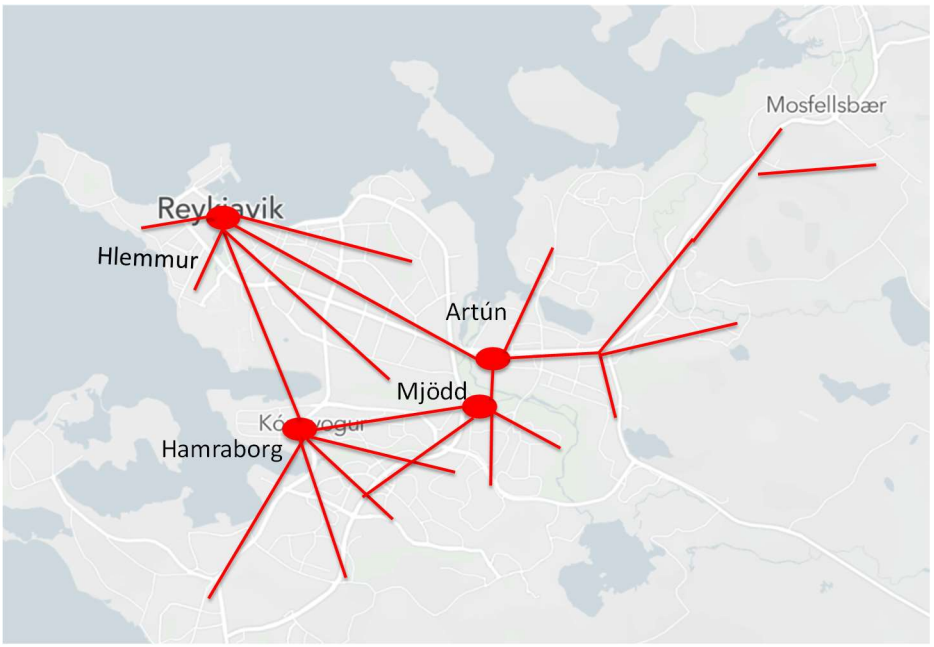

Figure 6: The existing Strætó network is radial from roughly 4 terminals

Figure 6 above depicts in a stylized manner the current structure of the route network. Many bus routes converge at these four terminals, where many passengers then transfer to other lines to complete their journey.

Creating a 'Frequent' Network

Most experts agree that a network of higher frequency bus routes, where passengers can rely on a bus coming in a reasonable amount of time at any time of day, is key to building bus patronage.

A frequent bus network includes those routes with frequencies of ***6 or more buses per hour***, or with headways 10 minutes or less, as shown below, with services continuing at this frequency into evenings and on weekends.

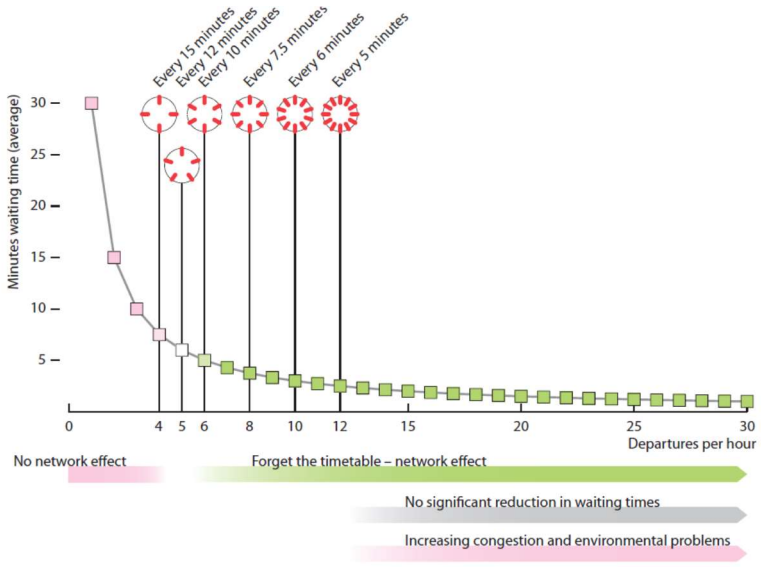

Figure 7. Figure illustrating at what level of frequency passengers no longer need to rely on a schedule

With limited budgets, this may require cutting back on some services to lower demand areas. Jarrett Walker and others point out that when people choose to live in lower density areas, this choice has some benefits (more sunlight and space) but comes with a cost (less frequent transit). Otherwise, people living in higher density, transit-oriented neighborhoods end up subsidizing the residents of lower density areas.

The current bus network in Reykjavík only has two routes with headways of 10 minutes or less (Routes 3 & 4) and none of the off-peak routes are more frequent than every 30 minutes.

In Table 1 below, the current ridership on each route is compared to the current frequencies on each route.

A rough estimate of the demand-based headway (i.e., the headway that would be needed to serve the existing demand) was then calculated.[1] There is one route – Route 1 – where the projected 2024 demand-based headway would be very slightly shorter than the current actual headway, but for all other routes the actual headways are shorter than the demand-based headway.

[1] Standard parameters were used: the maximum load on the critical link was estimated using a renovation factor of 1.5, the peak hour about 1/10 of this, divided by 75 passengers per bus yields a rough estimate of demand-based frequency

Route Name	Current Min Headway	Current Max Headway	Total daily boardings	MaxLoad	Demand based Frequency'	Demand-based Headway	Difference
1	10	30	7,330	489	6.52	9	-1
6	10	30	4,412	294	3.92	15	5
8	10	10	240	16	0.21	282	272
2	15	30	3,450	230	3.07	20	5
3	15	30	2,854	190	2.54	24	9
4	15	30	3,247	216	2.89	21	6
5	15	30	2,942	196	2.62	23	8
11	15	30	4,173	278	3.71	16	1
12	15	30	4,212	281	3.74	16	1
13	15	30	2,280	152	2.03	30	15
14	15	30	2,531	169	2.25	27	12
15	15	30	3,538	236	3.15	19	4
18	15	30	2,539	169	2.26	27	12
21	15	30	962	64	0.86	70	55
28	15	30	822	55	0.73	82	67
31	15	30	345	23	0.31	196	181
36	15	15	284	19	0.25	238	223
7	30	30	509	34	0.45	133	103
16	30	30	971	65	0.86	70	40
17	30	30	1,299	87	1.15	52	22
22	30	30	96	6	0.09	700	670
23	30	60	135	9	0.12	502	472
24	30	60	2,587	172	2.30	26	-4
43	30	30	207	14	0.18	325	295
44	30	30	200	13	0.18	338	308

Table 1. Existing routes, demand and frequency

It does appear, therefore, that the establishment of a backbone 'frequent' network would help increase transit patronage in Reykjavík.

Routes should be straight

As Jarrett Walker points out[2], the fastest routes tend to be straight. There are other factors as well that will affect route speed, such as traffic bottlenecks, road conditions, or topographical features, which should also be explored at a more detailed level of analysis, but as a first pass, straight is good. It is therefore a reasonable starting point to evaluate how straight the bus routes are and if they are not straight, to understand why.

In today's Strætо network, many of the routes are not straight. One of the main reasons for this is that they terminate at Hlemmur where there is space for the buses to lay-over (Figure 8 below). This does facilitate transfers at Hlemmur but adds considerable indirectness of route and needless additional bus kilometers.

[2] Walker, J. *Human Transit: How Clearer Thinking about Public Transit Can Enrich Our Communities and Our Lives*. Island Press, Washington, D.C., 2012, p.44-48.

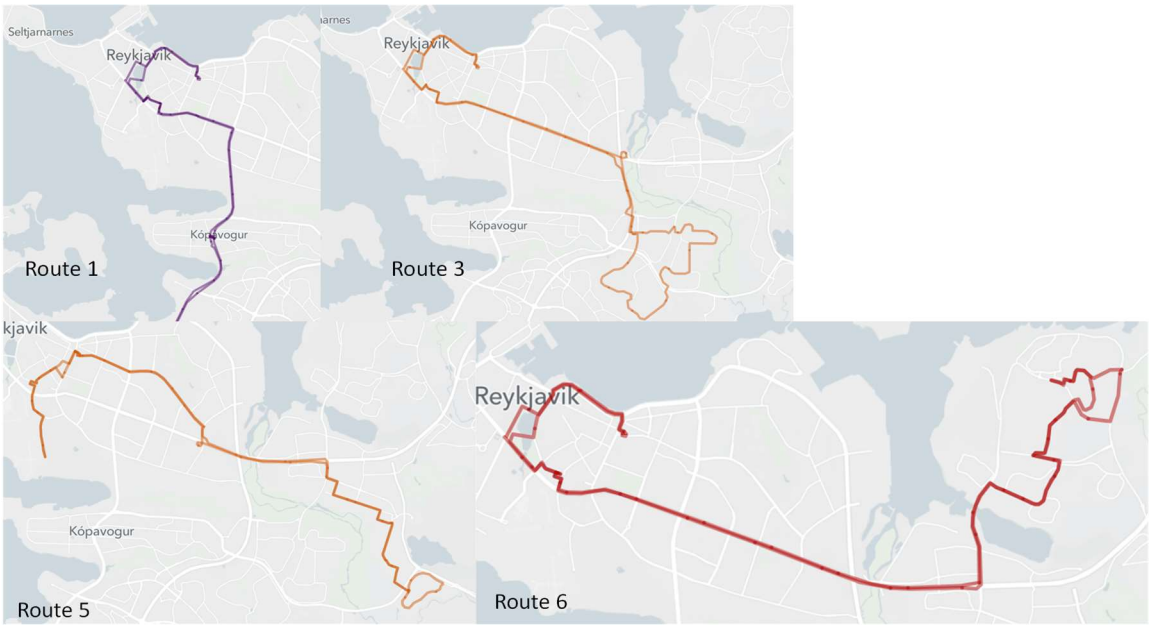

Figure 8. Current Strætó Routes that are not straight because they are passing through or terminating at Hlemmur

Many other routes are not straight for no apparent reason, as shown in Figure 9.

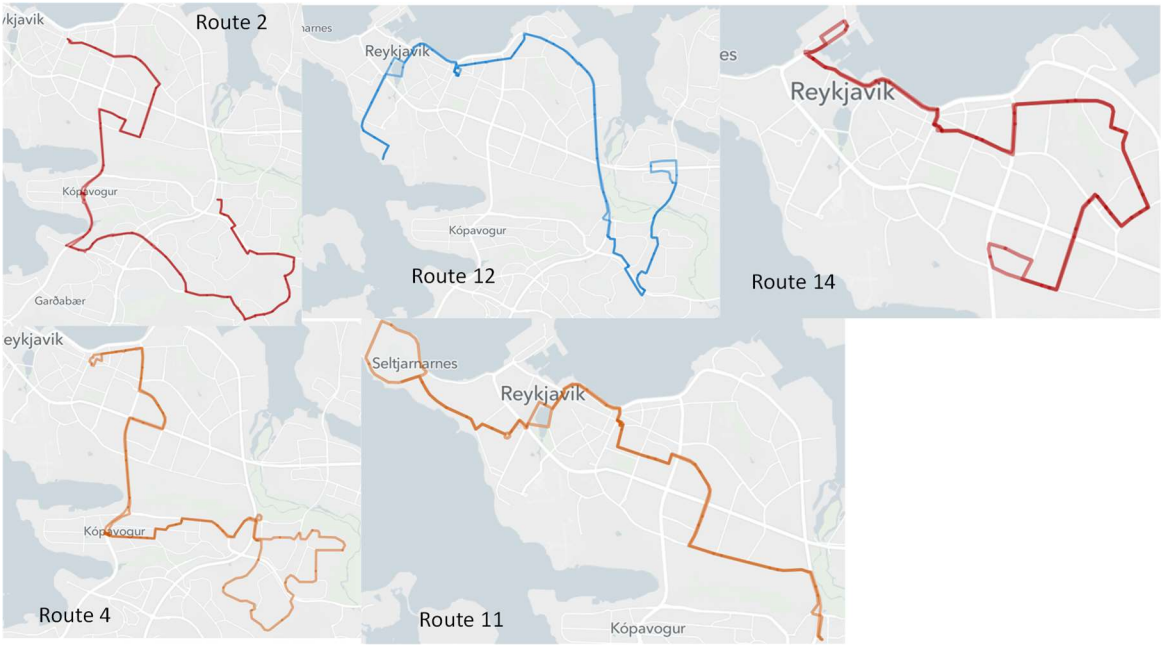

Figure 9. Major Strætó routes that are very indirect for no obvious reason

There are sometimes justifications for "U" shaped routes, where two routes have been interlined through an urban core or subcenter, for instance, but the reasons for this irregularity are not immediately apparent.

As part of route restructuring efforts, **we recommend the following**:

- **Calculate the passenger kilometer index** (total passengers per day divided by total km operated per day) to determine how efficient the current routes are.
- **Look at link-loads route per route to understand why these routes are shaped like this.** It is hard to imagine that they are particularly efficient.

Routes through denser urban areas should form a grid

Nielsen and Mees[3] point out the advantages of a grid pattern of frequent bus services, at least for the built-up areas of cities. In a grid, bus services are all straight, and every passenger can reach their destination anywhere in the built-up part of the city with only one transfer. The elasticity of demand with respect to frequency is not so high on a route-specific level, but the elasticity of demand matters greatly when passengers must transfer to complete their trips. In the built-up areas of a city, within which there is roughly a random mix of trip origins and destinations, a grid pattern of services is a reasonable starting point for analysis.

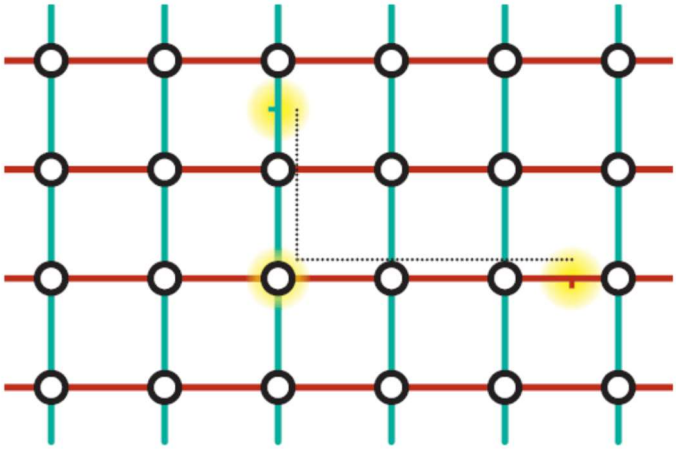

Figure 10. "Squareville" example: where a major city has a grid pattern of bus services

The same authors generally indicate that this grid of services should be roughly 800 meters apart, allowing roughly 400 meters of walking as the maximum to the nearest bus stop.

If, on the other hand, some OD pairs have much higher volumes than others, it may make sense to run a few services in "L" shapes to avoid needless high-volume transfers.

[3] Gustav Nielsen, et.al. 2005. *HiTrans Vol. 2. Best Practice Guide: Planning the Networks*; Mees, Paul., *Transport for Suburbia: Beyond the Automobile Age*. Earthscan, London, 2009

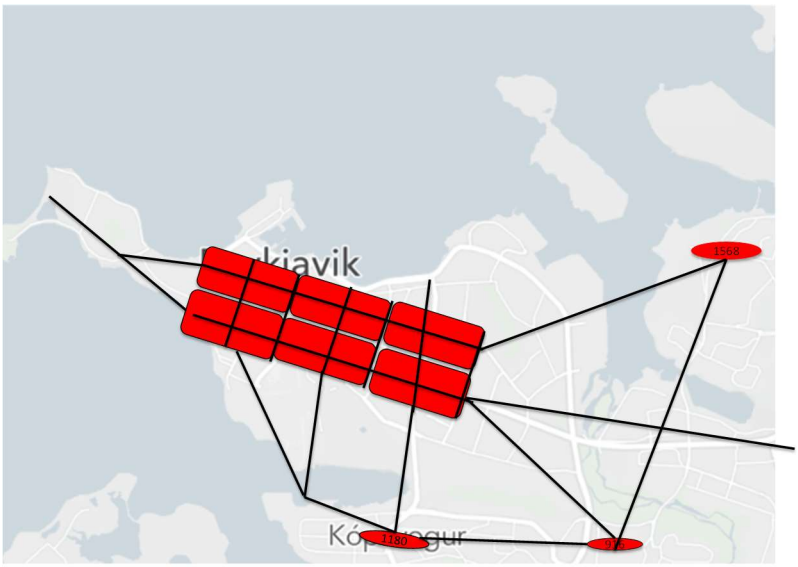

Figure 11: High-level service concept for the Capital Region

Figure 11 above provides a rough illustration of what a grid pattern might look like in the Capital Area. Because the Western side of the area shown in Red has higher volumes of trip origins and destinations, some "L" shaped routes may make sense into this area.

As can be seen from Figure 12 below, the most frequent routes in the Capital Area with headways of 12 minutes or less, the routes do not form anything like a grid.

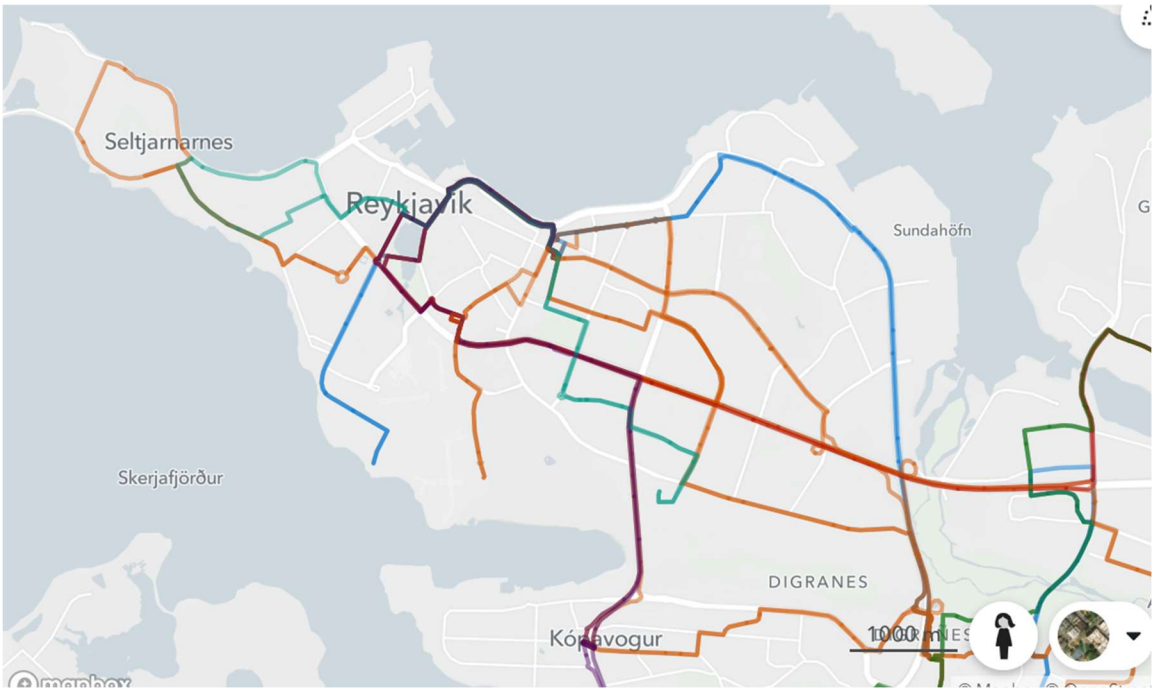

Figure 12. Downtown Reykjavík Routes with headways of 12 minutes or less

Creating a grid of routes through the denser part of Reykjavík is not easy, as there are topographical features such as inlets, bays, and wetlands that interrupt a natural grid pattern. Nevertheless, it does

appear that some efficiency might be gained if routes were straightened out and distributed in more of a grid pattern. Such ideas would need to be tested in the transit model.

Routes should pass through downtown rather than terminate downtown

Passengers headed downtown do not want to be forced to stop at the edge of downtown and then transfer to another bus or walk a long way to reach the other side of downtown. This problem is solved by interlining services through downtown. As shown earlier in Figure 8, a large number of routes terminate at Hlemmur. There is no advantage to having large numbers of buses idling on top of some of the city's most expensive real estate. As shown earlier, more than 1,000 passengers are transferring at Hlemmur.

These routes are, for the most part, serving two distinct transport markets. They are primarily serving passengers approaching downtown from two different directions.

If one route is approaching the downtown from the south, and another route is approaching from the east, and the maximum loads on the two routes are similar but in different locations (for example, at the approach to downtown from the south, and the approach to downtown from the east), these routes can often be beneficially interlined and turned into a single route. Interlining services with similar loads allows operations to reduce fleet requirements and reduce the frequency of routes overlapping downtown so that the roads and bus stops are less saturated.

It is also possible that some of the transfers occurring at Hlemmur could be avoided if more routes passed through downtown rather than terminating there.

Services should directly connect highest volume OD pairs

Bus routes should be as straight as possible, connecting the highest volume trip origin and destination pairs as efficiently as possible.

30 years ago, it was believed among transport planners that 'trunk-feeder' route structures are more efficient because larger vehicles could be used on the long-haul runs. In recent years, there has been a reappraisal of trunk-feeder routing structures in favor of more direct services. This has occurred because in most real world scenarios, the efficiency advantages of larger vehicles on consolidated trunk routes are not enough to offset the inefficiency that results from the inconvenient transfer, the indirectness of routes caused by pulling them off their normal route to a common transfer point, the generally higher fleet requirements, and the costly need for efficiently located transfer terminals.

The existing route network is not particularly direct, but the utmost caution should be used before splitting existing routes into trunk services and feeder services.

Strætó's proposed network

Strætó's proposed network redesign remains a work in progress. Several iterations have already been developed and discussed with stakeholders and several of them have been modelled. This network restructuring effort predates the development of the Borgarlína concept but has been harmonized with Borgarlína planning efforts.

BRTPlan's evaluation of the proposed Strætó network is based on what we believe to be the network called 'Scenario III' which was developed in March and April of 2020. The system evaluated is in the following file: (https://platform.remix.com/map/808de1f?latlng=64.12978,-21.91175,12.064)

It is possible that some modifications have been made since then.

BRTPlan performed an analysis of this Strætó-proposed network plan based on the criteria outlined above, and in the spring of 2020 made recommendations for modifications. BRTPlan's revised and recommended service plan from that time is available at the following Remix link: https://platform.remix.com/map/d675e29?latlng=64.13711,-21.97853,12.114. Since that time some additional information has become available. This document mainly describes our earlier comments with some minor modifications in light of new information received.

Strætó created a 'Frequent' Network

Route	Total boardings	Maximum Load Estimate	Proposed Min Headway	Proposed Max Headway	Demand-based Headway, 18 M	Demand-based Headway, 12 M
A	7,744	516	10	15	14.53	8.14
B	11,261	751	10	15	9.99	5.59
C	7,736	516	10	15	14.54	8.14
D	9,935	662	10	15	11.32	6.34
E	10,605	707	10	15	10.61	5.94
F	11,772	785	10	15	9.56	5.35
G	10,714	714	10	15	10.50	5.88
H	2,605	174	15	30	43.19	24.18
I	2,800	187	15	30	40.17	22.50
J	3,716	248	15	30	30.27	16.95
K	4,550	303	15	30	24.72	13.84
L	2,363	158	15	30	47.61	26.66
N	1,507	100	15	30	74.66	41.81
O	2,443	163	15	30	46.06	25.79
P	530	35	15	30	212.24	118.85
R	490	33	15	30	229.80	128.69
S	348	23	15	30	322.97	180.86

Table 2. Strætó proposed network headways

As shown in Table 2 the proposed Strætó network establishes a clear 'frequent' network of 7 routes with policy-based headways of 10 minutes during the peak and 15 minutes during the off-peak. It is supplemented with a network of non-frequent routes with a peak hour minimum headway of 15 minutes and an off-peak minimum headway of 15 minutes. This is consistent with best practice.

We estimated the demand-based frequencies in the following manner. We took the model-based 2023 boarding volumes and estimated the MaxLoads using a standard value of 1.5 for the renovation rate (total boardings/MaxLoad on the critical link). We then divided the MaxLoad by either 70 (for a 12-meter bus) or 125 (for an articulated bus). There is a reasonably good correlation between the proposed frequencies and the demand-based frequencies. Either 12 meter or 18-meter buses would work.

Some of the proposed routes are straight, others could be straighter

As most people do not want to travel in circles, bus routes are usually the most efficient if they are more or less straight. Of the proposed frequent routes, Routes A, C, and F are all quite straight (Figure 13).

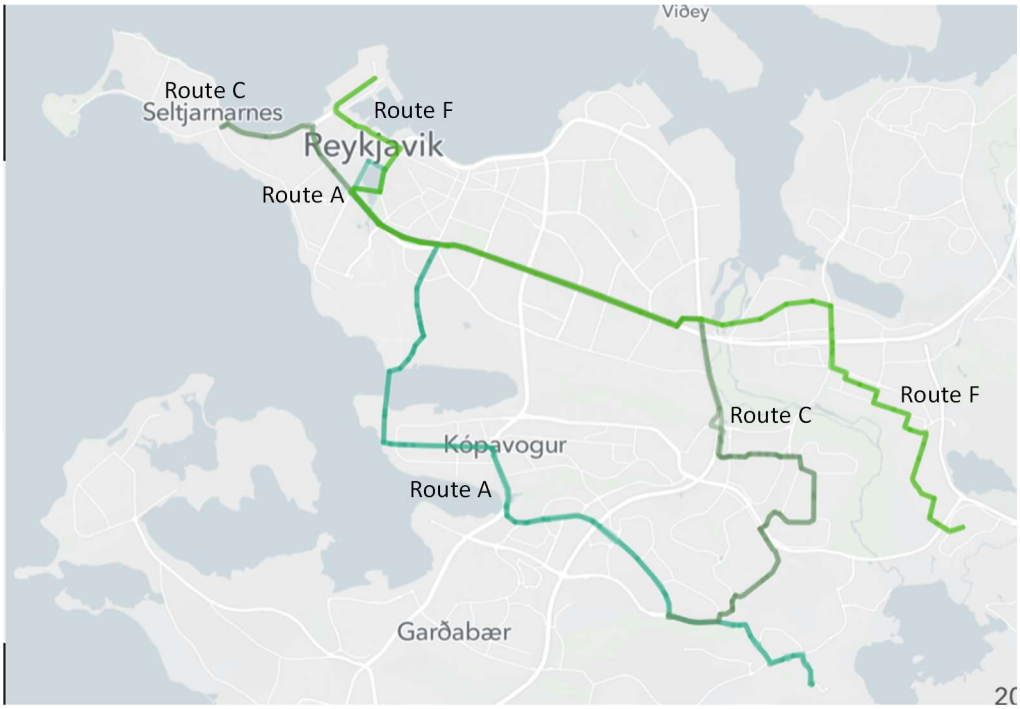

Figure 13. Proposed bus routes A, C, and F are quite straight and direct

Routes B, D, and E are also straight except for the detour they make to terminate at BSÍ.

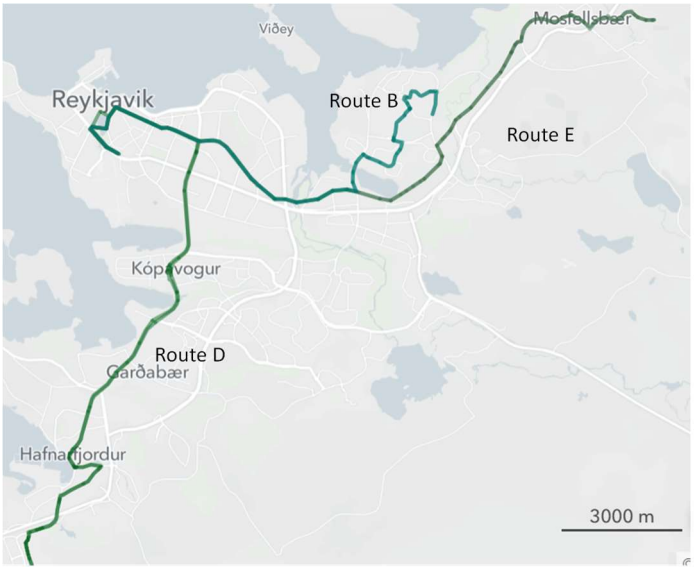

Figure 14. Routes B, D, and E are all straight except for the connection into BSÍ

As passengers can connect to other routes at many other stations along the route, this curving connection to BSÍ seems to needlessly add revenue kilometers, while saturating the trunk BRT corridor through downtown with more frequency than justified by the demand. For example, Routes A, B, C, D, E, F and G all use the section of Hringbraut between the National Museum of Iceland and BSÍ, though few of these routes are carrying any passengers on that length. According to the model, far more people transfer at the Hospital station than at BSÍ.

Frequent Route G (Figure 15) is nearly circular. A closer evaluation of the ridership pattern on Route G is necessary. It has high overall ridership, as projected by the model. It seems to function as a fairly direct connection between Hamraborg and Mjódd, interlined with a direct connection between Mjódd and Sundahofn/Laugarnes, interlined with a direct connection to the University. As Mjódd is a sub-center, we would not want to sever the route there. As such, the route seems ok as it is.

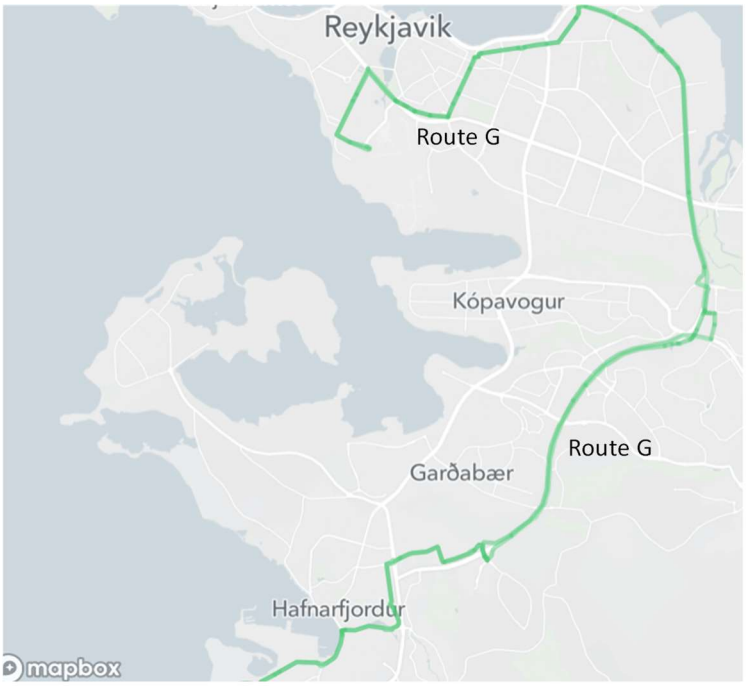

Figure 15: Frequent Route G is circuitous and should be further investigated

Of the standard (non-frequent) routes, Routes H, I, L, and O are reasonably straight.

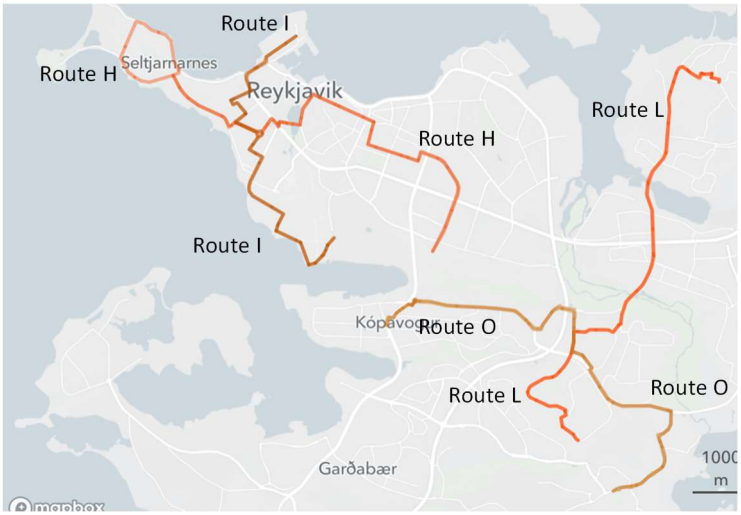

Figure 16. Standard routes H, I, L, and O are reasonably straight

Standard (non-frequent) Routes J, K, M, and N (Figure 17) are all quite indirect. Route J is straight but makes a diversion to the planned transfer terminal at Vogabyggð and the underlying road network is

also incomplete. Routes M and N seem needlessly indirect and should be investigated with a closer look at the link-loads (the number of passengers on board between each station stop) to better understand how these routes would function. Route K fills a few gaps in the network, but it does not follow any natural OD pair and should be further investigated at the link-load level.

Figure 17. Routes J, K, M, and N are quite indirect

Routes through downtown Reykjavík do not form a grid

This section assesses the degree to which the proposed Strætó network improves on the network grid in the downtown area.

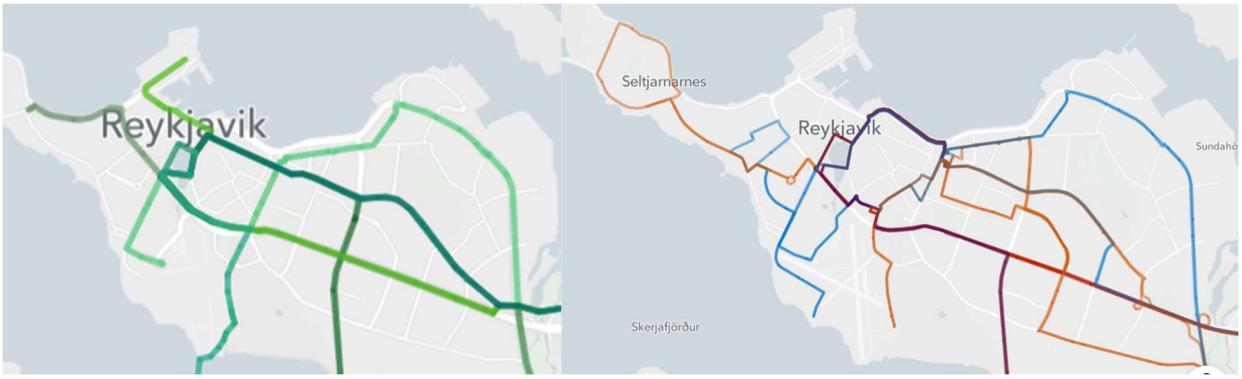

Figure 18: Proposed 'frequent' Strætó network (left) and existing Strætó network (12-minute headways or less), Central Reykjavík

Differences between the proposed Strætó 'frequent' network (Figure 18 above left) and the existing frequent services with headways of 12 minutes or less (Figure 18 above right) are compared above. The existing network has a greater density of routes. Its grid is interrupted by the narrow streets of historical downtown, and various inlets and bays.

Figure 19. Proposed full Strætó network (left) and full existing network (right)

The proposed Strætó network forms a better grid when all of the routes are considered, though the existing grid is denser.

Most, but not all, routes pass through downtown or sub-centers

Previously, most of the Strætó routes terminated at Hlemmur. This left numerous buses idling in the very commercial heart of Reykjavík. With plans to turn Hlemmur into a public plaza, several of the newly planned Strætó routes pass through the downtown but terminate at points beyond the downtown, in Seltjarnarnes, the University of Iceland, and the port area.

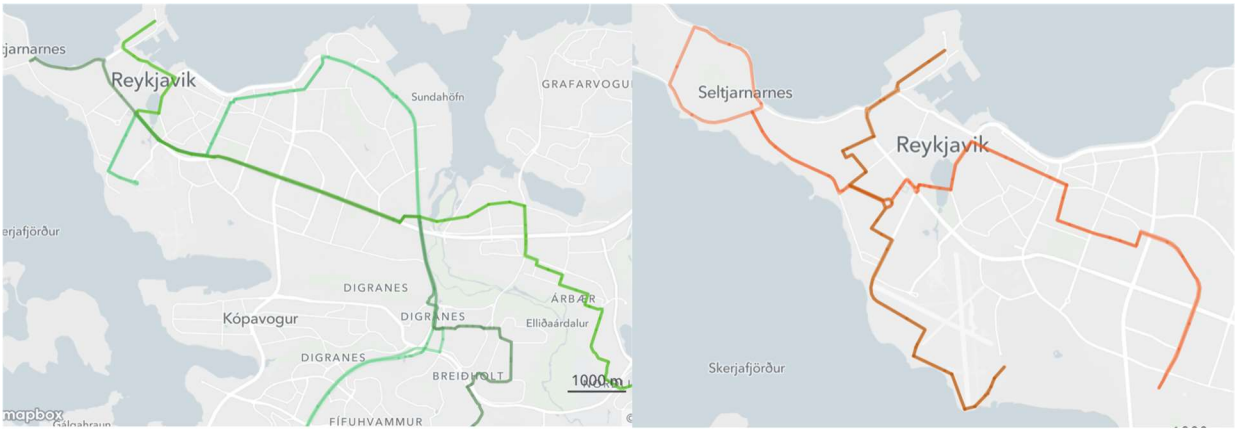

Figure 20. Frequent Routes C, F, and G pass through downtown but do not terminate there. Standard routes H and I also pass through the downtown but terminate at points beyond.

Figure 20 above shows frequent routes C, F, and G passing through downtown but not terminating there. It also shows standard (non-frequent) routes H and I passing through downtown without terminating there. Routes C and G also pass through the Mjódd sub-center without terminating there.

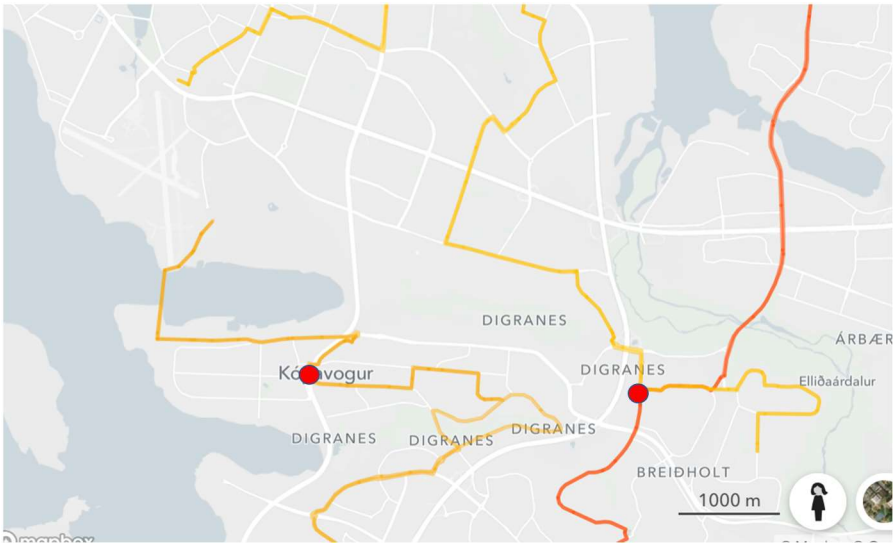

Figure 21. Standard services K, L, and N pass through but do not terminate at the sub-centers Hamraborg and Mjódd

Similarly, Figure 21 above shows that services K, L, and N pass through but do not terminate in the sub-centers of Hamraborg and Mjódd. This is consistent with best practice.

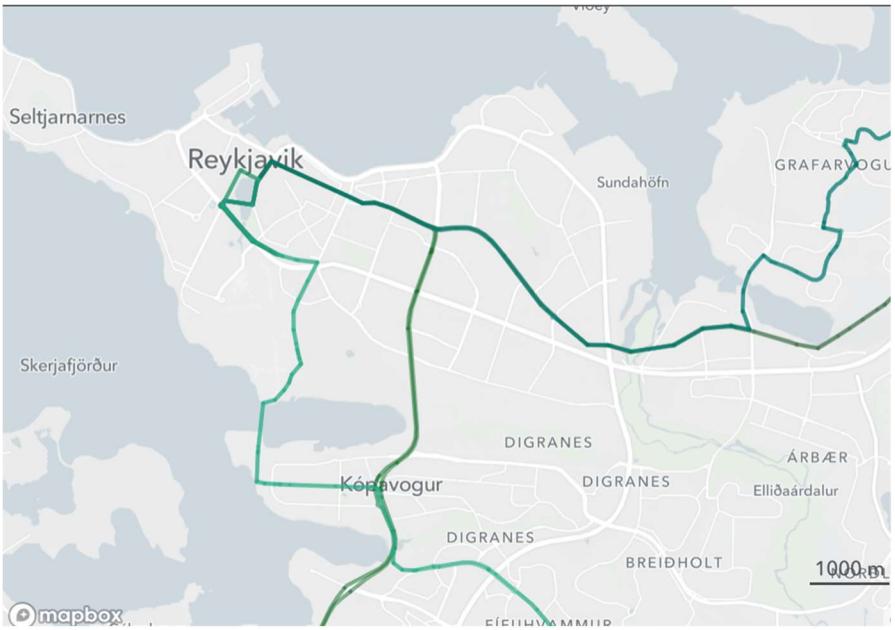

Figure 22. Planned Strætó Routes A, B, D, and E terminate either at BSÍ or circle Tjörnin Lake

Routes A and D also pass through but do not terminate at the sub-center of Hamraborg, which is consistent with best practice. However, Routes B, D, and E terminate at BSÍ, and Route A terminates in a circle around Tjörnin Lake. This is a significant improvement over the current structure, as BSÍ has space to accommodate the laying over of buses in a location that is outside the urban core, and Route A does not need to stop downtown. However, the location of BSÍ is not a natural location for most route termini, so terminating so many routes there leads to significant indirectness of route on several routes, as will be taken up in following sections.

Figure 23. Routes J, K also terminate at BSÍ, and Route O terminates at Hamraborg

Of the non-frequent routes, Route J terminates at BSÍ before reaching downtown, severing some OD pairs. Route K also terminates at BSÍ, but this is a more reasonable route terminus in this case. Route O terminates at Hamraborg. It is worth testing whether this route might be extended.

Routes directly connect some, but not all, popular trip origins and destinations

Popular trip origins and destinations should be connected with direct routes so as to avoid unnecessary transfers, rather than forcing passengers to take feeder routes to a trunk line where they must transfer. To assess how well the proposed network does this, we analyzed the transit OD matrix provided by COWI and created some maps to simplify the results.

Trips to and from Hlemmur area

The area around Hlemmur has the highest concentration of projected trip origins/destinations in Reykjavík. Figure 24 shows that trips originating or ending in Hlemmur most frequently begin in the old downtown of Reykjavík, followed by local trips within the same zone (but to another sub-zone), followed by the area around Laugardalur, then the University, then Kopavorgur, then Mjódd, etc.

Origin	Destination	PPHPD	Best Route	Comment
Old Downtown	Hlemmur	106	B,D,G,H	very good
Old Downtown	University of Iceland	37	many options	fair
Old Downtown	Arbaer	36	F	good
Old Downtown	Karsnes	32	A,D	very good
Old Downtown	Kopavogur	21	A	very good
Old Downtown	Hildaskola Gym	10	F, J to BCD	fair
Old Downtown	Rettarholtsvegur	10	F, J to BCD	fair

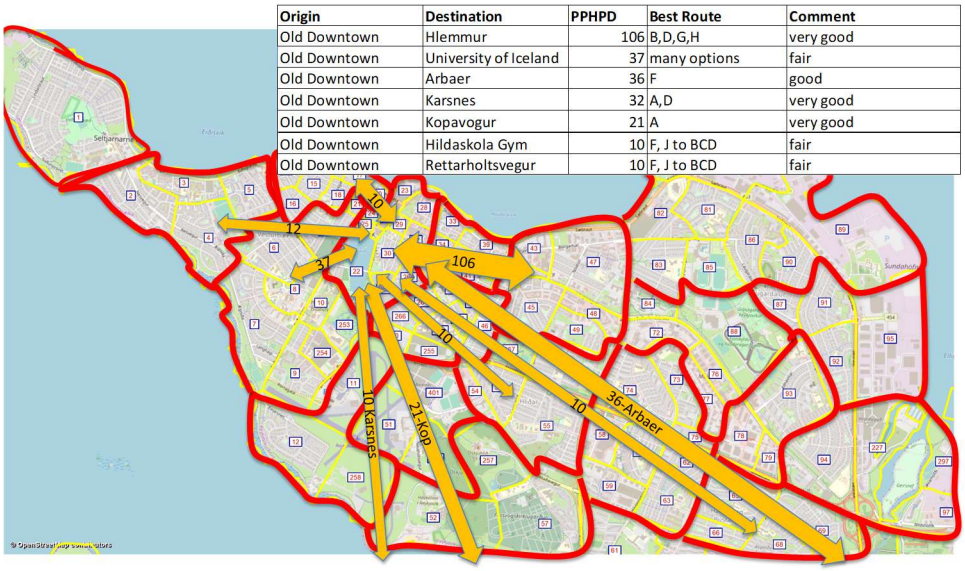

Figure 24. OD pairs to and from Hlemmur zone: Estimated peak hour, peak direction. Reasonably balanced loads approaching Hlemmur allows for interlining through the city center

The relatively similar passenger loads entering the Hlemmur area from the east and west indicates that frequent services can run through the Hlemmur area based on similar load factors. Overlapping of services between Hlemmur and the old downtown make sense as this link is the highest OD pair in the network.

Most OD pairs are well served with the proposed route restructuring. There are plenty of direct connections between old downtown and Hlemmur: Routes B, D, G, and H. This route redundancy makes sense as this relatively short link has a high demand. Between Laugardalur and Hlemmur Routes G and K provide direct connections. Between Hlemmur and the hospital, Route G provides a direct connection. Between Hlemmur and Vogabyggð both Routes B and E provide a direct connection. The only direct connection that appears to be missing is between Mjódd and Hlemmur. One can either take Route G for a one-seat but very indirect ride, or either Routes G or C and transfer at Vogabyggð for Routes B or E. That is not bad, as combined frequencies of all options are quite good (5 minutes) and the volumes are not that high, but it may be worth investigating if the connection can be improved.[4]

Trips to and from Old Downtown Reykjavík

The most popular OD pairs to and from Old Downtown Reykjavík are with Hlemmur (already mentioned), the University area, Árbær, Karsnes and Kopavogúr. The connection with Hlemmur is very good, as mentioned. The connection to Árbær in this scenario is also very good via Route F. The

[4] A direct connection between Mjódd and downtown via Borgarlína is theoretically possible by following the itinerary of Route C from Mjódd to Suðurlandsbraut and staying on Suðurlandsbraut rather than turning onto Miklabraut. It is not currently clear how this connection will be made.

connections to Karsnes and Kopavogúr are excellent with two options, one over the new bridge (Route A) and one via the current route (Route D).

The only connections that are not great are:

- **University:** This trip can be made in multiple ways but all involve some walking. One can either take Route G and walk or transfer to Routes A, B, D, E or F; or one can take Routes A, B, D, E or F and walk. A more direct link between the University and Old Downtown which involves less walking would likely attract some demand.
- **Bústaðavegur:** For destinations along Bústaðavegur, passengers must either walk to Miklabraut and take Route F, or one must take Route J and transfer at BSÍ. It is not obvious why Route J terminates at BSÍ and would seem to make more sense to continue east to complete another link in the east-west grid.

Origin	Destination	PPHPD	Best Route	Comment
Old Downtown	Hlemmur	106	B,D,G,H	very good
Old Downtown	University of Iceland	37	many options	fair
Old Downtown	Arbaer	36	F	good
Old Downtown	Karsnes	32	A,D	very good
Old Downtown	Kopavogur	21	A	very good
Old Downtown	Hildaskola Gym	10	F, J to BCD	fair
Old Downtown	Rettarholtsvegur	10	F, J to BCD	fair

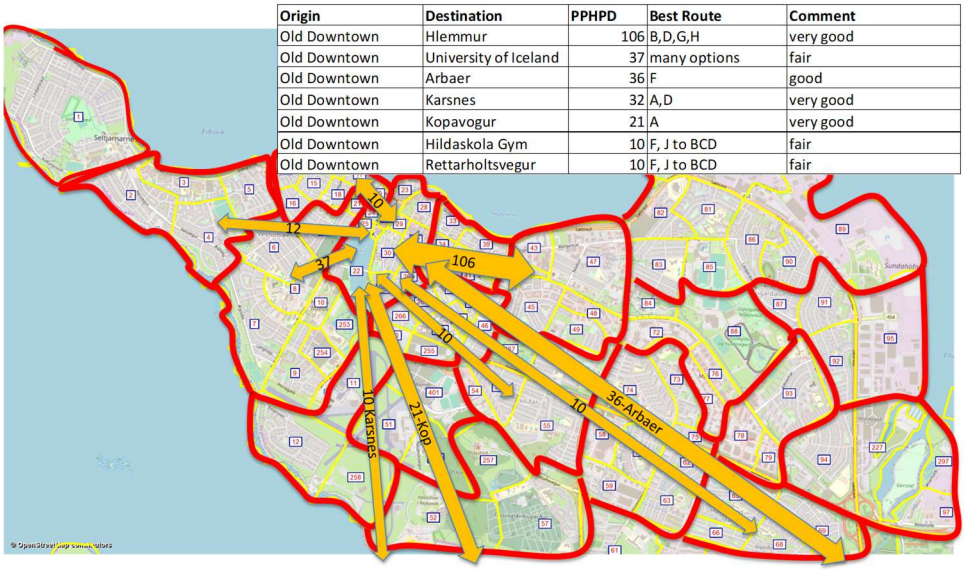

Figure 25. OD pairs to and from Old Downtown

Trips to and from the University of Iceland

Another popular destination for bus passengers in Reykjavík is the University of Iceland. Popular trips to and from the University of Iceland are with Karsnes and Kopavogúr, downtown Reykjavík, Hlemmur, internal to the University Area, Laugardalur and Mjódd.

Origin	Destination	PPHPD	Best Route	Comment
University of Iceland	Karsnes	50	A	fair
University of Iceland	Kopavogur	40	A	fair
University of Iceland	Old Downtown	37	A,B,C,G	fair
University of Iceland	Hlemmur	29	G, B-walk,D-walk	good
University of Iceland	University of Iceland	17	G	good
University of Iceland	Laugardalsvogur	13	G	good
University of Iceland	Mjodd	10	C	fair

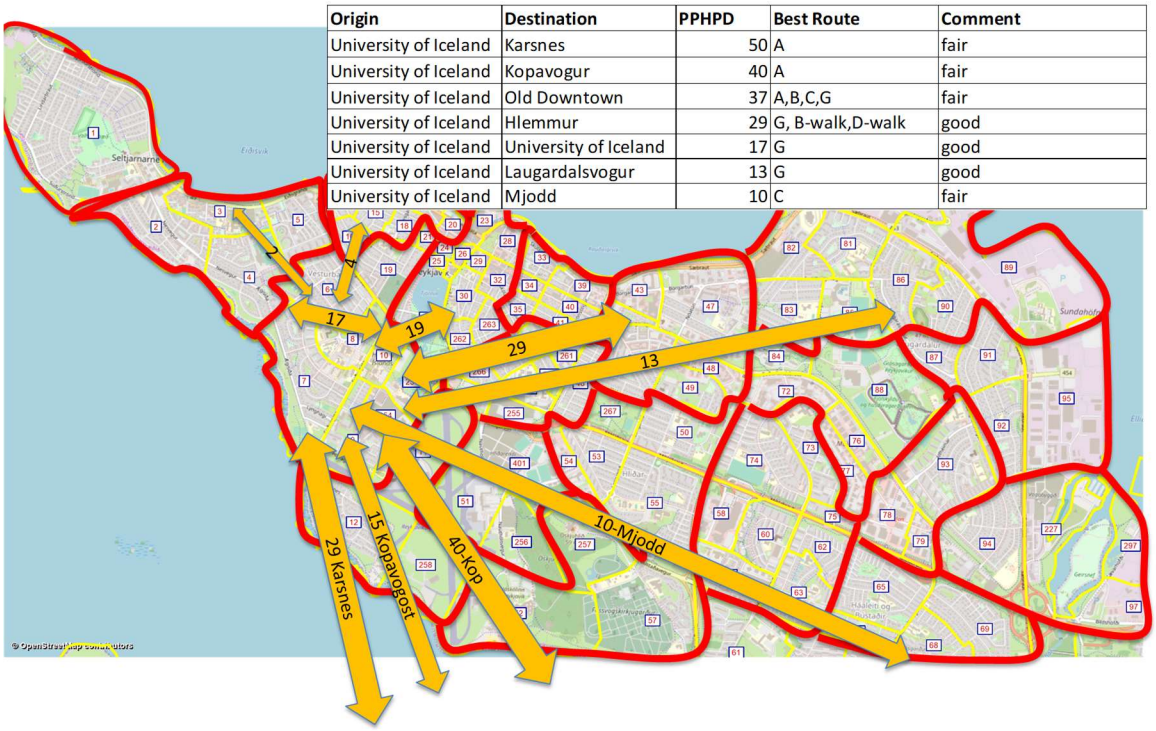

Figure 26: Trips to and from University of Iceland, peak hour peak direction

Of these trips, as has been discussed, trips to Hlemmur, Laugardalur and those internal to the University area can be made easily using Route G and are an improvement over existing services. Trips to Karsnes and Kopavogúr are much better than before because of the new bridge, but still involve either a transfer to Route G or a walk for most trips into the University area. Also, as was discussed above, the trip from the University of Iceland into downtown involve a bit of walking.

In summary then, the following minor alterations to the proposed network, based on the analysis of popular OD pairs, concludes the following:

- Mjódd to Hlemmur
- Old Downtown Reykjavík to the University
- Old Downtown Reykjavík to destinations along Bústaðavegur
- University to Karsnes/Kopavogúr

None of these involve more than one transfer so all of them are ok. **However, more direct connections between these OD pairs should be considered.**

Other popular destinations and their OD pairs were evaluated but the proposed routes performed well and no significant gaps in the network were discovered for any high-volume OD pairs.

The routes take advantage of the Borgarlína corridor whenever possible

Many of the proposed frequent routes will use sections of the Borgarlína BRT infrastructure.

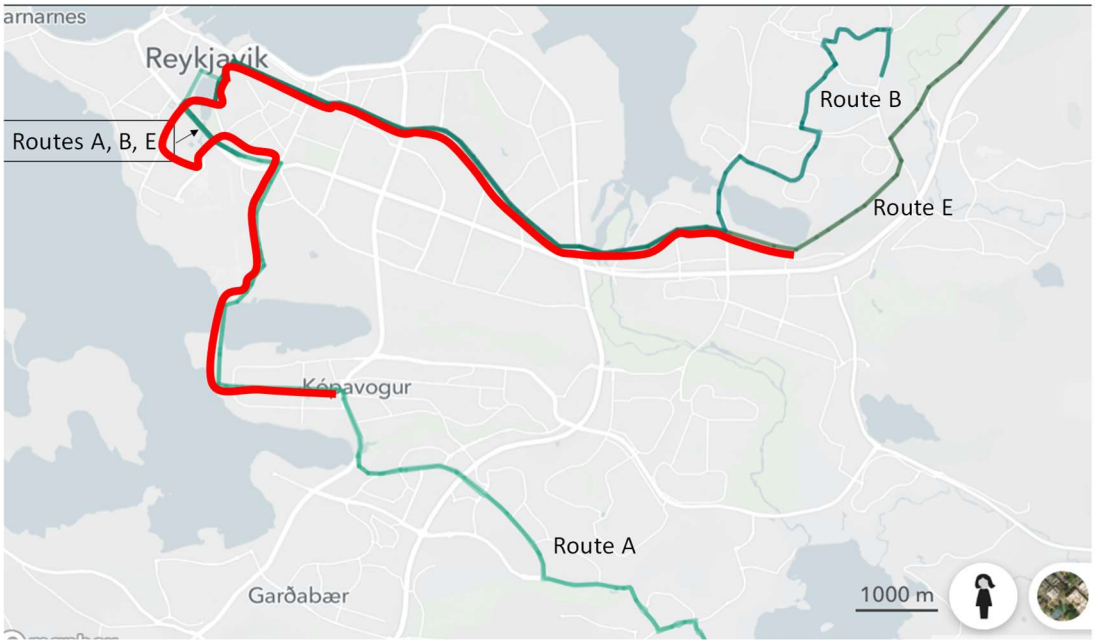

Figure 27. Routes A, B, and E overlap the BRT infrastructure entirely (corridor shown in red)

The decision to route Borgarlína through the University of Iceland and off Miklabraut entirely was relatively recent and Strætó routes will need to be adjusted accordingly. Frequent Routes A, B and E overlap the proposed Borgarlína BRT infrastructure except for the diversion at the University. As is consistent with third-generation BRT system design, these routes continue past the end of the Borgarlína infrastructure.

Also consistent with third generation BRT service design, many of the other routes also overlap the BRT infrastructure for critical sections of their trip. In this way, as many passengers as possible can benefit from the time savings advantages of the BRT infrastructure.

As shown in Figure 28 below, frequent Route C only overlaps the Borgarlína corridor between the Hospital and the National Museum of Iceland roundabout. Frequent Route D only overlaps from Hlemmur through the old downtown, and around to BSÍ. Frequent Route F only overlaps for a short section to make the connection at Vogabyggð and another short section from the Hospital to the old downtown. Frequent Route G only overlaps for the short section between the Hospital and BSÍ.

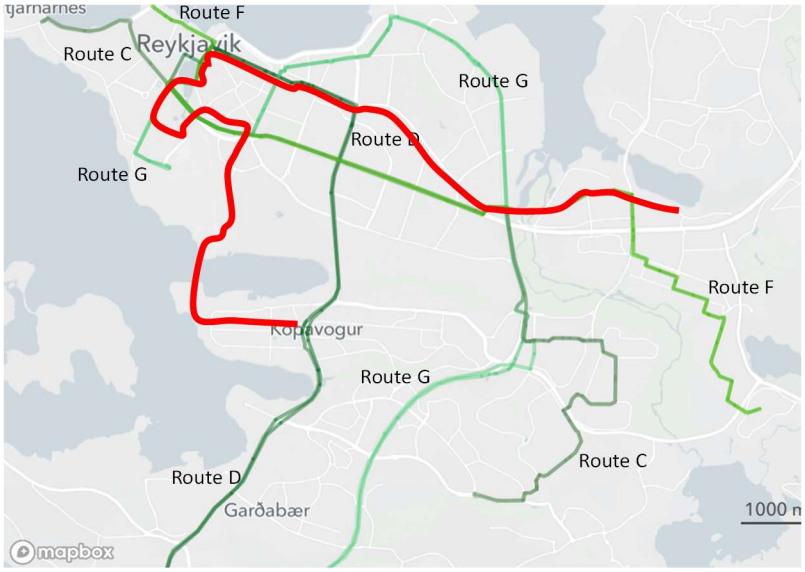

Figure 28. Routes C, D, F and G and their overlap with the Borgarlína corridor

As shown in the figure below, standard (non-frequent) Route J uses the BRT infrastructure only to make the connection at Vogabyggð, and Standard Route H only uses the downtown section of the BRT corridor. Route N only uses the BRT and bike-only bridge between Karsnes and Reykjavík and a short section of that corridor as far as Reykjavík University.

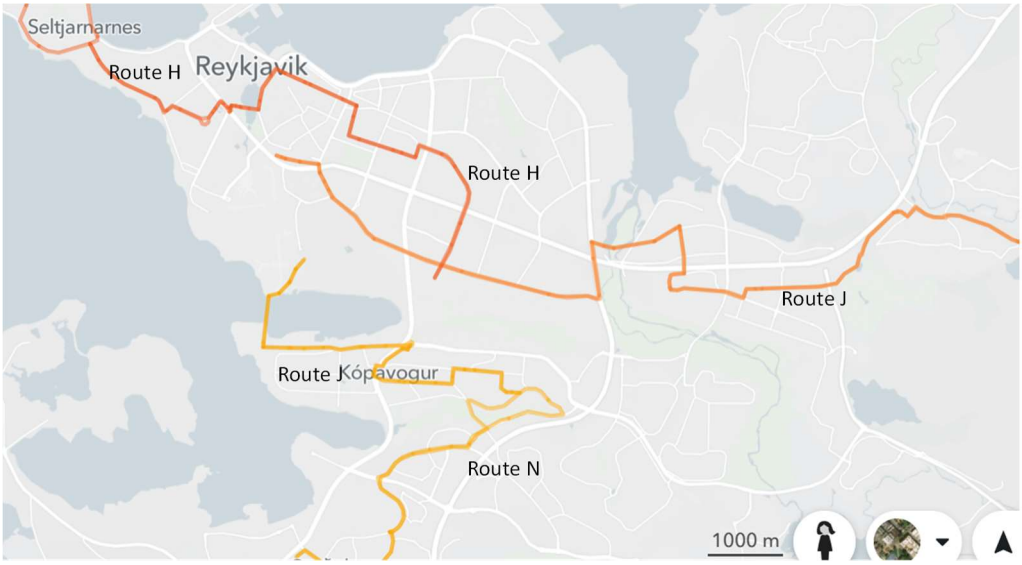

Figure 29. Routes H and J use small sections of the Borgarlína BRT corridor

This seems generally reasonable so as many of the routes as possible can benefit from the BRT infrastructure and dedicated bus lanes.

It does raise the issue of which of these routes should be branded as 'BRT routes' or 'Borgarlína' Routes. It is generally a good idea to give the BRT system something of an identity, possibly with the use of special BRT buses, perhaps articulated buses with special colors etc.

Because Routes A, B and E overlap the Borgarlína corridor for the longest distance, they are the most obvious candidates for special BRT branding.

Some transfer points are superfluous

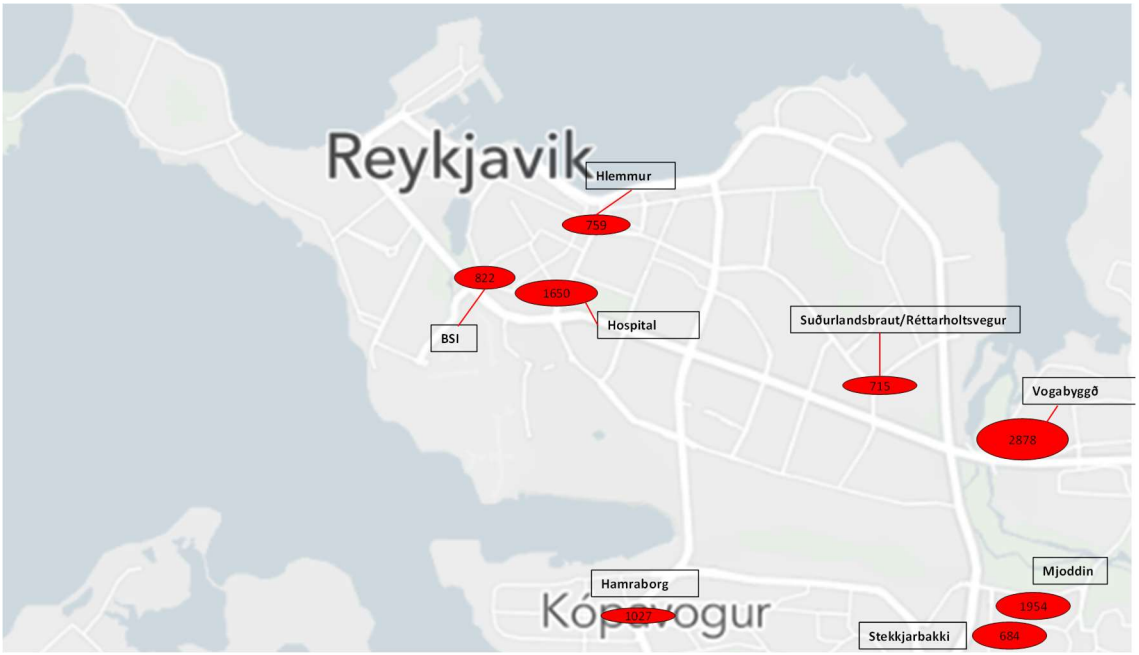

Figure 30. Highest volume transfers, 2024 network

Figure 30 above shows the projected 2024 transfer volumes at the most popular bus stops. These are reasonably modest transfer volumes. The highest volume transfer points, in order of importance, are as follows:

- Vogabyggð
- Mjóddin & Stekkjarbakki
- The Hospital
- Hamraborg
- BSÍ
- Hlemmur

Vogabyggð and Suðurlandsbraut/Réttarholtsvegur

Vogabyggð is at a natural bottleneck. Because of the Geirsnef and Ellithardanur wetlands, there are very few east-west roads. As all east-west routes will need to pass through this bottleneck anyway, it is thus a good place for a transfer. The high volume of transfers at Vogabyggð is probably the result of passengers travelling on Routes B and E that want to reach destinations along Miklabraut transferring to Route F or want to reach destinations along Bústaðavegur transferring to Route J, or passengers on Routes F and J that are bound for Suðurlandsbraut /Laugavegur into the downtown (See Figure 31). The high-volume transfer at Suðurlandsbraut is from passengers transferring from the C to the B and E routes.

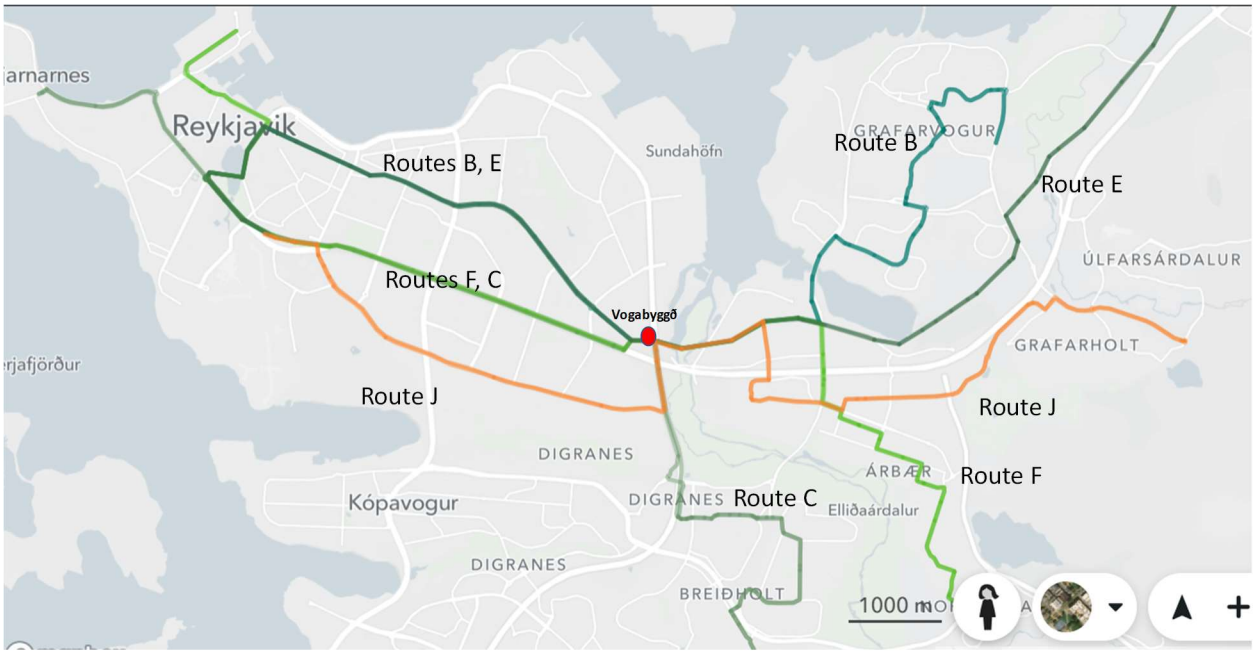

Figure 31. High transfer volumes at Vogabbyd probably due to transfers between the B, E, F, and J routes

It may be possible to reduce somewhat these transfer volumes by testing whether Route E or B would have fewer transfers if it continued onto Miklabraut or if Route F shifted onto Sudurlandsbraut, but this transfer seems relatively unproblematic. Given relatively low passenger volumes, adding additional services to reduce these transfers seems unlikely to be warranted.

Mjóddin & Stekkjarbakki

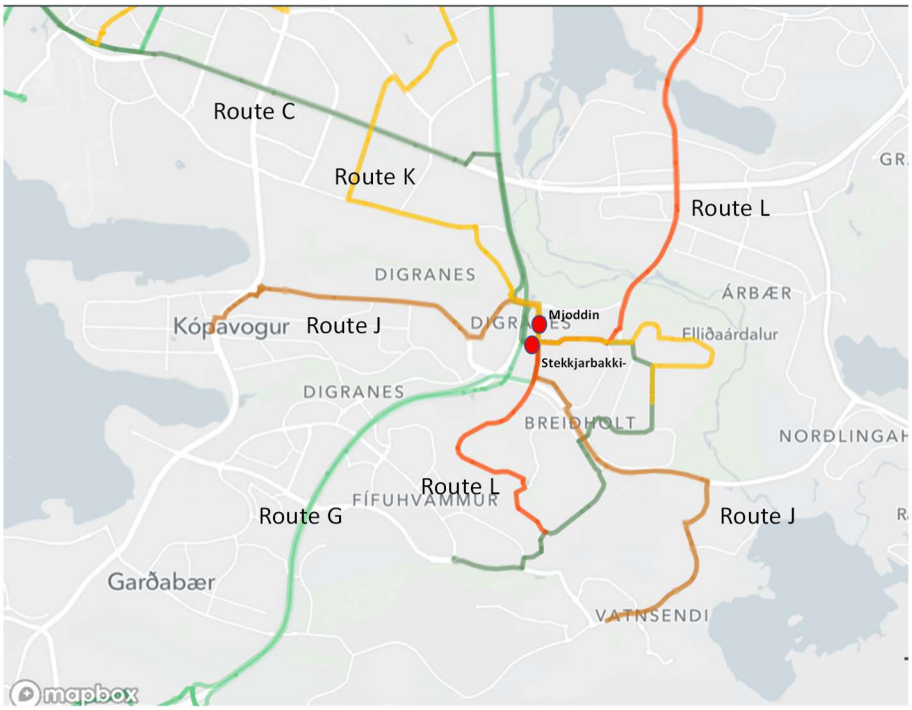

Figure 32. Routes C, G, K, L, and O all pass through Mjódd

Mjódd is a sub-center. With so many routes converging there, it is unsurprising that there would be a high volume of transfers. As most of the routes are already extended through Mjódd rather than terminating there, there are no obvious routes that might be extended to reduce the transfer volumes, though **it may be possible to interline these services more efficiently by more carefully matching the loads entering and exiting Mjódd.**

Hospital

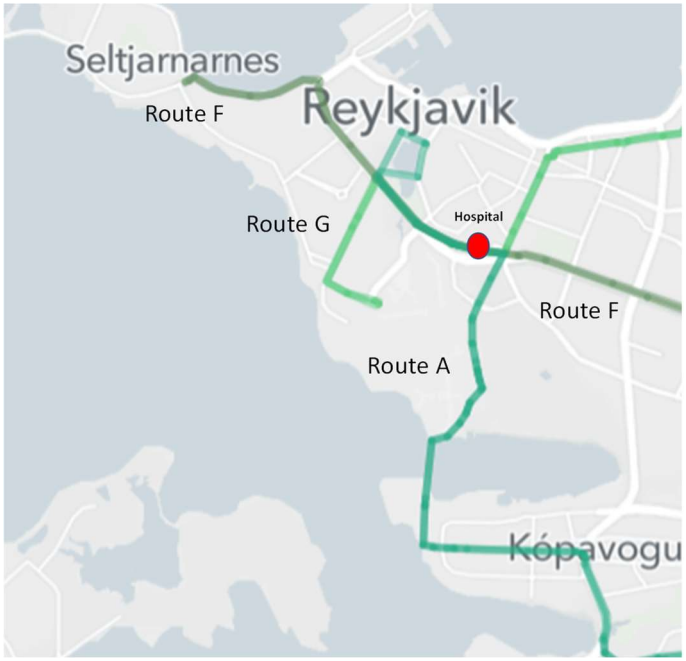

Figure 33. Probable reason for high transfer volumes at Hospital is University-bound students from Kopavogúr

The high volume of transfers at the Hospital is likely a result of University-bound passengers coming from Kopavogúr and Karsnes transferring from Route A to G to avoid a long walk into the University, but may also reflect transfers to other destinations. **We recommend exploring a more direct connection to the University from Kopavogúr to reduce these volumes.**

Hamraborg

Hamraborg is an urban sub-center with a cluster of destinations as well as a popular transfer point. As such, services should be routed through it rather than terminating there. Hamraborg is ripe for a revitalization of its urban core, which has potential to be a pedestrian and transit-oriented sub-center but is currently oriented to automotive access and egress ramps and a bus transfer point. If transfers could be reduced at this point, and the bus terminal slightly downsized, it might help with revitalization of this sub-center.

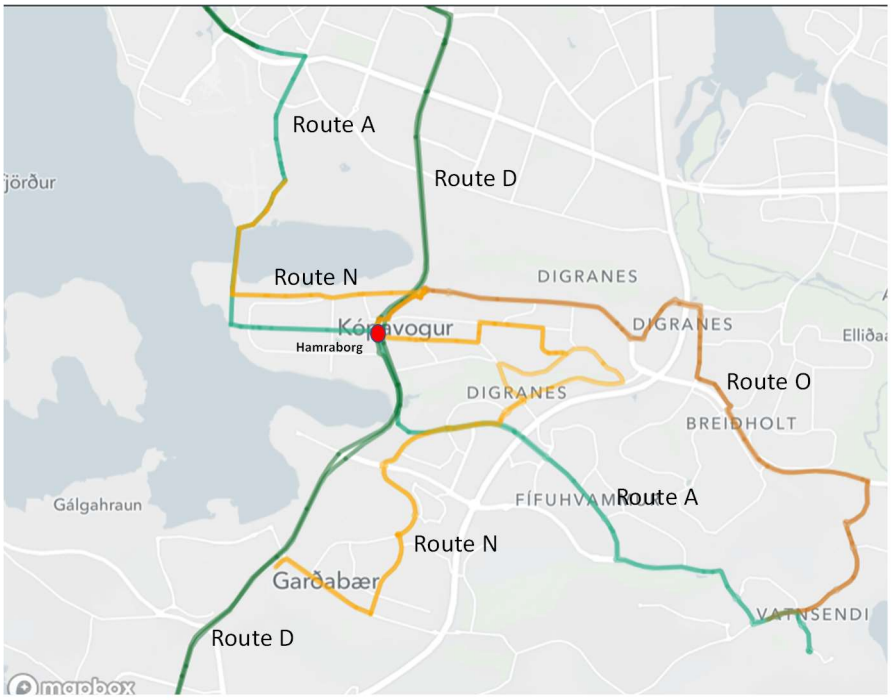

Figure 34. Several routes pass through Hamraborg. Only Route O terminates there

The proposed routing structure is efficient and only proposes one standard frequency route, Route O, to terminate at the Hamraborg terminal. Perhaps it would make sense to extend Route O over the bridge and into town to avoid some transfers, but the demand is not high enough to justify too many routes into town.

BSÍ and Hlemmur

BSÍ turns out to not be a particularly important transfer node, despite the fact that numerous routes terminate there, with most passengers preferring to transfer at the Hospital.[5]

Route J is an important part of the city grid and currently terminates at BSÍ, which we suspect may account for some of the transfers at BSÍ. Other routes that terminate at BSÍ are backward-bending and are probably not a large source of transfers, as passengers could easily transfer at any of the downtown stations. **Extending Route J is therefore suggested.**

Suggested Modifications to the Proposed Strætó/Borgarlína Network

Summary of proposed issues to resolve

After completing the review of the merits and issues with the existing services and the proposed Strætó reforms, the main areas for further consideration are listed below:

- **Many routes would be straighter and more direct if they did not terminate at BSÍ**
- **The frequent routes would form more of a grid if they did not terminate at BSÍ**

[5] Note that the model will tend to assign a transfer to the first node where a transfer is possible even if there are multiple transfer points possible.

- **Some adjustments should be made in light of the routing of BRT infrastructure through the University and away from Miklabraut.**

- **More direct connections might be considered between the following popular OD pairs:**
    - University to Karsnes/Kopavogúr
    - Old Downtown Reykjavík to the University
    - Old Downtown Reykjavík to destinations along Bústaðavegur
    - Mjódd to Hlemmur
- **Route J, which currently terminates at BSÍ, should be considered for extension.**
- **Route O, which terminates in Hamraborg, should be considered for extension.**
- **Routes K, M, and N are highly indirect and should be investigated**

Details on these proposed changes are below

Reducing the importance of BSÍ as a route terminal

The effort to terminate many routes at BSÍ leads to a significant number of additional bus kilometers along a corridor that is already providing a very high frequency of services, and where there is a risk that the high bus frequency will saturate the downtown stations. BSÍ is not a natural transfer point for many routes so most passengers are anyway transferring at other stations like Hospital or Hlemmur any of the downtown stations.

- **Route A should follow Borgarlína infrastructure through the University and terminate there**

There are more people currently going from Karsnes/Kopavogúr to the University than there are headed into old downtown, and the currently proposed route network does not provide a direct connection. Under the current scenario, passengers for the University from Karsnes/Kopavogúr are likely to either walk or transfer to Route G, which probably accounts for some of the transfer volumes at Hospital. By routing Route A to the University, rather than to downtown, trip times to the University can be reduced and transfer volumes at Hospital reduced. Passengers headed downtown will need to transfer but they are fewer than those going to the University.

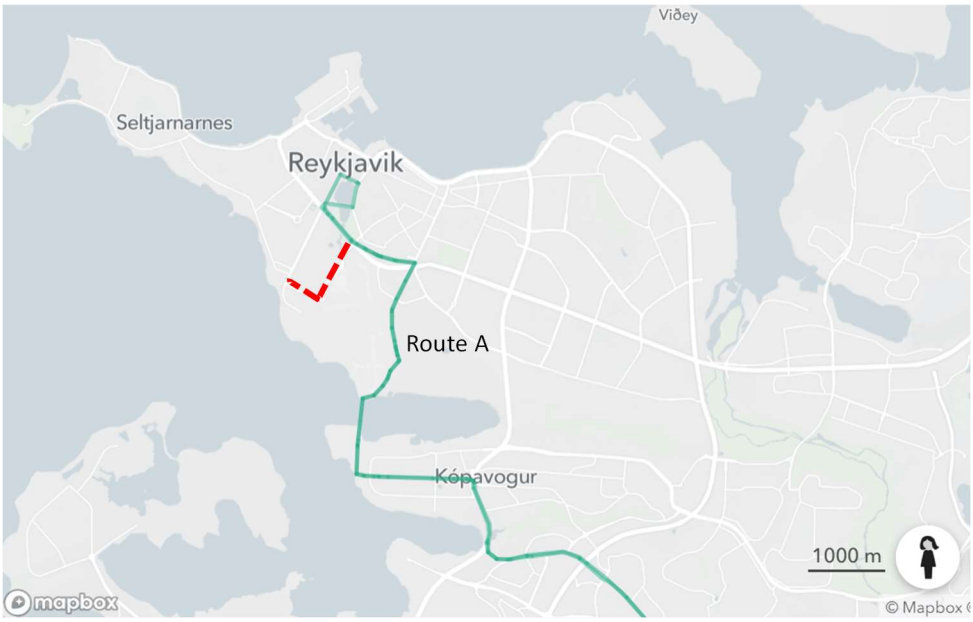

Figure 35 Route A could go directly to the University rather than to Lake Tjörnin. The fewer passengers headed downtown can easily transfer at BSÍ or Hospital

The currently proposed route circles the old downtown with no obvious place for the driver to stop and rest or change shifts. Facilities for a bus layover such as a toilet and rest area for drivers should be easier to locate near the University close to the end of the line.

- **Route B should terminate at the University rather than at BSÍ**

No one headed to downtown Reykjavík on Route B is going to have BSÍ as their destination, as it is out of their way. There is some University demand however coming from Suðurlandsbraut and Laugavegur, and there is a missing direct connection between old downtown and the University. Terminating Route B at the University would straighten the route, create a more direct connection between the University and Borgarlína's main east-west route, and make greater use of the Borgarlína corridor.

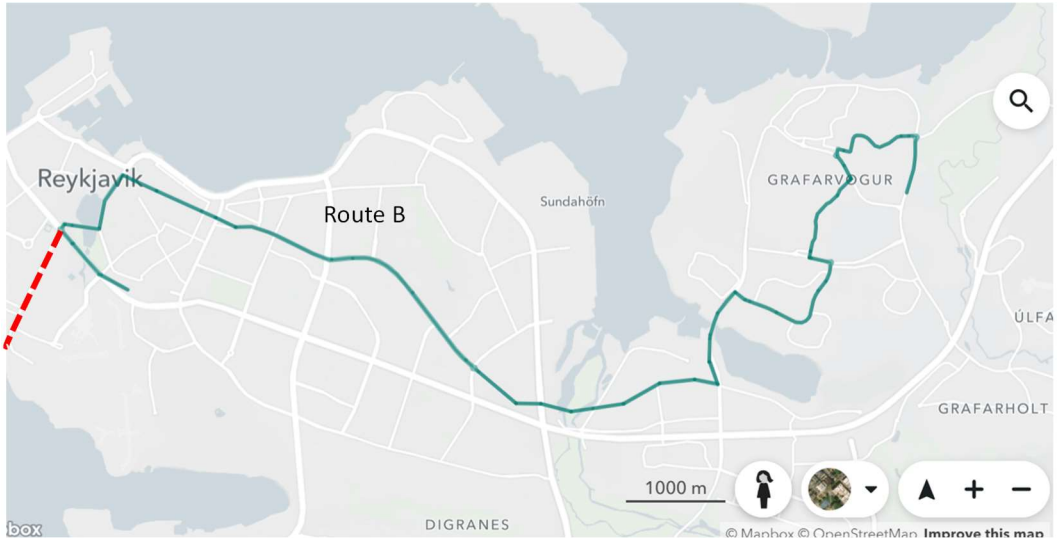

Figure 36. Route B could terminate at the University instead of BSÍ

This route could use the same line terminal as Route A where some basic Borgarlína driver facilities and layover for parking could be provided.

- **Route C makes sense as envisioned.**

Route C is the most direct connection between Mjódd and Downtown. It requires a transfer to Route F to get into the heart of downtown, but the volumes are not that high.

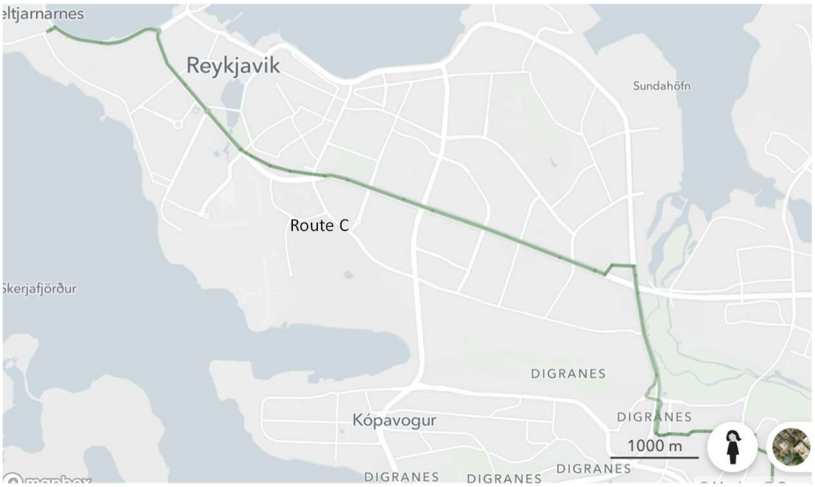

Figure 37. Route C makes sense as envisioned. Passengers between Mjódd and old downtown can transfer for Route F

- **Route D should continue to Seltjarnarnes rather than circle back to BSÍ**

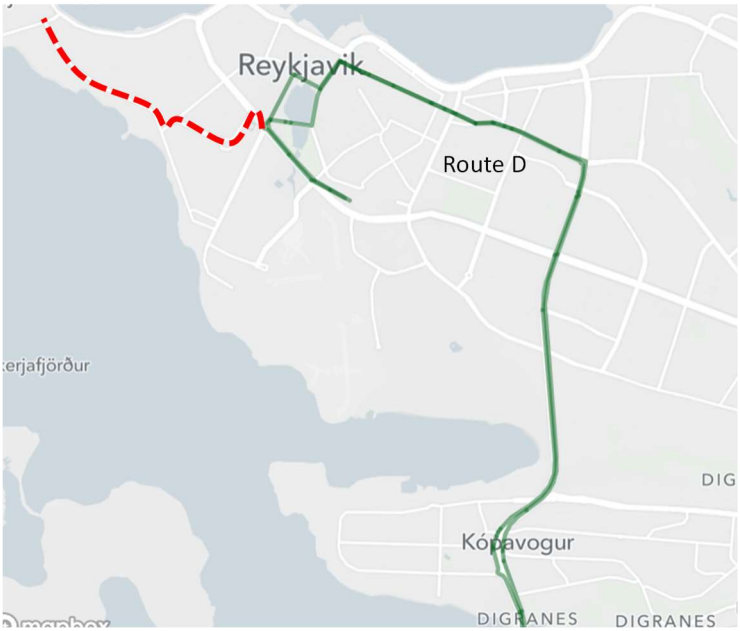

Figure 38. Route D shown extended to Seltjarnarnes rather than circling back to BSÍ

Route D currently also circles back to BSÍ. Few passengers have BSÍ as their destination. For the same operating kilometers, Route D could therefore provide a direct connection to Seltjarnarnes rather than

circling back to BSÍ. In this way, the western half of Route H becomes unnecessary. As the loads approaching downtown from both east and west are similar, this represents an interlining of Routes D and H.

- **Route E should extend to Seltjarnarnes rather than circle around to BSÍ**

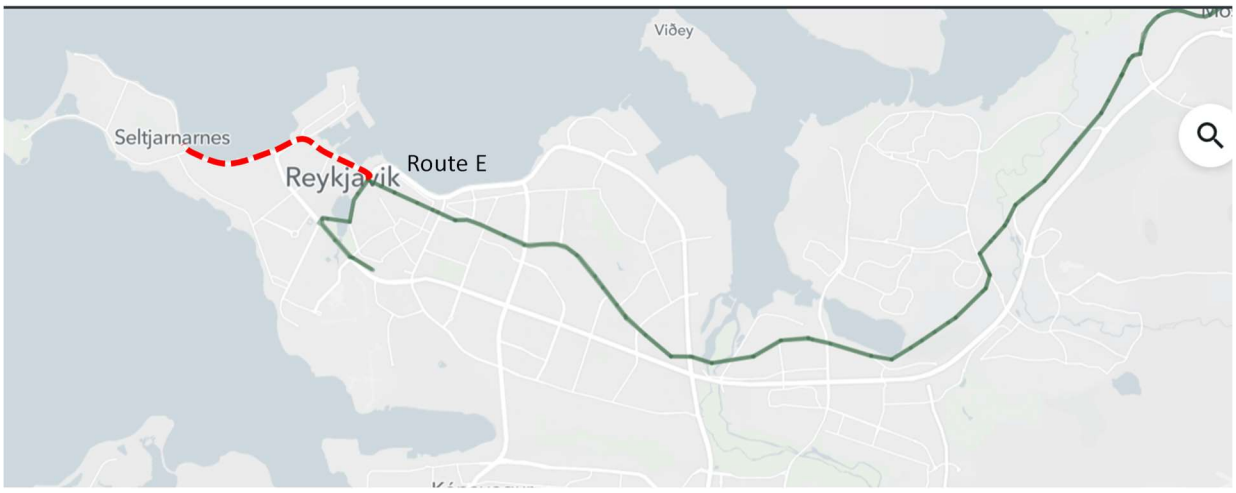

Figure 39. Route E should be extended to Seltjarnarnes rather than circling back to BSÍ

In the current plan, there is no continuous service along the north shore. The relatively few passengers headed to southbound downtown can easily transfer to Routes B or D. By extending Route E to Seltjarnarnes rather than circling back to BSÍ, the services in the northern part of the downtown grid along the north shore will be completed.

- **Route F makes sense as envisioned**

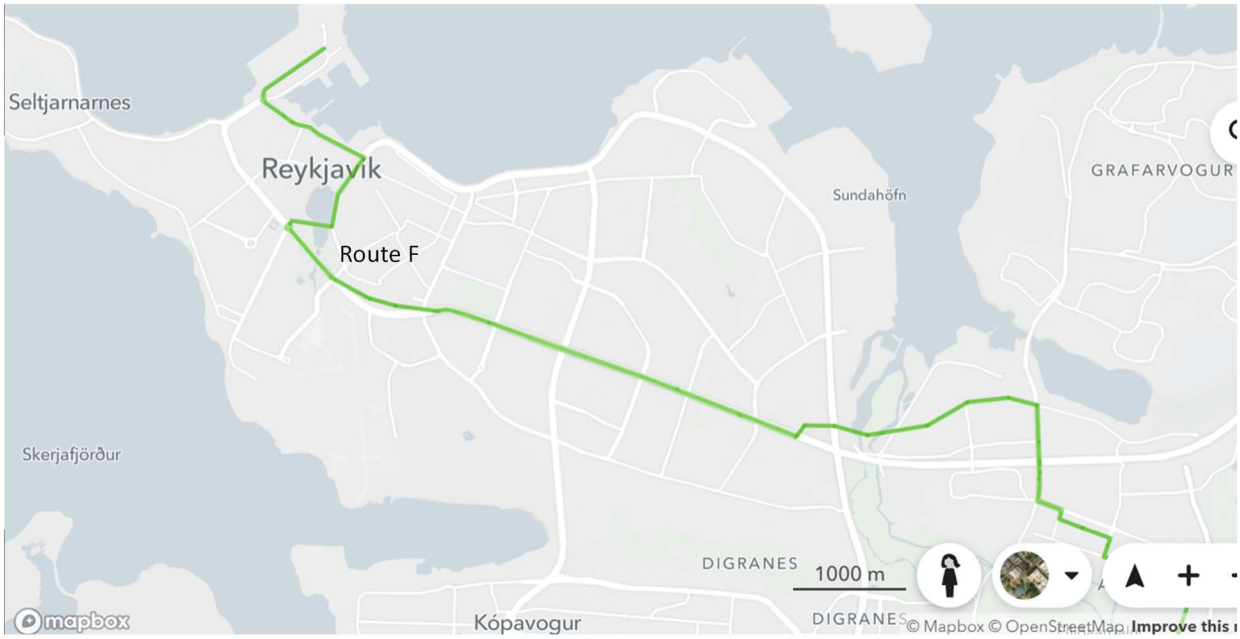

Figure 40. Route F makes sense as envisioned, except for the diversion to the university

Route F provides a direct service into downtown Reykjavík via Miklabraut and is extended to the Old Port to provide a direct frequent connection to the Old Port area.

Note that we do not endorse the idea of Route F following the Borgarlína corridor through the University as it will create a diversion for most passengers.

- **Route G should follow Borgarlína to the University**

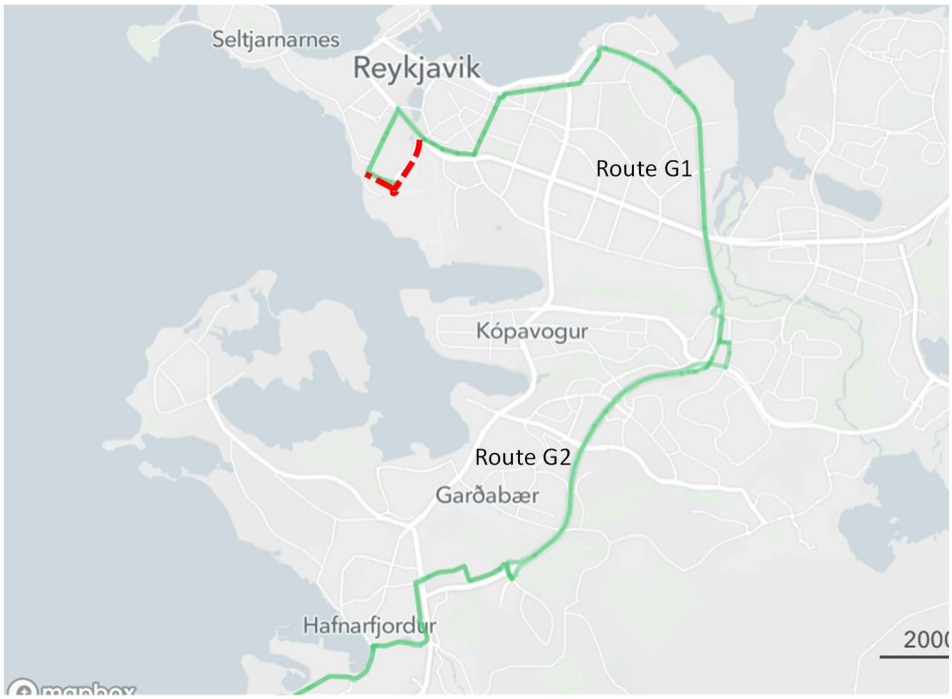

Figure 41. Route G, while circuitous, makes sense as it is. It links the north coast to the University, Mjódd to the north coast, and the south to Mjódd, and the model indicates it has reasonable ridership.

Route G makes sense as it is, with a very minor adjustment to follow the proposed Borgarlína routing to the University. While it appears to be very circuitous, it connects the south to Mjódd, Mjódd to the north coast, the north coast to the University, and it helps complete the downtown area grid with an important North-South axis. While it may be a bit long for service regularity, it is something of a series of reasonably interlined routes, and modelling projects it to have reasonably high demand.

Other Measures to Consider

While it was beyond our scope to further recommend changes to the less frequent services, some other points are mentioned for the record:

- Route J could be extended into downtown to better complete the grid

Route J currently terminates at BSÍ rather than continuing into downtown. As a result, there is no direct connection from destinations along Bústaðavegur into downtown. This is probably a reason for some unnecessary transfers at BSÍ. Extending Route J across downtown would better complete the grid, reduce transfers, and would not add much in terms of kilometers.

- Route H could probably be removed with other minor changes

With the proposed extension of Route D, the part of Route H to the west of the old city center becomes redundant, so this route can be rethought or eliminated.

- Route I operates partially on roads that do not currently exist. If this route is implemented, it could extend across the bridge to Hamraborg.

Figure 42 shows a map of the new service plan if the above recommendations are taken in their totality. Together, they should improve the directness of the route structure and create a more comprehensive grid of services through Reykjavík.

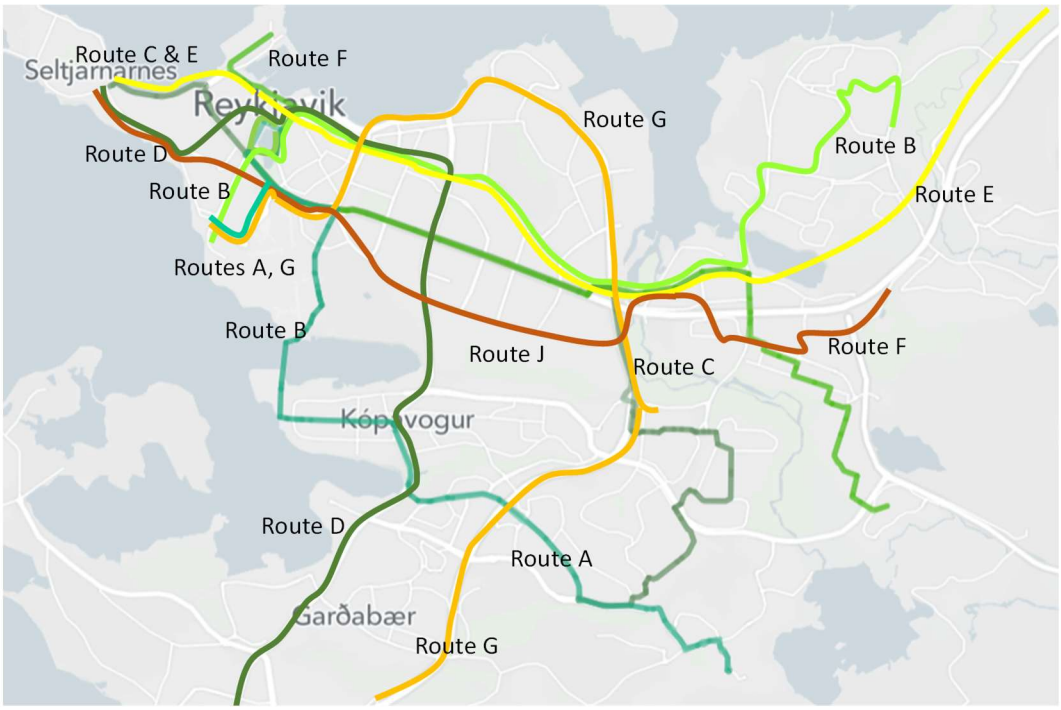

Figure 42. BRTPlan proposed modifications to Strætó route network, in full

Chapter 4. Borgarlína Design and *BRT Standard* Score

The Borgarlína corridor is approximately 14km long and includes roughly 12km of dedicated two-way bus lanes running from the eastern side of Reykjavík to the southern municipality of Kópavogur.

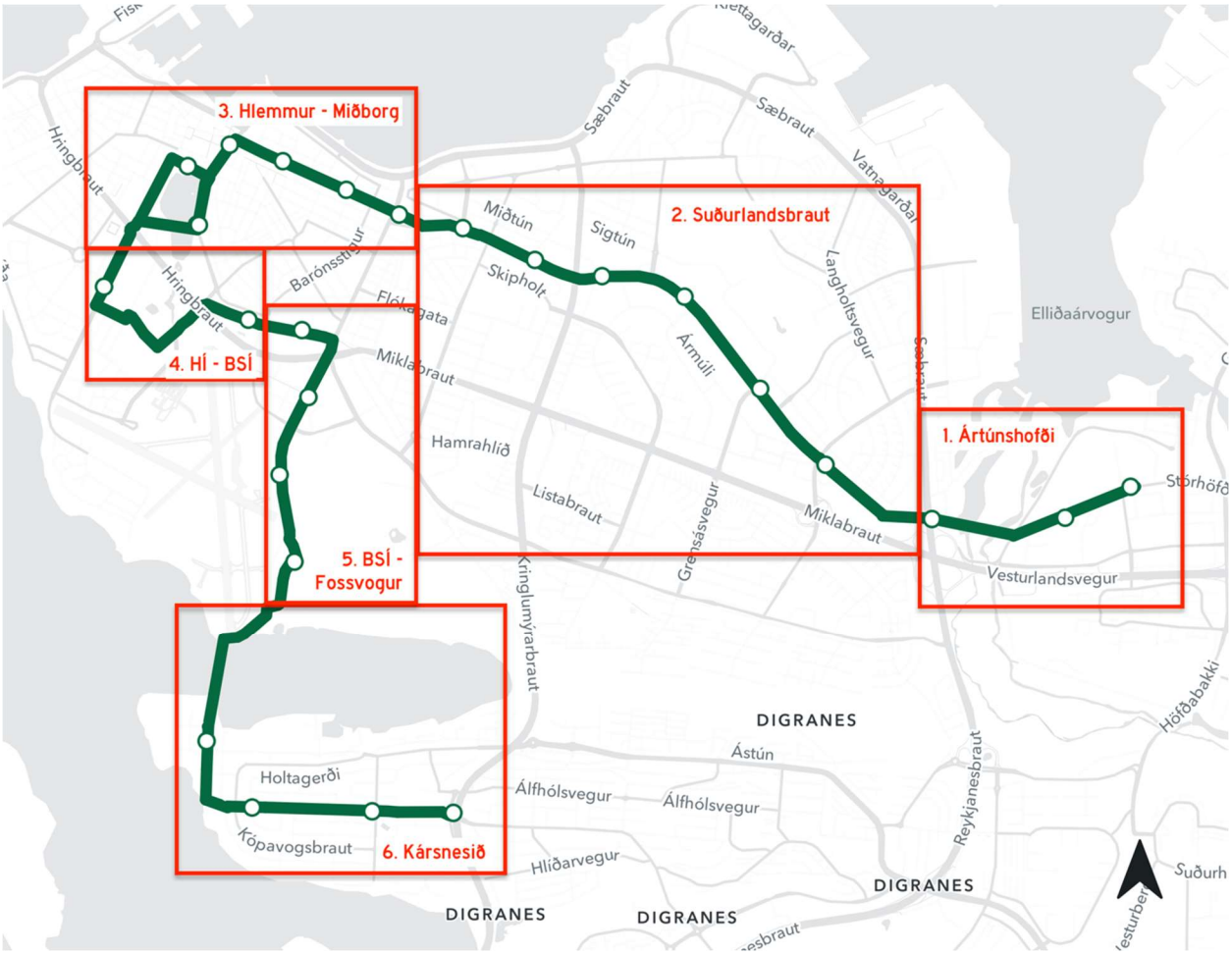

Figure 43: Borgarlína corridor separated into six sections for design review, as shown in Conceptual Design

The corridor begins in the eastern section of Ártúnshofði (box 1 above) at Stórhöfði and the BRT will operate on a new road to be built through this area during redevelopment. On one section, it is a bus and bike only street, on another section it is a central median alignment. This road feeds into a bus-only bridge over the Geirsnef park and Sæbraut highway that connects to a new Vogabyggð transfer hub, to be constructed above-grade near the highway interchange near a new set of mixed-use developments within walking distance of Vogabyggð. Borgarlína then returns to street grade on Suðurlandsbraut (box 2 above), where it operates in median-aligned bus lanes on a relatively unconstrained right-of-way.

After Kringlumýrarbraut, Suðurlandsbraut becomes Laugavegur and Borgarlína continues for just under a kilometer before reaching the Hlemmur station (box 3 above), in a new central pedestrian plaza, where buses veer right onto Hverfisgata. After Hlemmur, Borgarlína operates in an exclusive bus lane westbound on Hverfisgata with no other westbound lanes, and in a single mixed traffic lane eastbound. The corridor then continues southbound on the wide Lækjargata in exclusive, median-aligned lanes, before it splits at Vonarstræti, where southwest-bound buses turn right into mixed traffic, passing in

front of City Hall before continuing southbound on Suðurgata where after the roundabout in front of the National Museum of Iceland the corridor returns to central median-aligned dedicated bus lanes. Northeast-bound buses travel in mixed traffic over the Skothúsvegur bridge over Lake Tjörnin, before turning left on Fríkirkjuvegur in mixed traffic, and then rejoining a dedicated busway on Lækjargata.

With both directions rejoining each other on Suðurgata, Borgarlína travels through a newly signalized intersection at Hringbraut into the campus of the University of Iceland (Haskolí Íslands, HÍ) in median lanes (box 4 above).

After passing the main University buildings, it turns east on Sturlugata into mixed traffic to exit the campus and return north on Njarðargata, back into dedicated median lanes. After crossing Hringbraut again, the bus joins a fully BRT-exclusive road to pass through the planned developments on the current sites of the BSÍ bus terminal and the Landspítalinn (box 5 above). Once it reaches Snorrabraut, it crosses over Miklabraut on a new road built as part of the planned decking over of the highway before joining another bus-only road southbound through Arnarhlíð which later becomes Nauthólsvegur, remaining bus-only through the campus of Reykjavík University (Haskolí Reykjavík, HR).

Borgarlína then crosses a new bridge over Fossvogur (box 6 above), and onto Bakkabraut on the Kársnes peninsula which is partly in dedicated busway and partly in mixed traffic. Using a new bus-only connection to be built, Borgarlína then turns east onto Borgarholtsbraut, where it operates in mixed traffic, then on a stretch where one direction is in a dedicated bus lane and the other direction is in mixed traffic, until finally it becomes a median-aligned busway as it approaches the Hamraborg transfer station where the BRT infrastructure ends.

Borgarlína Design Principles and The *BRT Standard* Score

The BRT Standard allows us to score existing and planned BRT systems against best practice in BRT design internationally. Figure 44 below shows the scoring system, as well as the points required to achieve BRT Basic, BRT Bronze, BRT Silver, or BRT Gold.

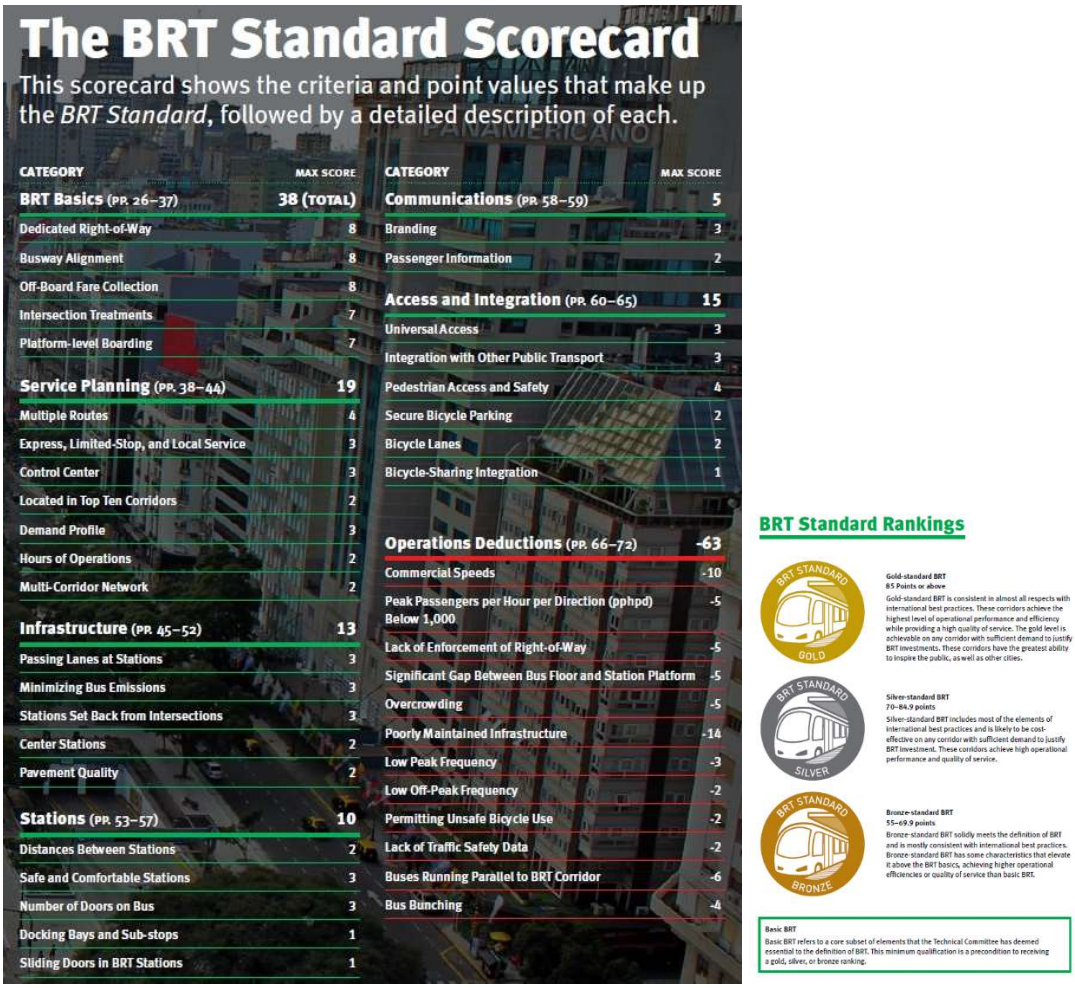

Figure 44: The BRT Standard *scorecard and rankings*

BRTPlan evaluated Borgarlína's design using the *The BRT Standard.* Where there was insufficient detail about a measure, it was assumed that the design would follow the design principles articulated in the conceptual design report. The overall design is generally consistent with best practice, and compatible with a 'gold standard' BRT rating. As currently articulated, the actual rating will likely be either BRT Silver or BRT Gold, depending on a few issues that are yet to be clarified.

Corridor definition

To score Borgarlína using the *BRT Standard,* the first step is to define what constitutes the BRT corridor. According to *The BRT Standard,* "A BRT corridor is a section of road or contiguous roads served by a bus route or multiple bus routes with a minimum length of 3 kilometers (1.9 miles) that has dedicated bus lanes." Because the Capital Area is currently planning one project and that project meets this definition, we applied the full corridor end-to-end from Ártunshofði to Hamraborg in our BRT standard scoring.

BRT Basics

Dedicated Right-of-Way

A core attribute of a BRT is that the buses operate in a dedicated right of way, free from traffic congestion. BRTPlan measured the length of the corridor from end to end using Google Earth. We then

determined based on the conceptual design whether the section was consistent with *The BRT Standard* definition of fully dedicated right of way, which is worth 8 points. Where the busway has a dedicated right of way it will be built with red pigmented asphalt for high visibility and separated from general traffic by a grass-covered median. Where the section is fully dedicated in both directions it was given 8 points multiplied by the share of the total corridor. Where it is dedicated in only one direction it was given half points, and if it was in mixed traffic it was given zero points for that length.

Table 3: Details of scoring for Dedicated Right-of-Way

			Dedicated ROW Score		Cross Section Score
Section	**Length**	**% of 8 pts**	**Score**	**% of 8 pts**	**Score**
Kennitolur - Sudurlandsbraut	1.95	100%	1.10	1.00	1.10
Suthrlandsbraut - Hlemmur	3.13	100%	1.77	1.00	1.77
Hverfisgata	1.05	50%	0.30	0.50	0.30
Laekjargata	0.271	100%	0.15	1.00	0.15
Lake Tjolnin	0.71	0%	0.00	0.00	0.00
Suthurgata	0.534	100%	0.30	1.00	0.30
Sturlugata	0.548	0%	0.00	0.00	0.00
Njargata - Snorrabraut	1.23	100%	0.70	1.00	0.70
Bustathavegur to Karsnes	2.81	100%	1.59	1.00	1.59
Bakkabraut mixed traffic	0.289	0%	0.00	0.00	0.00
Bakkabraut to Borgarholdsbraut	0.195	100%	0.11	1.00	0.11
Borgarholdsbraut	0.847	50%	0.24	0.50	0.24
Borgarholdsbraut to Hamraborg	0.554	100%	0.31	1.00	0.31
Total	**14.118**		**6.59**		**6.59**

The total corridor received **6.59 out of a possible of 8 points**.

Busway Alignment

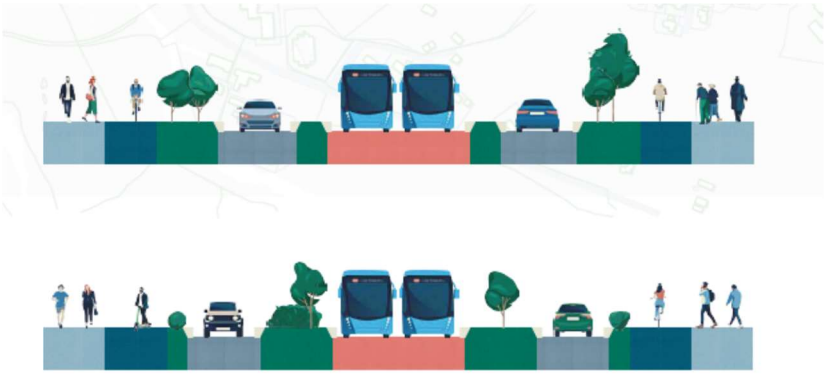

Figure 45. Standard cross sections

These same segments were analyzed in terms of their cross section. Where the busway is dedicated, bus lanes are in the middle of the roadway to minimize conflicts with stopping vehicles and other obstructions that are more likely along the roadway. Alternatively, they are on bus-only roads. Bus lanes

will be 3.5 meters wide, narrowing to 3.25m at stations. This is possible because buses pull adjacent to the station platform at stops, narrowing the required road width. This configuration is consistent with full points for cross section. Where the busway is in mixed traffic it received zero points. Where the dedicated busway was in only one direction it was given half points for cross section. Thus, Borgarlína received the same score for cross section as for dedicated right of way: **6.59 out of 8 points**.

Fare Collection

A BRT system receives the highest points for having fare payment occur at a validator located at the entrance of a pre-paid zone before the passenger enters the bus. This is because the process of passengers paying the driver is commonly one of the most significant causes of delay on a bus. The pre-paid zone can either be physically separated and entered only through a turnstile, or it can be designated with pavement markers and enforced with CCTV cameras and/or inspectors (Figure 46 below).

Figure 46. Examples of off-board fare collection in pre-paid zones: Los Angeles Orange Line and Chicago Loop Link

Another popular alternative is to have passengers pay off-board in the station without a pre-paid zone, but rather, with inspectors who randomly check tickets on-board the bus. Such a 'proof of payment' system is the second-best option. The third best option is to have multiple validators on-board the bus and to purchase the ticket off-board but to validate it on-board the bus. Ideally this would be specified in the conceptual design as the station designer will need to know this detail in order to move to detailed design.

We understand that Strætó is planning to implement off-board fare collection systemwide in the coming years. Further, based on our discussions with the Borgarlína design team, we believe that Borgarlína routes will be included in this implementation. Most likely, the stations will feature proof-of-payment with onboard validation at all doors of the bus. This would be worth 4 points. However, here is no mention in the Conceptual Design document, to our knowledge, of the manner in which fares will be collected. One of the central tenants of BRT system design is that neither fare payment nor validation should occur at a single door near the driver. This traditional approach to fare payment or fare validation causes significant delay as passengers can only enter through a single door and must wait while each passenger pays or validates their fare under the watchful eye of the bus driver.

We would recommend that the conceptual design feature more information about the station configurations and equipment in order to confirm this scoring. As no detail was specified but given the

upcoming implementation of systemwide off-board fare collection, we assumed a **range between 4 and 8 points**.

Intersection Treatments

The more turning movements allowed across the busway, the less green time the BRT buses are likely to enjoy. Various signal prioritization methods can also increase the share of green time enjoyed by BRT buses.

The Conceptual Design does not clearly identify how turns across the busway will be treated, as the level of design detail provided usually only shows whether an intersection is signalized or not. Based on the report, it does not appear that transit signal priority (TSP) will be implemented at the signalized intersections.

In general, intersections will restrict mixed traffic left turning movements across the busway.

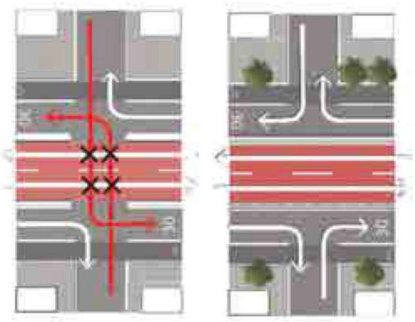

Figure 47. Design guideline showing the restriction of left turns across the busway

However, a number of complex intersections on the outskirts of downtown, such as Suðurgata-Hringbraut and Njarðargata-Hringbraut, are expected to see turns permitted across the busway. As a result, we estimated that somewhere between 20-40% of turns across the busway will be permitted, which provides a scoring **range of 4.2/7 to 5.6/7** points for this metric. We recommend that these intersection layouts be clarified in the Conceptual Design to show where motorists may expect to be routed once the corridor is operational, which will allow for refinement of this score.

Platform-Level Boarding

Significant delay can be reduced by having the bus station floor level with the bus floor. This at-level boarding can save up to 0.5 seconds per boarding and alighting passenger. It is hard for elderly, people with strollers, and particularly people in wheelchairs to board the bus otherwise, frequently causing long delays. At-level boarding is therefore strongly incentivized with a potential of 7 points.

At all Borgarlína stations, the platform will feature a gap of 0.30-0.35 cm (according to Section 0.2.10) to ensure level boarding from the platform, which is within the definition of “level boarding” as established by *The BRT Standard* and results in a **score of 7/7**.

Figure 48. Borgarlína rendering showing bus station platform level with the bus floor, such that wheelchairs can roll right on.

Service Planning

Multiple Routes

Too often BRT system designers think about BRT services as if they were designing a train service and run only a single service up and down the BRT infrastructure. This generally results in a sub-optimal service requiring lots of needless transfers and tends to limit the number of passengers that will benefit from the BRT infrastructure. To incentivize planners to think more broadly about service planning, 4 points are awarded for designing a third-generation BRT, with multiple services using the BRT infrastructure.

The Borgarlína service plan reviewed by our team included three primary BRT routes, Routes A and B with Route E becoming a branded BRT route when the full infrastructure to Mosfellsbær is complete. Several other routes use the infrastructure for part of their journey. This results in a score of **4/4 points** for having multiple routes on the corridor.

Express/Limited/Local Routes

Often express buses provide a very high-speed service for passengers coming into an urban area from a suburban area. Incorporating routes that skip stops into BRT infrastructure is difficult but brings big speed benefits. To incentivize the inclusion of limited-stop services, up to 3 points are awarded.

BRTPlan proposed making Route E an express service on Miklabraut which would then use elements of the Borgarlína corridor in the city center. While it is not known if this design has been retained, the service plan would meet *The BRT Standard*'s metric of "at least one local and one limited-stop and/or express service", but not the requirement for "multiple types of limited-stop and/or express services". Given that the initial service plan had only local routes and that a revision would only include one express service, we have assigned a scoring **range of 0/3 to 2/3** for this metric.

Control Center

A state-of-the-art control system is critical to ensuring that buses maintain their schedules and avoid bunching. Avoiding service irregularity is critical to customer service and maintaining the capacity of the busway.

We do not have complete information about whether buses will be controlled using an operational control center and if so, what type it would be. Fully automated computer assisted real-time adjusted control center at least for Routes A, B, and E would score 3 points. No operational control system would get 0 points. We have therefore, assigned a scoring **range of 0/3 to 3/3** for this metric.

Located in Top Ten Corridors

Some BRT system designers have an inclination to put a BRT corridor on the edge of the city where there are wide roads and little risk that a BRT will disrupt traffic, but also limited benefits to BRT passengers. To resist this tendency, up to 2 points are awarded for designing the BRT on one of the top 10 highest demand transit corridors ranked by the level of ridership.

The Borgarlína corridor itself is composed of at least two distinct axes: a primarily east-west axis from Lækjargata to Artunshofdi along Hverfisgata, Laugavegur and Suðurlandsbraut; and a generally north-south axis from Lækjargata along Suðurgata, Nauthólsvegur, and the Fossvogur bridge to Hamraborg. These axes are two of the highest demand, and together, are certainly in the top 10 corridors in the Capital Area. Thus, Borgarlína **scores 2/2 points for being in the top ten highest-demand corridors**.

Demand Profile

Many BRT system designers will design a great BRT corridor on the approaches to downtown, only to abandon the buses to mixed traffic precisely where the dedicated BRT infrastructure is most needed in the congested downtown. To resist this tendency, *The BRT Standard* awards 2 points if the BRT infrastructure continues through the highest demand section of the corridor.

The links with the highest demand, which are understood to be the approaches to Hlemmur and the Lækjargata stretch in the city center, both operate in a Tier 1 configuration busway. Borgarlína scores **3/3 points for featuring Tier 1 configurations on its busiest links**.

Hours of Operation

Ideal for BRT is to have a service that can be relied upon to operate throughout the day, into the night, and on weekends at a reasonable frequency. We understand that the current thinking by Strætó is to operate the services between 06:00 – 01:00, 7 days a week.

However, no final decision has been taken. Therefore, while we expect 2 points for this, we are assigning a scoring **range of 0/2 to 2/2**.

Multi-Corridor Network

While for the purposes of this scoring, Borgarlína Phase 1 is a single corridor, in fact, the Borgarlína project itself is truly two conjoined corridors meeting in the city center. By this alone it would not be a stretch to call Borgarlína part of a multi-corridor network; however additional BRT corridors are in the visioning stages along other busy roads in Reykjavík such as Snorrabraut which would intersect with the Borgarlína corridor and permit efficient through-service. This allows Borgarlína to score **2/2 points**.

Infrastructure

Passing Lanes at Stations

The best BRT systems have passing lanes at bus stops. Passing lanes allow for express buses to use the busway and pass local buses without having to enter mixed traffic. Passing lanes are also critical to reduce the risk of station saturation, or buses bunching up at station stops.

Borgarlína has said in its design guidance that it will use passing lanes where boarding and alighting volumes require it, as shown in Figure 49 below. It is not anticipated that this will be necessary, but it awaits modelling of the final service plan. Given this, we anticipate that the score will fall in a **range of 0/3 with no passing lanes at stations to 1/3 with dedicated passing lanes at a few high-volume stations**.

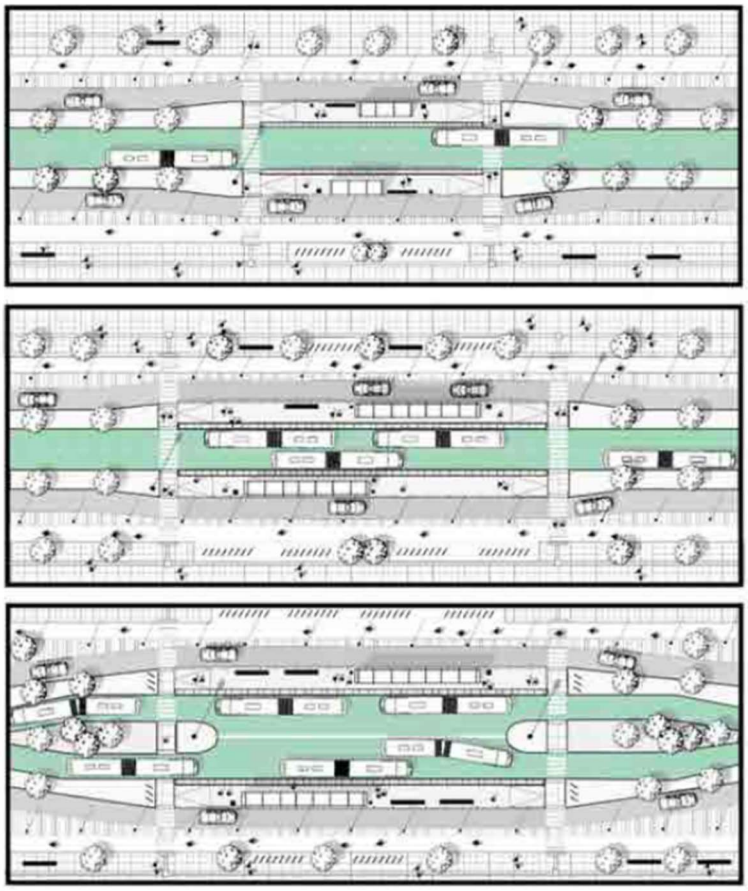

Figure 49. Three station types and typical dimensions

Minimizing Bus Emissions

Because BRT stations are usually semi-enclosed, and passengers generally wait in these stations for periods of time, they are often exposed to unhealthy levels of exhaust emissions unless the buses are very clean. Particularly important is to reduce the particulate emissions which have the most damaging impacts on the human lungs, followed by SO2, nitrogen oxides and carbon monoxides.

A formal decision has been made that Borgarlína will use domestic green energy- either CNG, hydrogen, or electricity. A very clean bus, whether battery electric or Euro VI, would qualify for 3 points. A reasonably clean bus, with either Euro IV or Euro V with a particle trap, would receive 2 points. A Euro III bus with a particle trap or a Euro IV or V bus without a particle trap, or a CNG bus would receive 1 point. **The range is therefore between 1 – 3 points**.

Station Setbacks from Intersections

One of the most common causes of delay within a busway is interference between buses boarding passengers and the functioning of the traffic signal. If a bus stop is next to an intersection, it is common

for the bus to pull to a stop at the station while the traffic signal is green. By the time the boarding and alighting process is finished, the light has turned red. The next bus would like to pull up to the station to allow passengers to board and alight, but it cannot because the station is blocked by the bus in front which is waiting for the traffic signal. Setting the station back from the intersection by at least 2 bus lengths reduces the risk of this type of delay significantly.

There is not enough detail in the conceptual design to determine whether the stations will be sufficiently set back from intersections. *The BRT Standard* awards full points (3) if 75% of the stations are set back 40 meters from the intersection. If 75% of the stations are set back by at least 25 meters, then 2 points are awarded. If 25% of the stations are set back by 25 meters, then 1 point is awarded. There is an exemption for areas of the city where due to short block length achieving the 40- or 25-meter setback is physically impossible. This would likely apply to much of downtown Reykjavík. **The range of possible scores is therefore 0 – 3 points.**

Center Stations

BRT best practices typically recommend a single central platform permitting easy transfers between services as well as reduced capital and operating expenses of building and maintaining facilities at two platforms instead of one. This configuration has the downside that it requires fleet with doors on the left of the bus, which often requires a large new fleet procurement.

Each Borgarlína station area will have two right-side boarding stations: one in each direction. Borgarlína as a result scores **0/2 points**.

Pavement Quality

If the pavement on a busway buckles, cracks, and/or forms large depressions, the BRT service is disrupted, and the bus floor will not remain level with the station floor. Both will have adverse impacts on the quality of service. Therefore, we recommend considering rigid pavement (concrete) with a 30-year expected commercial life.

There is some language in the Conceptual Design that suggests that colorized asphalt will be used for the busway. Asphalt may or may not be durable enough depending on the axle loads, particularly at stations and intersections where stopping and starting tends to put additional wear and tear on the pavement. This adds significantly to infrastructure costs. The passenger volumes on Borgarlína are unlikely to translate into heavy axle loads. It should therefore be possible to only use rigid pavement with a 30-year commercial life only at station stops and intersections. This would receive 1 point. The possible outcomes therefore vary between **0 and 2 points for pavement quality.**

Station Design

Stations will be designated as one of three types:

- **Core stations**: Stations serving multiple bus routes with high volumes of boarding and alighting passengers
- **Transfer stations**: Stations serving two bus routes with some likelihood of transfer between them
- **Public stations**: simple stations serving only a single route

Stations with more than 30 passengers per hour boarding and alighting are to be 51 meters in length. Stations with fewer than 30 passengers per hour boarding are to be 26 meters in length.

If a station is to have passing lanes, 51 meters is still long enough for two articulated buses, as long as the stop distance of the second bus behind the first bus is at least 7 meters. The pedestrian refuge islands may also be a bit oversized and may lead to slower maneuverability of buses around each other.

Distance between Stations

Stations on average should be about 450 meters apart. In a continuously built up area, this is the point at which the benefits to the passengers on board the bus of having fewer station stops equal the benefits to the passengers planning to board who face shorter walking times.

Overall, the average distance between stations falls within the scoring criteria in *The BRT Standard* and is also contextually appropriate given roadway conditions, terrain, and expected passenger flows. We do, however, recommend shifting the station currently located at Landspitalínn further east to Snorrabraut, as the proposed station is fairly close to the BSÍ station to the northwest and somewhat far from the Hliðarendi station to the south. This would also facilitate easier transfers with local Strætó services running on Snorrabraut. Regardless, Borgarlína will score **2/2 points on these criteria since the average distance between stops is acceptable**.

Safe and Comfortable Stations

Stations feel very crowded with there is more than 1 passenger per square meter and they feel more and more crowded as this figure reaches 3 or 4 passengers per square meter.

The stations have been planned with the following general minimum dimensions:

Station Width

Station Element	Meters
Walking Zone	2
Waiting Zone	1
Safety Zone	0.5
Minimum Total Width	3.5

The waiting zone will vary with projected waiting volumes but will not go below the minimum. This is consistent with best practice and meets the “wide” criteria for stations in *The BRT Standard*.

The stations will also feature shelters, which meets the “weather-protected” criteria, and will serve as “landmarks” where “the environment of the stations will be able to change and adapt to the characteristics of each location with different materials, artwork and vegetation”, thereby meeting the “Attractive” criteria set out in the *The BRT Standard.*

What is unclear based on the Conceptual Design are the safety elements of each station: how the stations will be monitored, whether through CCTV cameras or security patrols. It is also reasonable that this information might not find its way into the conceptual design. As a result, we are unsure if the criteria of “Safe” is met, and therefore will issue a scoring **range of 2/3 to 3/3**.

Number of Doors on Bus

The more doors on a bus, the faster passengers can get on and off the bus, assuming that boarding and alighting is allowed through multiple doors.

The number of doors on the bus have not yet been specified, nor has the size of the buses to be used. Doors must be at least 1 meter in width to score any points under this metric. An 18-meter bus must have at least 3 doors of 1 meter each to receive full points, and a 12-meter bus must have at least 2 doors of 1 meter width. To get the full 3 points, at least 70% of the fleet must meet these criteria. **Borgarlína will therefore score between 0 and 3 points.**

Docking Bays and Sub-Stops

In BRT systems with high passenger volumes, the risk that the buses will bunch up at stations drops very significantly if each station has more than one docking bay per direction, and these docking bays are separated by at least 7 meters in order to allow one bus to pull around and pass another bus. This requires a passing lane. This metric only requires two docking bays to receive the 1 point, and the station design appear to have this, for **1 point**.

Sliding Doors

Some BRT systems – particularly those with high passenger demand and high levels of saturation at stations – feature sliding doors to prevent passengers from entering (or falling onto) the right-of-way. These may not be necessary given the low expected demand numbers for Borgarlína and could be a maintenance challenge with Icelandic winters; thus, Borgarlína scores **0/1 point**.

Quality of Service

Branding

The most successful BRT systems develop an identity that set them clearly apart from normal bus systems. Borgarlína is already branded separately from Strætó though the specifics of the brand have yet to be determined. Depending on the approach to branding, **Borgarlína will receive between 1 and 3 points.**

Passenger Information

Passengers are more able to make strategic decisions about their travel if they have real-time information on their services. Passenger information systems are therefore highly desirable for BRT passengers. Strætó has already begun a process to display real time information to passengers at stations. The first information boards were installed in the spring of 2020. It is therefore likely that Borgarlina will have real-time information and **will score 2 points**.

Integration and Access

Universal Access

Our understanding is that Icelandic law requires public transportation projects to be universally accessible to people with disabilities. The Borgarlína stations, as discussed in the Conceptual Design and shown in several artistic renderings, feature accessible ramps for passengers in wheelchairs or other assistive devices. Currently, Strætó's buses are accessible with wheelchair securements as well as visual and aural announcements for passengers with blindness or deafness, so it is expected that the Borgarlína service will offer the same level of accessibility, thus scoring **3/3 points**.

Integration with Other Public Transport

While this category often refers to multi-modal transportation in a city with intercity and/or metro, streetcars, and other forms of transit common in larger cities, the only other public transportation in Reykjavík are the local buses. Based on the fact that Borgarlína hubs are expected to be focal points of

the local bus network as well, and that both networks are to be operated by Strætó using the same fare equipment, Borgarlína scores **3/3 points**.

Pedestrian Access

In some cities, a beautiful BRT system is built but no attention is paid to the walking environment around the station. Passengers ultimately need to be able to reach the BRT station. To incentivize high quality pedestrian facilities in the station areas, *The BRT Standard* awards up to a total of 4 points. While these details are not yet available, the design guidance in the conceptual design is consistent with a score of **4/4 points.**

Bicycle Lanes

Rebuilding a corridor with BRT is also a great opportunity to improve the cycling network. Passengers who would like to bike to a BRT station often need to bike along the corridor for some distance until they reach the nearest station. Therefore, to incentivize intermodal integration, *The BRT Standard* awards 2 points for bicycle lanes along the BRT corridor or on a close parallel corridor.

The entire corridor is to have bicycle paths with a minimum width of 2.2 meters on both sides of the street, separated from the pedestrian walkway by a comfort zone of between 0.8 and 1.5 meters. In some specific spot-treatments, bicycles are permitted either to use the busway for brief periods of time (such as on the Skothúsvegur bridge, or on Sturlugata), to use shared pedestrian spaces to navigate around Borgarlína stations (on Hverfisgata), or to diverge slightly from the corridor (such as on Njarðargata) in order to navigate around complex intersections and permit a more pleasant ride. Thus, the corridor scores **2/2 points for featuring cycle lanes**.

Bicycle Parking & Bike Sharing

We could not find evidence in the Conceptual Design of bicycle parking located at the stations; however other bicycle parking may be located or provided in some areas independent of the Borgarlína system. The design standards for stations (section 0.2 of the Conceptual Design) do define “core stations” as having bicycle rental or bike-share facilities either at the station or perhaps co-located to the station, however there are insufficient core stations to meet the scoring criteria of the *Standard*. As a result, the corridor scores between **0/2 and 1/2 points for bicycle parking**, pending a detailed review of alternate cycle parking availability, and **0/1 points for bike-sharing integration**.

BRT Standard totals

Based on what is known and what is unknown about Borgarlína, it could score anywhere between 62.4 points (bronze) and 90.2. We have a high degree of confidence that BRT Silver will be reached (70 – 84.9 points) and believe that a rating of BRT Gold, with a score above 85 is achievable and makes sense for Borgarlína. A score as high as 90.2 could be justified in the Reykjavík context.

Corridor Name:	Borgarlína BRT, Reykjavík, Iceland - Based on August 2020 Conceptual Design		
Corridor Description			
Infrastructure Length	14.1	Approximated	
# of stations	24		
BRT Standard Scorecard			
Measure	**Total Points Available**	**LOW SCORE**	**BEST SCENARIO**
BRT Basics			
Dedicated right-of-way	8	6.59	7.29
Busway alignment	8	6.59	7.29
Off-board fare collection	8	4	8.00
Intersection treatments	7	4.2	5.60
Platform-level boarding	7	7	7.00
BRT Basics total	**38**	**28.4**	**35.2**
Service Planning			
Multiple routes	4	4	4
Express, limited, and local services	3	0	0
Control center	3	0	3
Located in top ten corridors	2	2	2
Demand Profile	3	3	3
Hours of operation	2	2	2
Multi-corridor network	2	2	2
Service Planning total	**19**	**13**	**16**
Infrastructure			
Passing lanes at stations	3	0	1
Minimizing bus emissions	3	1	3
Stations set back from intersections	3	0	3
Center stations	2	0	0
Pavement quality	2	0	2
Infrastructure total	**13**	**1**	**9**
Station Design and Station-Bus Interface			
Distance between stations	2	2	2
Safe and comfortable stations	3	2	3
Number of doors on bus	3	0	3
Docking bays and sub-stops	1	1	1
Sliding doors in BRT stations	1	0	1
Station Design and Station-Bus Interface total	**10**	**5**	**10**
Quality of Service and Passenger-Information Systems			
Branding	3	1	3
Passenger information	2	2	2
Quality of Service and Passenger-Information Syst	**5**	**3**	**5**
Integration and access			
Universal access	3	3	3
Integration with other public transport	3	3	3
Pedestrian access	4	4	4
Secure bicycle parking	2	0	2
Bicycle lanes	2	2	2
Bicycle-sharing integration	1	0	1
Integration and access total	**15**	**12**	**15**
Total		**62.4**	**90.2**

Figure 50. Preliminary BRT Standard scoring for Borgarlína

Detailed Design Evaluation

In the following sections, we review the conceptual designs, section by section, beginning in the eastern Ártúnshöfði section. Our review is based on designs which were released by the Borgarlína team in early 2020 and the following sections reflect our original comments on those designs. Since our original comments, the Borgarlína team has revised the designs to release the report, "Borgarlínan: Fyrsta lota Ártúnshöfði – Hamraborg." We have therefore included, in our comments below, some commentary on which of our original comments were addressed – and how they were addressed – as well as which were not.

1. Ártúnshöfði

As part of our review of the Conceptual Design for the Borgarlína project, we reviewed the Artúnshöfði section of the corridor in April and then again in September as the final version of the Conceptual Design was produced. This section has three BRT stations: Krossamýrartorg, Sævarhöfði and Vogabyggð.

Nearly the entirety of the routing through Artúnshöfði is located on new roads to be constructed as part of the overall redevelopment of this area which is currently industrial. With the exception of Storhofði, located on the eastern tip of the corridor, none of the roads upon which the Borgarlína corridor will operate, currently exist. This creates a unique opportunity for clean-slate design.

East of the intersection of Stórhöfði / Breiðhöfði to Svarthöfði there will be no public car traffic. West of the intersection, Stórhöfði / Breiðhöfði will have one lane in each direction for public traffic.

Parking and Drop-Off in Artúnshöfði

In our original review of the conceptual design, we expressed concern that a single mixed traffic lane with no to minimal parking through a dense, mixed-use area could be problematic. Delivery vehicles and taxis could end up blocking the sole traffic lane, resulting in vehicle traffic trying to use the bus-only lane. Our suggestion was for a "cutaway" parking/loading zone which would allow these types of vehicles to pull over in a manner that did not impede any of the multiple road uses.

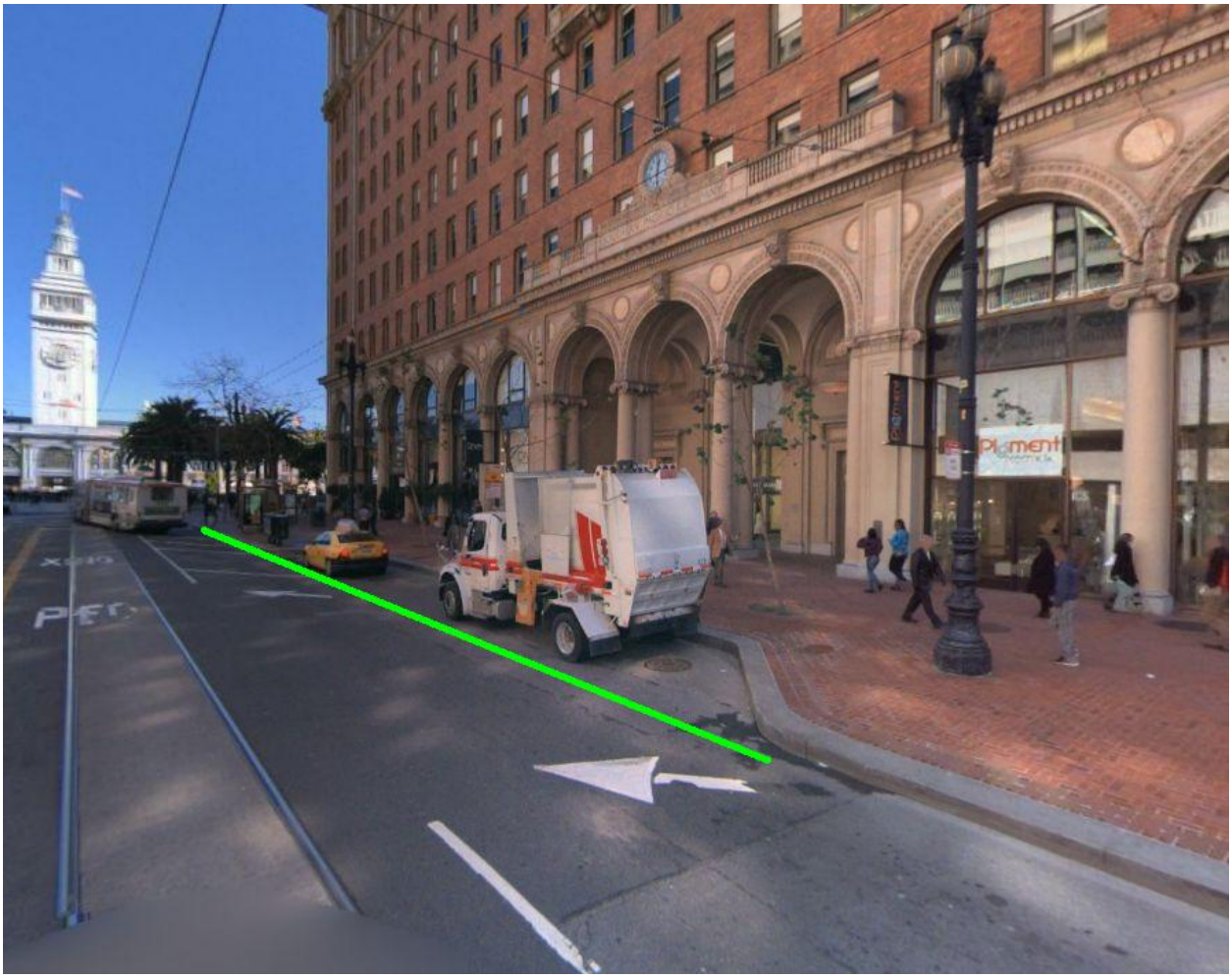

Figure 51: Example provided by BRTPlan of Loading Cutaways (San Francisco, CA) being used by taxi and sanitation vehicle

While the released conceptual design does not show any detail of the street, the approach described in Section 1.3.1 of the conceptual design report suggests that such pullovers will be included within the plan, specifically targeted to locations where this kind of activity is likely.

> "In the space, between the bike path and the lane, is possible to leave a bay for loading and unloading and for standing vehicles, e.g. at the planned primary school south of Stórhöfði."

We fully endorse this site-specific approach to parking and drop off.

Construction Phasing in Artúnshöfði

Based on our understanding of the development timeline, construction of the new roads and the surrounding buildings in the planned development could lead to long-term service disruptions while the works are being completed. This might include keeping the current transfer hub at Artún active, with Borgarlína service using it as a transfer point until these roads and the Vogabyggð transfer station are operational.

Vogabyggð Interchange Design

The initial conceptual design we reviewed had the following diagram overlaid on satellite imagery, which indicated a number of different possibilities for the Vogabyggð interchange station and the lead-in roads which will be constructed over the parkland and industrial area in between Ártúnshöfði and Vogabyggð.

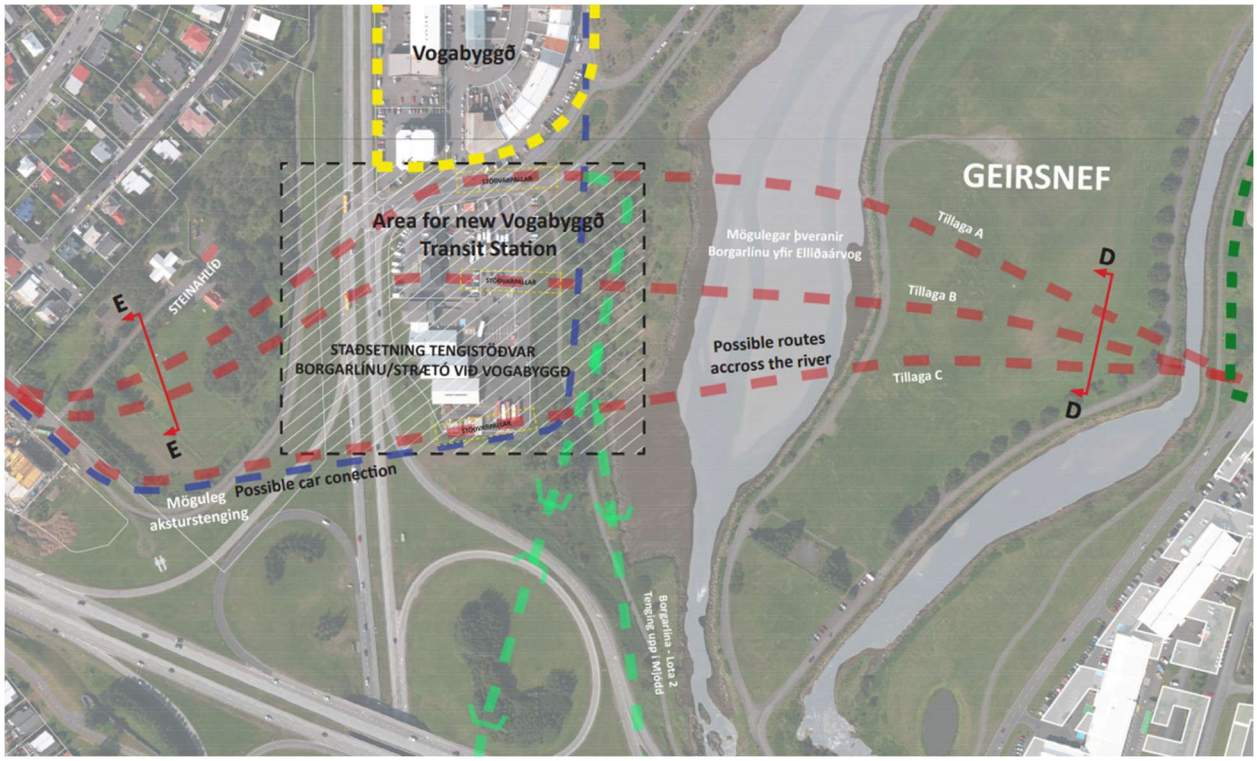

Figure 52: Draft Conceptual Design from April showing lead-in options to Vogabyggð

We indicated in April that the intersection and the deck-over plan for Vogabyggð must be designed in an integrated manner with the transfer facility. We also indicated the importance of deciding on the services that will use this transfer facility prior to completing the design. Based on our understanding of Strætó's service plan, this interchange will need to accommodate the following movements:

- Routes B, E, and F travel east-west between Suðurlandsbraut, Giersnef Island and Ártúnshöfði / Elliðaárvogur. The current drawings accommodate this movement.
- **Route G should connect to routes B, E, and F**, as this is the only direct route between Mjódd and Hlemmur, a very popular OD pair. Ideally, Route G should be brought up from Sæbraut so that it can also use the Vogabyggð station. Otherwise, transferring passengers will have a lot of steps to climb or a slow elevator to use to make the connection. **Getting this connection right is important**.
- Route C's connection to Routes B, E and F is not fully clear, nor is Route C's detailed routing. If Route C turns left off Sæbraut and joins the Borgarlína BRT corridor briefly, then the transfer could theoretically occur at station 2.4.1. Skeifan. We believe this is what the model is assuming, as there is a large volume transfer there that can otherwise not be explained. However, currently, station 2.4.1. is located to the west of the Skeiðarvogur/Réttarholtsvegur roundabout. If Route C returns to Miklabraut on Réttarholtsvegur, it will miss station 2.4.1.

We recommend that the consultants hired to perform the detailed design of this transfer terminal be guided to provide at-grade fast and comfortable transfers between Routes B, E, F, and G, and that station 2.4.1. Skeifan be relocated to the east of the Suðurlandsbraut / Skeiðarvogur Réttarholtsvegur roundabout, to allow for an easy transfer between Routes C, B, E, and F.

Figure 53. Crude BRTPlan concept of a transfer station at Vogabyggð, with a ramp up from Sæbraut to allow at-level connection between Route G and Routes B, E, and F. A second station across the roundabout would reduce the need for buses circling.

It also appears to show some high-quality bicycle and pedestrian infrastructure which we support (see black/grey dashed lines in Figure 54 below).

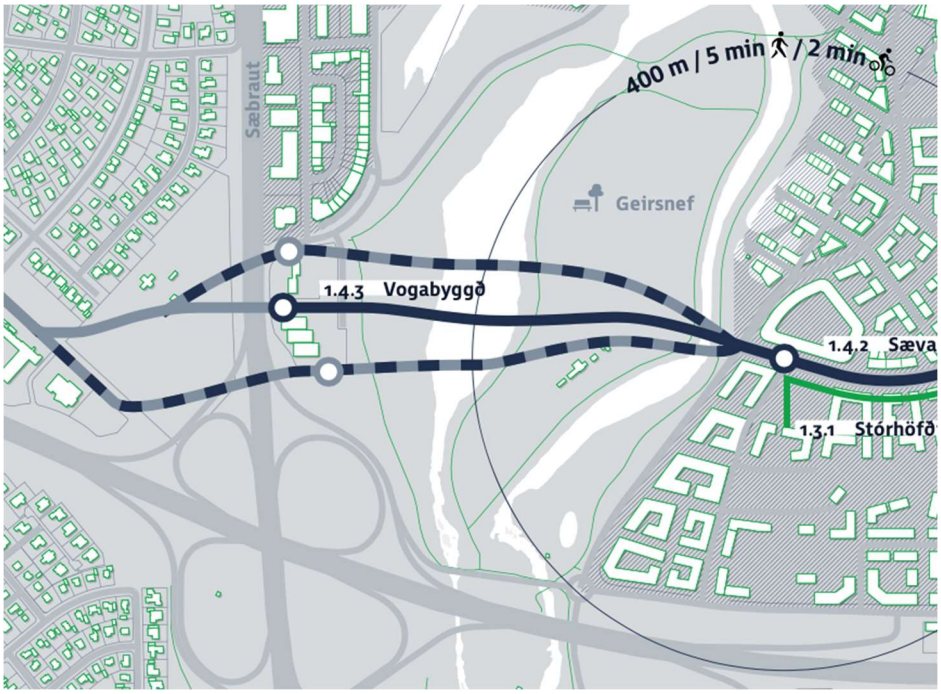

Figure 54: Final Conceptual Design showing lead-in options to Vogabyggð

The first draft design showed a “possible” automobile connection between Suðurlandsbraut and Súðarvogur. We recommended against including this in the final design, since it would likely complicate both the construction and the operation of the Vogabyggð interchange if private cars were introduced to this otherwise bus-only area. The final conceptual design does not appear to include such a connection.

2. Suðurlandsbraut/Laugavegur

The Suðurlandsbraut/Laugavegur section of the corridor, from Vogabyggð to Katrinartun on Laugavegur, for the most part, will follow the classic BRT cross section as suggested in the design guidelines, as shown in Figure 55 below. This section is the easiest on which to build a classic BRT cross section with central-median alignment, as it is very similar to the existing cross section, though it will require the relocation of utility poles which are currently situated in the median. It is consistent with BRT design best practice.

Figure 55. Suðurlandsbraut will for the most part have a classic BRT cross section as above

As part of our review of the Conceptual Design for the Borgarlína project, we reviewed the Suðurlandsbraut section of the corridor in April and then again in September as the final version of the Conceptual Design was produced.

Separation of Busway at Mörkin

The current Conceptual Design shows that for a portion of Suðurlandsbraut in the vicinity of Mörkin, the BRT corridor operates in a bidirectional roadway, physically separated by trees from the mixed-traffic public roadway, as shown below.

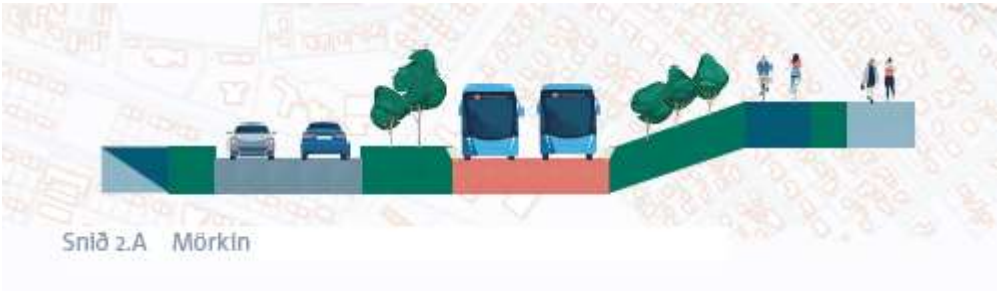

Figure 56: Cross-section of Suðurlandsbraut in the vicinity of Mörkin

Since the busway is descending from the Vogabyggð flyover, this alignment seems logical. However, it could be confusing for pedestrians or other road users who might not know to look in both directions each time when crossing all rights-of-way (bicycle, bus, mixed traffic). ***We recommend clearly flagging***

this as a potential hazard in the Conceptual Design to ensure that adequate signage and possibly fencing or a vegetative swale be used to clearly delineate the busway.

Also, as mentioned above, the Skeifan station will need to be relocated to this section or else Route C may not be able to connect to Routes B, E and F.

Skeiðarvogur Intersection

At the Skeiðarvogur intersection, as shown in the image below, the Conceptual Design shows that the busway will cross over traffic and into the central median alignment it follows for the remainder of Suðurlandsbraut. The design also shows that this intersection, currently a roundabout, is to be signalized.

Figure 57: Excerpt of Conceptual Design showing signalized intersection at Skeiðarvogur

The movement of the BRT crossing to the median at this signalized intersection creates a very unusual set of traffic movements that motorists and pedestrians may not be expecting without very clear signage. It is probably correct that this intersection will need to be signalized in a way that gives a dedicated phase to the two-way BRT movement between the north side of the road and the central median. It will add some delay, but the mixed traffic volumes are not high, so ***a real-time actuated signal priority for the BRT should be considered.***

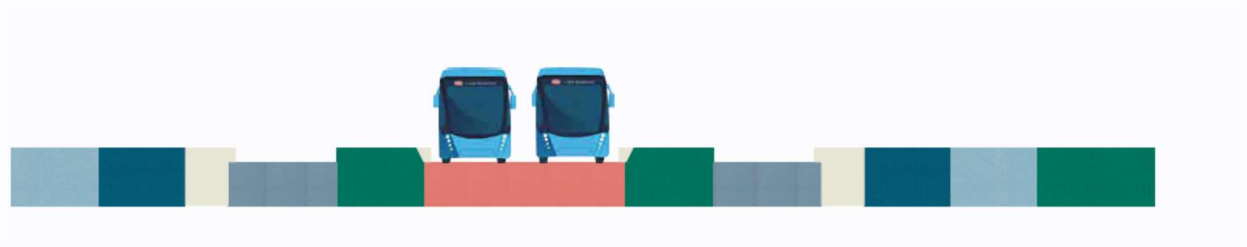

Figure 58. The cross section along ***Suðurlandsbraut*** *follows the standard central median-aligned cross section*

From the Skeiðarvogur intersection to the end of Suðurlandsbraut, Borgarlína follows the standard cross section as shown above in Figure 58. This is consistent with best practice.

In some cases, where the urban character of the road is such that there are likely to be many taxi, ride-hailing, and delivery vehicles stopping in the single mixed traffic lane, we would tend to advocate for a second mixed traffic lane or pull-by zone for delivery vehicles on the side of the road (the southwest side) where this risk is greatest. This could be secured by offsetting the Borgarlína stations and narrowing the medians between stations. If there is extensive community resistance to the proposed design, offsetting the stations and adding a second mixed traffic lane on the southwest side of the roadway, where there is more development and more is planned, could be considered. The only downside of offsetting the stations is that they would make the busway slightly less straight, which does not present any significant difficulty.

3. Hlemmur, Hverfisgata and Kvosin / Tjörnin

Borgarlína from Hlemmur to the National Museum of Iceland runs through the heart of downtown Reykjavík. When first discussed during our workshop in December, it was not yet clear what the Borgarlína routing would be through downtown, particularly around Lake Tjörnin. The decision was eventually to split the bus route into two one-way pairs operating in mixed traffic, with southbound traffic on the west side of the lake and northbound traffic up the east side of the lake. This was our preferred solution and we support it, as it simplifies somewhat the traffic signals.

Station Sizing and Saturation in Downtown Reykjavík

The stations along this section have the highest boarding and alighting volumes and therefore run the greatest risk that the buses will back up at the station, causing delays, or that the bus stations will become overcrowded with waiting passengers.

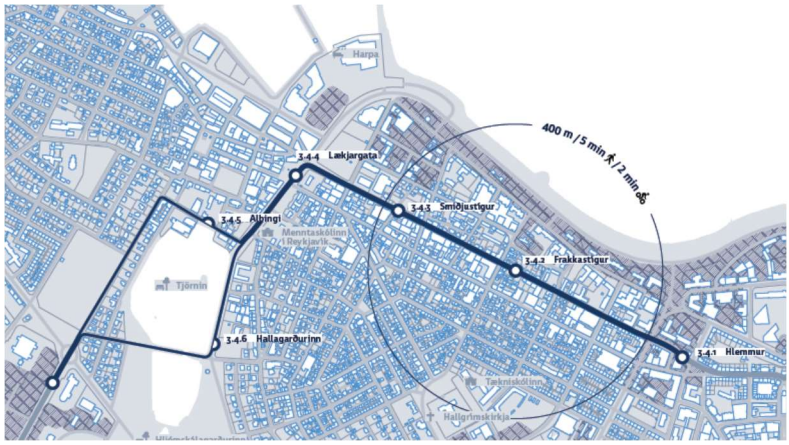

Figure 59: Borgarlína stations from Hlemmur to the National Museum of Iceland

Some BRT systems around the world include passing lanes at stations to allow for greater operational flexibility and reduce delays. This possibility was identified in the conceptual design report, under the design principles section. Passing lanes are most important at the stations with the highest bus volumes, as a way of reducing the risk of station saturation.

The level of saturation depends on whether the stations have complete BRT treatments, or whether they are standard bus stops, or something in between. “Full BRT” delay reduction treatments include:

1. Bus floor at-level with the station platform (within 1.5 cm);
2. All-door boarding on a bus with two or more doors; and
3. Ticket validation off the bus; and

While the conceptual design does indicate that at-level boarding is to be provided, we did not find any indication of whether or not the stations will provide all-door boarding, or in what manner it will be provided. The risk of station saturation is very much dependent on the nature of fare collection.

Because boarding generally takes longer than alighting, these stations are more likely to saturate in the afternoon peak, when people are leaving downtown, than in the morning peak when they are arriving. Based on similar systems, it was assumed that at-level stations without all-door boarding and pre-payment of fares would require 2.5 seconds per boarding passenger and 1.5 seconds per alighting passenger. Full BRT treatments at the stations, with pre-paid fares and all-door boarding, would reduce boarding times to 0.7 seconds for boarding and 0.4 seconds for alighting. In both standard station and BRT station scenarios, fixed dwell time (the time for the bus to slow down, stop, open and close doors, and accelerate again) is assumed to be 16 seconds.

Normally, a station is considered saturated when there are buses stopped at the station for at least 40% of the total peak hour. In other words, if there is a bus at a station for 24 minutes out of 60 minutes, the bus stop will start to back up and thus is considered saturated. This is due, in part, to high levels of irregularity in passenger loads and arrival times.

We performed our analysis based on the estimated boarding volumes per station on the proposed Strætó 2024 service plan as it stood in December of 2019[6].

Table 4: Calculation of station saturation at high volume BRT stations

Station	Boardings (pax/PM peak hour)	Alightings (pax/PM peak hour)	Frequency (buses/hr)	Fixed Dwell (s) - all station types	Variable Dwell (s)		Total Dwell (s)		Saturation (%)	
					Standard Stations	BRT Stations	Standard Stations	BRT Stations	Standard Stations	BRT Stations
Hlemmur	401	156	30	475	1237	343	1712	819	48%	23%
Háskóli Íslands	356	71	9	137	996	277	1133	415	31%	12%
Stjórnarráðið/Lækjartorg	328	66	30	475	919	256	1394	731	39%	20%
LSH-Future	313	63	30	475	877	244	1353	720	38%	20%

The most crowded station, in terms of bus saturation, in 2024 is expected to be Hlemmur, followed by the University (Háskóli Íslands), then Stjórnarráðið/Lækjartorg (downtown), and finally the Hospital (LSH).

With full BRT treatments including pre-paid all door boarding, none of the stations in the system are at risk of saturation or overcrowding (see far right column in Table 4) given the current dimensions, nor will passing lanes be needed. This is because buses will be able to move through the stations quickly and should thus be able to keep the highest volume stations clear about 75% of the time. These conditions are unlikely to change by 2024.

Without pre-paid boarding, but with at-level boarding at these stations, under the current service plan, passing lanes are needed at Hlemmur, and will be needed at Lækjartorg and the Hospital within the life of the infrastructure (20 years).

Passing lanes could still be made unnecessary if frequency were dropped. Some of our proposed service modifications (such as a more direct routing of Route A to the University of Iceland) would reduce the frequency and hence the fixed dwell time. Some of the frequencies on the other routes could also be dropped moderately if saturation becomes a problem. In other words, service planning changes *can* be used to remove the need for passing lanes even with standard, non-BRT stations, but ideally not to the disbenefit of passengers.

Station spacing in downtown Reykjavík

Currently, the station spacing is fine, with stations on average about 400 meters apart, which is consistent with best practice. However, the spacing between Lækjartorg and Fríkirkjuveginum stations is nearly 800 meters, which is too long. This will tend to increase the risk of overcrowding at the Lækjartorg station.

Hlemmur Area

Hlemmur, the current downtown bus transfer hub, consumes a lot of land right in the center of Reykjavík for bus layover. With the planned Strætó route restructuring, none of the bus routes terminate at Hlemmur, so much less space is needed for bus layovers. This is critical to making Hlemmur a new pedestrian-dominated central square for Reykjavík, as conceptualized in Figure 60 below.

[6] Estimated boarding volumes were provided by COWI

Figure 60. Concept for Hlemmur Central Square

On 18 March, the Borgarlína Team sent to BRTPlan a draft conceptual design package for Hverfisgata and Miðbær. The following summarizes our comments on those designs, including a description on whether and how our comments were addressed in the Conceptual Design report.

The first section of Laugavegur between Katrinartun and Hlemmur, through Hlemmur Square, as far as the Snorrabraut/Hverfisgata intersection, will be bus only, as shown in Figure 61 below.

Figure 61. The approach to Hlemmur on Laugavegur past Katrinartun, continuing through Hlemmur to Hverfisgata, will be a bus, bike, and pedestrian only street.

This is consistent with best practice and should cause no significant mixed traffic issues.

Hverfisgata (Hlemmur – Lækjargata) Details

The section along Hverfisgata between Hlemmur and Lækjargata will be a bus only lane in one direction, and a mixed traffic lane in the other direction.

Figure 62. Cross section for Hverfisgata has a one-way bus only street, and a mixed traffic lane in the opposite direction.

The design assumes that bicycles will share the walkway with pedestrians, or take a parallel cycling route, but design speeds along the busway will be kept to a maximum of 30 kph to account for the significant risk that cyclists will use the busway.

Bike-Bus Interaction

During the draft Conceptual Design phase, there was considerable discussion about bicycles treatments along this section. It is fairly common for bicyclists to share a pedestrian zone demarcated by bollards in Japan. It is uncommon in the United States particularly in locations where pedestrian volumes are likely to be high.

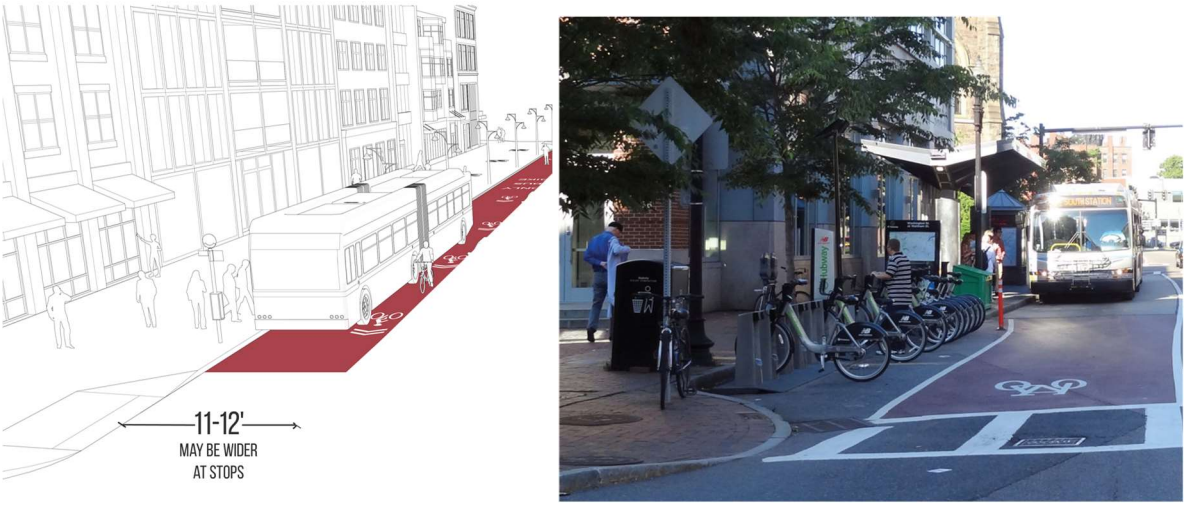

Figure 63. Images from the NACTO guide on bike/bus lane interaction

Our preference would be to design the street for bicycles to share the street with buses. The National Association for City Transportation Officials (NACTO) Urban Street Design Guide[7] suggests that the bus lane be designed for cyclists to pass the bus on the left at stops but otherwise to simply share the bus lane. This would be made easier if the station locations were directionally offset.

[7] https://islandpress.org/books/urban-street-design-guide

Figure 64. Bike-busway design from Chicago where cyclists pass behind the bus station.

A better alternative, where space permits, is to design the bike lane to pass behind the bus station. This design works well in Chicago on the Loop Link, and in San Francisco on Market Street, among other places. Another option would be for cyclists to enter the walking zone only at stations.

Roadway paint can be used to indicate that bicycles are expected to mix with pedestrians and cross behind the stations, which might be indicated with 'sharrows' on the walkway. Since bicycle volumes are expected to be relatively low on Hverfisgata, as a parallel bike route is being provided on Skulagata, and since it is relatively common for bicycles to ride on the sidewalk in Reykjavík, this seems a safer solution.

While the current designs do not show how the sidewalk will be separated from the bus lane in these segments, ***we recommend separating the sidewalk from the bus lane and mixed traffic lanes with bollards rather than curbs*** (Figure 65) to allow the free flow of movement of bicycles between the sidewalk and the bus lane and mixed traffic lane.

Figure 65: Example of bollards that could be used to separate the carriageway from the pedestrian walkway

It would also be helpful to show the proposed Skúlagata bike route as the primary route for bike through-trips as well as to explain why that decision has been made.

Dedication of the busway

The current conceptual design includes a busway westbound and a mixed traffic lane eastbound, to enable certain residential and commercial access on Hverfisgata.

In terms of the proposed busway, we agree with the following:

a) Local access car trips and deliveries should be permitted to access the parking garages.
b) The level of traffic likely to use the mixed traffic section will be minimal, serving a local access function but no traffic flow function. As such, local access only should be sufficient, though ideally, pick-ups and drop-offs would happen on perpendicular streets.

Thus, we propose an alternative where both directions are treated as 'bus only' but where local trips (perhaps identified by a windshield parking access permit) are permitted to make the necessary movements. This sort of regulatory regime is currently being used on the 3rd Avenue Busway in Seattle, on 14th Street in New York City, and on Market Street in San Francisco. We recognize that this involves more administrative complexity from the perspective of traffic management. However, we recommend that the issue be studied in greater depth.

Signage can explain certain exceptions to the 'bus-only' regulation as follows:

a. All vehicles with a parking permit in their windshield for private residential garages on Hverfisgata may use the road following the traffic pattern indicated in Version D
b. All vehicles trying to reach the commercial parking garage can access it from the nearest perpendicular street only. Enforcement is by stationary cameras.

c. All vehicles making deliveries to shops along Hverfisgata may use the road for a maximum of one block and make use of designated pull-by locations or before or after busway operation.

This would send a clearer signal to drivers and citizens that Borgarlína is intended to have full priority.

If one direction of Borgarlína is left open to mixed traffic in one direction, it will reduce the number of points for dedicated right of way in *The BRT Standard* from 8 to 6.59.

In a draft version of the Conceptual Design for this section that we reviewed in March, the permissible eastbound movements were shown as pictured below.

Figure 66: Hverfisgata Road Change version D (slide 16) from Draft conceptual design

The final Conceptual Design does not provide any detail about the proposed traffic routing along Hverfisgata, so it is not possible to ascertain whether this same traffic routing plan is in place. The final design consultants should be given clear instructions about these issues.

Lækjargata and Lake Tjörnin

Figure 67. Station placement, Lækjargata *and Lake Tjörnin*

When first reviewing the plans for Lækjargata and Lake Tjörnin, it had not yet been decided whether Borgarlína would be designed two-way to the northwest of Lake Tjörnin, or two-way on Fríkirkjuvegur, or on two one-way pairs around the lake. We suggested that the design team implement one-way BRT pairs around Lake Tjörnin running one-way southbound on *Suðurgata* and one-way northbound on Fríkirkjuvegur. This recommendation has been taken in the Conceptual Design.

The current plan is for the standard BRT cross section to be used along Lækjargata, then to switch to mixed two-way traffic around Lake Tjörnin on roads also shared with bicycles. These mixed traffic sections are about 0.7 km and thus will lead to another loss of about 1.5 to 2 points in *The BRT Standard*.

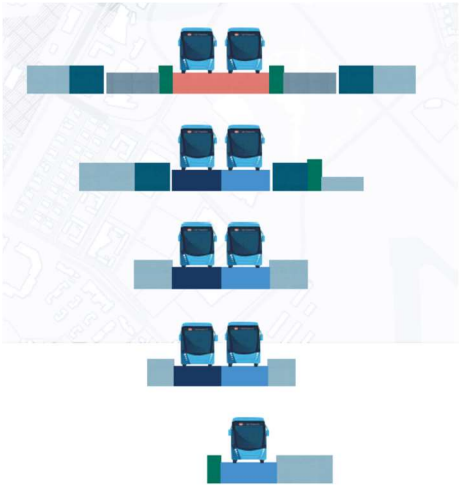

Figure 68. Various cross sections, Lækjargata *and around Lake Tjörnin*

We recommend that the detailed design consultants develop a bus-only alternative for Lake Tjörnin. It should be possible to have only one-way mixed traffic around Lake Tjörnin, which may simplify traffic signals and address any mixed traffic saturation delay, but detailed traffic impact analysis is required.

This section of the BRT corridor serves five overlapping bus routes (Routes A, B, D, E, F under the current plan) and ***will result in significant delays in the very core of the system if left operating in mixed traffic.***

We also suggest that a two-way bike lane adjacent to the lake on Fríkirkjuvegur be considered, even if the footpath needs to be cantilevered over the lake on a boardwalk.

Spur on Geirsgata

We proposed that a spur of the BRT corridor continue onto Geirsgata as far as the approach to the Old Harbor (where the road narrows significantly). There is significant new development along the harbor, and it is also a tourist destination. Further, there is residential density throughout the Old West Side. This proposal would require first a service which continues along this path, and this is being discussed with Strætó. If it is decided that such a service should be included, then ***it is suggested that a BRT spur, including a station, be designed along Geirsgata in order to stress the importance of the Old Harbor as a destination***. This proposal has not been included in the Conceptual Design report.

Figure 69: Proposed corridor alternatives and extensions

4. University (HÍ) - BSÍ

Background and General Comments

In the design draft we reviewed in April, the Borgarlína design team proposed three potential routings through the university area:

- **Option A**: Routing through the University Campus on Sturlugata
- **Option B**: Routing through the University Campus on Eggertsgata
- **Option C**: Routing bypassing the University Campus on Hringbraut

These options are visualized in the following map:

Figure 70: BRT Infrastructure alternatives, University area

The principal question is: Where should BRT infrastructure be built that would bring the greatest benefits to transit passengers at the least disbenefit to everyone else?

Our recommendation was to build Option C with a BRT corridor operating on Hringbraut, which would provide a direct route into downtown as well as a spur for routes operating on Suðurgata. This seemed cleaner and better related to the planned services. The Conceptual Design selected Option A, with a routing on Sturlugata through the University of Iceland campus.

Figure 71. Borgarlína routing through the University of Iceland

This option has the advantage that is does not require any changes on Hringbraut. There are plans to bury Hringbraut, and these plans could conflict with Borgarlína development plans. It also has the

advantage of simplifying the two intersections: the Suðurgata and Hringbraut intersection, and the Njarthargata and Hringbraut intersection. These intersection treatments depend, however, on how the planned services relate to this planned intersection.

Service Plan Impacts

In planning a BRT corridor, it is best practice for the dedicated infrastructure to be located where there are the highest volumes of bus passengers and the greatest amount of delay. Thus, BRT infrastructure planning requires a strong link to the BRT service plan.

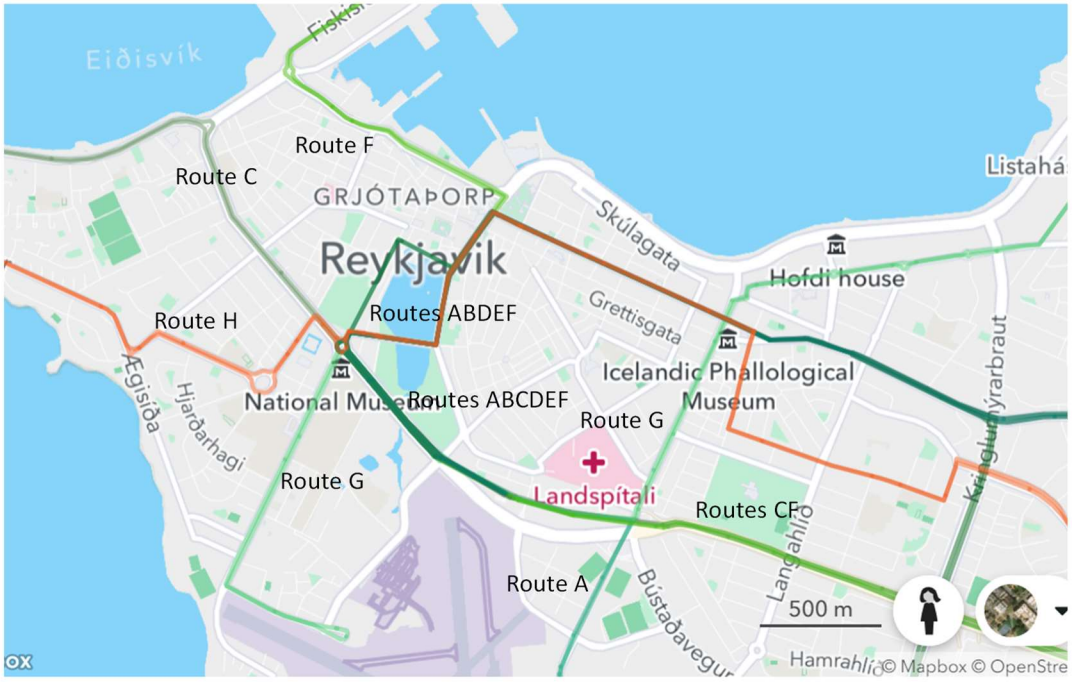

Figure 72. Proposed bus services in the University area

Currently, six routes use Hringbraut, (routes A, B, C, D, E, F); Route G uses Suðurgata; and none of the routes use Njarðargata or Sturlugata. This leaves open the question of how the services will be routed with this current Borgarlína alignment.

We recommend that* no *downtown-bound Borgarlína routes use Njarðargata/Sturlugata/Suðurgata for their entire route.

Routing any downtown-bound routes (A, B, C, D, E, F) onto the Borgarlína infrastructure would cause a detour of 1.24 km and an estimated delay of ~03:40 minutes for passengers on these routes heading into Downtown Reykjavík, or for any destinations beyond. This is much greater delay than is reduced by the Borgarlína infrastructure.

In our recommended route modifications, where we have taken into account the proposed infrastructure, we have suggested that no routes simply follow this loop around the University. Rather:

- Route B should take Suðurgata and terminate at the last University station. This is a good location for route to terminate as it is far from the city center and there are few popular destinations farther west.
- Routes A and G should also terminate at the last University station but would come from Njarðargata to Sturlugata.
- Only Routes C and F would remain on Hringbraut and would operate in mixed traffic. To divert these two routes onto Borgarlína would cause the loss of time mentioned above.

Figure 73. Close up of recommended routing changes related to University area

Suðurgata and Hringbraut Intersection

Suðurgata will have the standard Borgarlína BRT central median alignment. We agree with this decision. The existing cross section is easily adapted to the newly proposed cross section which is consistent with best practice.

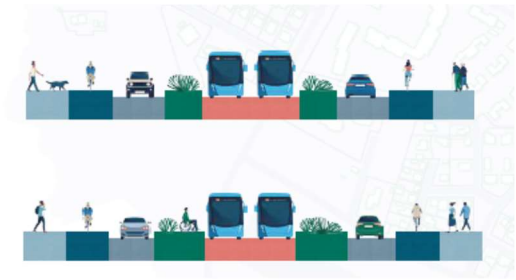

Figure 74. Cross section proposed for Suðurgata

The routing decisions will have a significant impact on the design of two critical intersections.

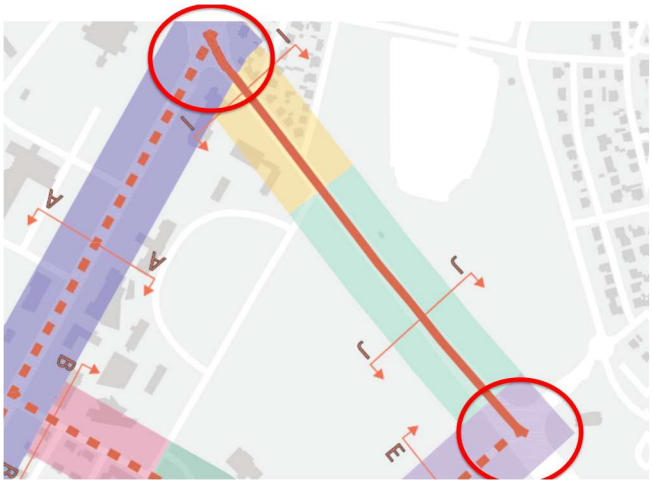

Figure 75: Two critical intersections on Hringbraut

Currently, the intersection at Hringbraut and Suðurgata (top circle in Figure 75 above) is an unsignalized roundabout. It is handling 3,627 personal-car-units (PCU) in one direction and 2,807 in the other direction during the peak hour. This is a relatively high-volume intersection and it is operating reasonably well as a roundabout.

Figure 76: Peak hour PCUs at the Hringbraut and Suðurgata roundabout

Introducing central median-aligned BRT on Suðurgata into this roundabout adds a degree of complexity. The current plan is to signalize the intersection, but no further detail has been provided.

The following images show the various Strætó turning movements that would need to be accommodated through this intersection.

Figure 77. Strætó services moving between Hringbraut and Suðurgata north

Under the current service plan, Routes A, B, D, E and F all move between Hringbraut and Suðurgata north of the intersection as shown in Figure 77 above. In BRTPlan's proposed alternative service plan, only Route F would make this turning movement. This movement under the current infrastructure plan is in mixed traffic in both directions so it poses no special complexity.

Figure 78. Strætó services moving between Suðurgata south and Suðurgata north

Movement between Suðurgata south and Suðurgata north involves only Route G under the current Strætó proposal, and only Route B in the proposed BRTPlan modified service plan. This movement is also relatively unproblematic.

Figure 79. Strætó movements along Hringbraut

In addition, under both scenarios, Route C would move up and down Hringbraut. This movement is also relatively unproblematic as it occurs entirely in mixed traffic and is straight.

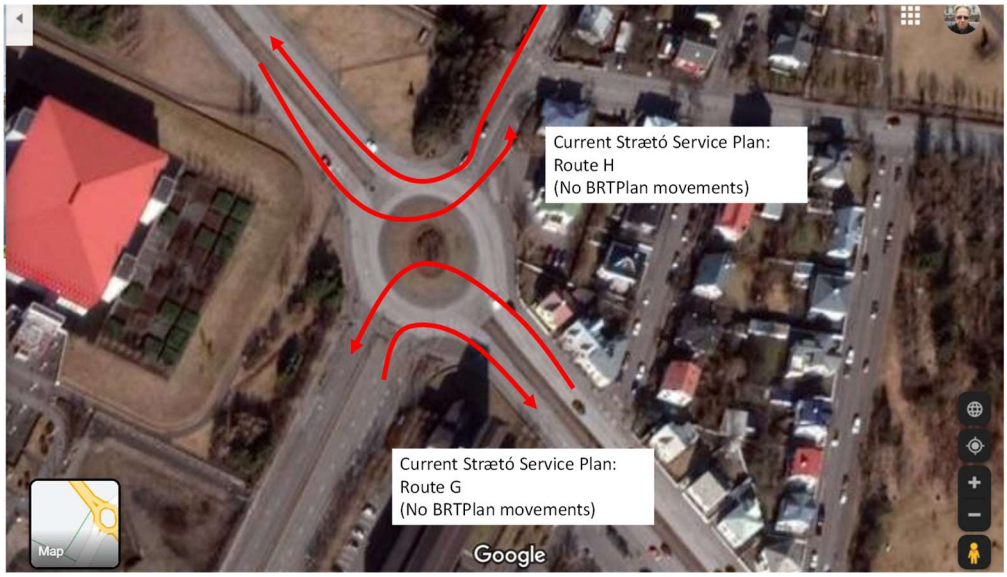

Figure 80. Strætó movements between Hringbraut west and Suðurgata north

In addition, the Strætó plan would require a movement between Hringbraut west and Suðurgata north. This would be used by Route H. In addition, there is a movement between Hringbraut east and Suðurgata south by Route G. In the BRTPlan alternative, no routes would make these movements.

To accommodate these movements and the mixed traffic movements would require a four-phase signal, as shown in Figure 81 below. None of these movements are easily eliminated.

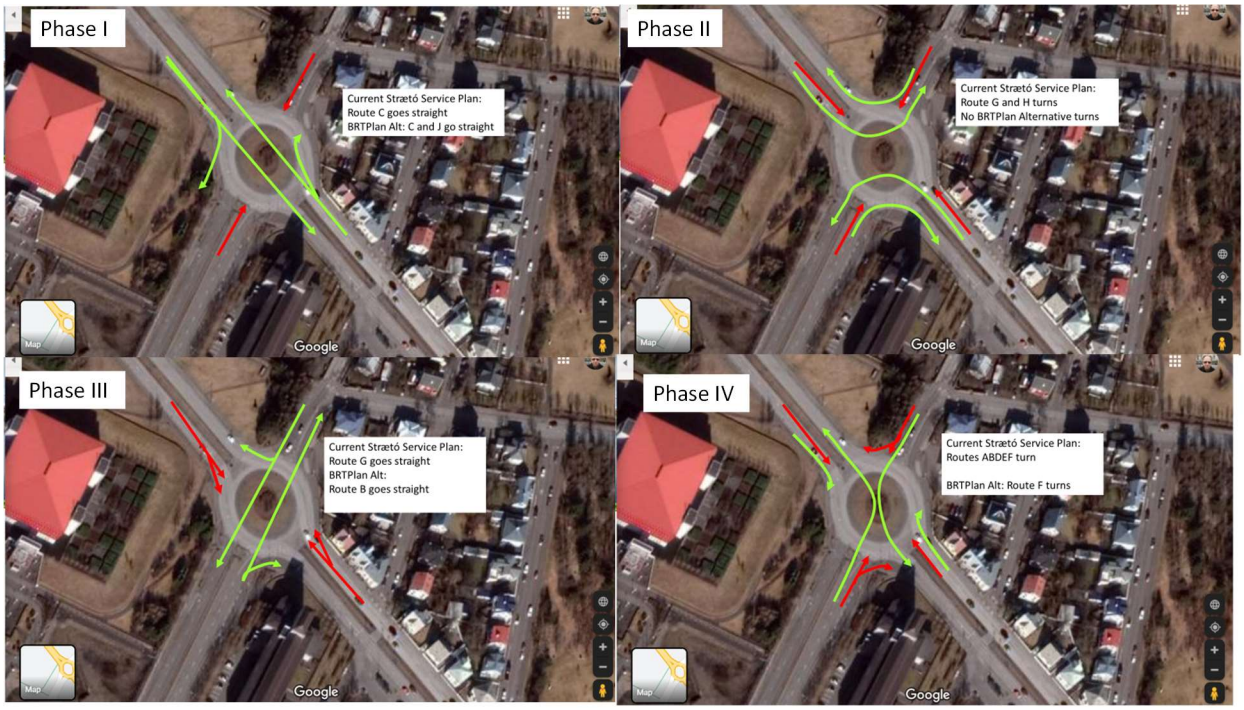

Figure 81. Four phases required to handle planned turning movements

Generally, BRT system designs aim to eliminate all four-phase intersections and reduce them to a maximum of three phases and, in ideal cases, two phases. The language in *The BRT Standard* rewards the percentage of turning movements across the busway prohibited. This metric is confusing to apply and is currently under review. Most likely, the guideline will be changed to offer 7 points if more than a certain percentage of intersections have a minimum of 40% green time for the BRT services in both directions.

Given the number of BRT turning movements that must be allowed at this junction, we recommended that the detailed design consultants run a microsimulation of a signalized alternative as above and of leaving the intersection as a roundabout. Since the intersection flows well as a mixed-traffic roundabout currently, and only one approach has BRT infrastructure planned, ***we suspect the intersection will perform better for both Borgarlína passengers and mixed traffic if left as a roundabout.***

Hringbraut and Njarðargata intersection

The proposed BRT movement across the Njarðargata intersection is complex. We do not possess the signal timing for the existing Njarðargata intersection and the signal phasing for the proposed design has yet to be developed.

Figure 82. All proposed Strætó routes (A-G) follow the above routing indicated in green arrows.

Currently, there are no routes which would proceed through the intersection on Njarðargata. It must be presumed, however, that some service changes would be made to make use of the proposed Borgarlína infrastructure on Njarðargata.

Figure 83. BRTPlan proposed Routes A and G would cross Hringbraut on ***Njarðargata***

No detail has been provided as to how this signal would be designed or its current design. We believe the signal is a traditional four-phase signal, with each approach to the intersection given one phase for vehicles to move in all directions.

Because of the peculiarity of the BRT system's main movement through this intersection, based on our discussions in April, the current thinking is to add a fifth phase to the signal.

The image below indicates the special Borgarlína signal phase, and the number of intersection movements that must be stopped so that Borgarlína buses may proceed during a fifth signal phase, as is currently being discussed. The Borgarlína left and then immediate right turning movements from Hringbraut into BSÍ would be made during the main Hringbraut left turn signal phase. Note that southbound traffic on Hringbraut and east- and westbound right turning movements from Njarðargata onto Hringbraut could both be made during the BRT phase.

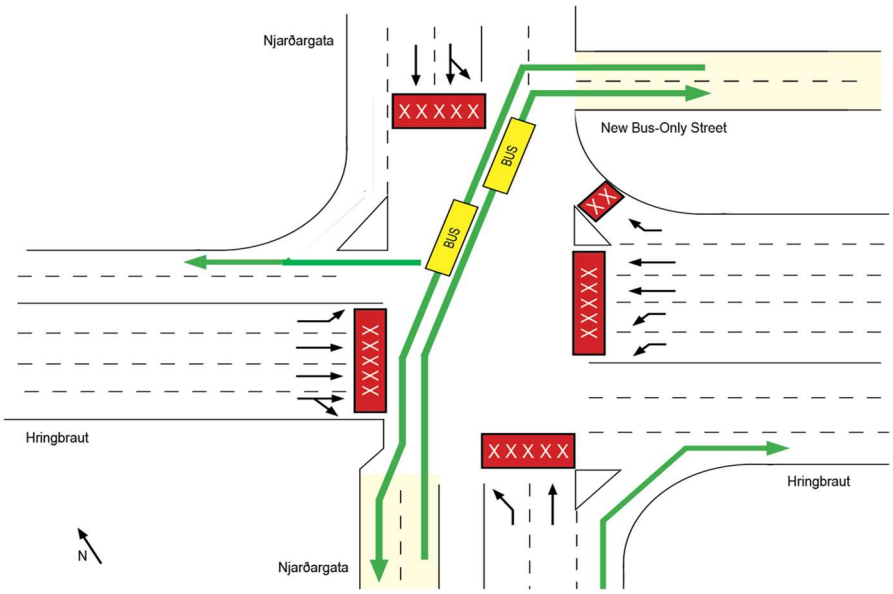

Figure 84: Movements through the Hringbraut/Njardargata intersection that can be permitted simultaneously with the main BRT movement; i.e., permitted movements during a fifth BRT signal phase.

The above alternative would give very little green time to the Borgarlína buses and would reduce the throughput of the intersection in general, lowering the level of service at the intersection. This intersection is already moderately congested.

Other alternatives that might be considered are:

- A bus-only flyover from BSÍ over Hringbraut onto the north side of Njarðargata, having the buses exit BSÍ where they currently do at Gamla Hringbraut and travelling in mixed traffic (see Figure 85).
- Eliminate some left turning movements and convert them to U-turns beyond the intersection; or
- Create a high capacity roundabout or ‘square-about’.

Figure 85: Bus-only flyover for TransMilenio BRT shown in Bogotá, Colombia

Since the level of service at this intersection could be very negatively impacted by the Borgarlína project, resulting in traffic congestion on Hringbraut, we recommend this intersection be analyzed with great care.

5. BSÍ - Fossvogur

As Borgarlína passes BSÍ and the hospital, it is planned to be on its own right of way, with no mixed traffic, only cycling and walking facilities on either side. This will create a nice aesthetic but complicates the Njarðargata/Hringbraut intersection as discussed above. Where it enters the hospital area, there will be a single-mixed traffic lane on either side, with ambulances using the busway as needed.

Figure 86. Borgarlína past BSÍ and the hospital

The cross sections for this segment are shown in Figure 87 below.

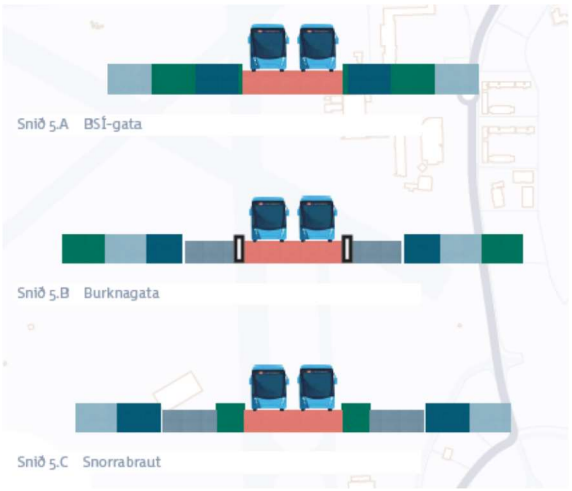

Figure 87. Borgarlina cross sections through BSÍ and the hospital

On 22 April, the Borgarlína Design Team sent for BRTPlan's review the segment from the current BSÍ terminal to Fossvogúr and the Reykjavík University (HR). On 29 April, the BRTPlan team presented its comments in a Zoom call with Hallbjörn Hallbjörnson and Ragnheiður Einarsdóttir of the Borgarlína Team. Many of the details under discussion have not been included in the Conceptual Design report as it now stands.

Background and General Comments

The Borgarlína Design Team has proposed one general routing for this segment which involves several new streets to be constructed through the BSÍ, Landspítalínn, and Hliðarendi area.

Broadly speaking, we support the designs that have been proposed. There are several potential challenges to answer highlighted below, which will be discussed further in this memo. We raised three principal concerns during our review in April:

1. **Delay to ambulances at Landspítalinn:** There is a risk that ambulances will be stopped behind Borgarlína buses at the Landspítallin bus stop if the station and BRT lane design near Landspitalínn in the current design are not modified. These designs are not shown in the current Conceptual Design.
2. **Impacts of the Miklabraut development:** The planned development over Miklabraut is an exciting urban development project, but its potential operational impacts on Borgarlína must be considered in greater detail. This does not appear to have been considered in the Conceptual Design; however, it is possible that this is being considered outside of the scope of the design.
3. **Location of main transfer hub:** Under Strætó's current service plan, and under our proposed alternative, the hospital is a more important transfer point than BSÍ. There was a proposal to make the Hospital station a Borgarlína Central Station closer to the intersection of Miklabraut and Snorrabraut.

Delay to Ambulances at Landspítalinn

The Borgarlína corridor will run on a brand-new road through the BSÍ/ Landspitalínn site. While this means that a new cross-section can be developed from a clean slate, there is still some complexity since

a clear path must be given for ambulances to access the hospital. All the cross-section plans allow ambulances to use the BRT lanes on this cross-section, which we endorse.[8]

A potential challenge in this respect is that the two station platforms at Landspitalínn are directly across from one other. If only one bus is pulled to a stop at the Landspitalínn BRT station, the ambulance could go around it into the oncoming lane. However, if there are buses stopped at both the eastbound and westbound BRT stops, an ambulance will not be able to pull around the buses. An ambulance could be stuck waiting for one of them to clear the platform and resume movement.

In the April draft design, the Borgarlína Design Team provided a cross-section showing a low-rise median which separates the busway from the single mixed traffic lane, as shown below.

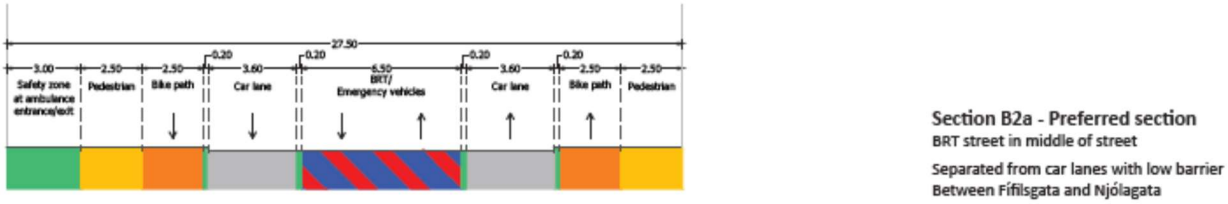

Figure 88: Preferred cross section for Burknagata between Fifilsgata and Njolagata

Our concern was that an impassable median could potentially inhibit ambulances stuck behind buses at the bus stop from shifting over to the mixed-traffic lane to bypass the station.

This could be easily mitigated by having a permeable barrier between the bus lane and the mixed traffic lane in the area approaching the bus stop. However, there is a risk that the mixed-traffic lane could also be blocked by traffic congestion, as shown below, thus eliminating the benefit to ambulances of using the BRT lane in this section.

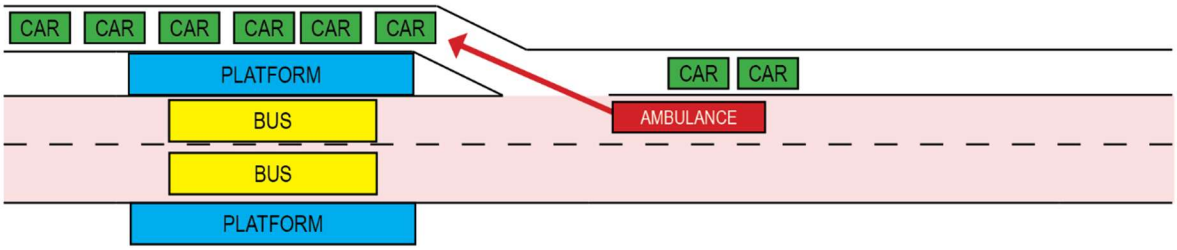

Figure 89: Birds-Eye View of Ambulance Bypass in Mixed Traffic with congested conditions (Not to Scale)

As a result, we recommended that this station be redesigned with offset BRT platforms. In the case described above with two stopped buses, this would allow an ambulance to overtake the stopped bus in the oncoming BRT lane. Given the professionalism of both bus and ambulance drivers, allowing overtakes in the oncoming lane is a minimal risk. Beyond the reduced risk of delaying an ambulance, this may also allow for a narrower overall profile of the corridor, allowing for wider BRT lanes, station platforms, and sidewalks, as shown below.

[8] To avoid future confusion, it should also be clarified on a city-wide scale whether emergency vehicles will be permitted to use BRT lanes or if this policy only applies on this segment.

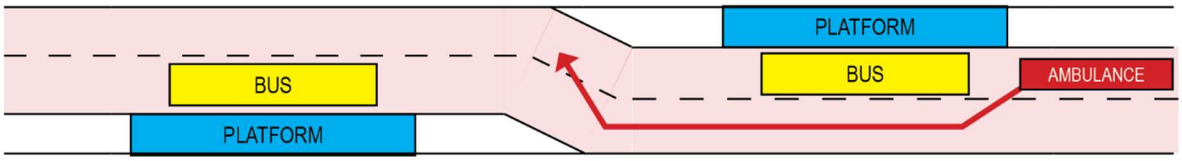

Figure 90: Birds-Eye View of Ambulance Bypass using Offset Stations (Recommended – Not to Scale)

In the discussion of the Landspítalinn station in the Conceptual Design, there is a referenced need for ambulances to pass unimpeded (Sec 5.3.1, p.71). However, we did not see any mention of offset platforms or other infrastructure-based solutions to provide this crucial access. ***We recommend that this potential problem be addressed in the Conceptual Design and that the station locations be more clearly specified, particularly as they relate to ambulance routes, as the hospital is a crucial stakeholder in this project.***

Impacts of the Miklabraut Development

One of the more challenging parts of the Borgarlína corridor is the intersection between Miklabraut and Snorrabraut, where it is expected that the corridor will emerge from the new road passing through Landspítallin. This area is especially challenging for two reasons: First, this is a major highway interchange between a limited-access highway (Miklabraut) and an arterial street (Snorrabraut), so the volume of traffic affected by BRT in this area is high. Second, the movements required by Strætó's proposed BRT service plan across this intersection are only possible with significant reconstruction to the intersection.

Figure 91: Proposed deck over Miklabraut which provides a new road with direct connection

We understand that there is a planned decking-over of Miklabraut at this location. This would bury the freeway and construct numerous residential and commercial high-density properties on top of the deck, thereby allowing for a reconfiguration of Snorrabraut and Bústaðavegur which would enable the desired BRT movement on top of the deck.

As this is an expensive and complex project which will not be complete until *after* Borgarlína is operational, ***we recommend that Borgarlína's Conceptual Design also include the expected routing of the corridor during the construction phase(s), as the buses are likely to operate on this alternate route for months, if not years, due to the time frame of the construction project.***

Even when the deck is complete, there may still be access limitations that would impede Borgarlína access to the deck in favor of construction vehicles. ***We recommend that this deck-over project be more clearly coordinated with both the service and infrastructure components of Borgarlína, and that this coordination be reflected in the Conceptual Design.***

As a result, we recommended that the design team and the service planning team at Strætó study in detail the expected impact this could have on the infrastructure and service.

Additionally, if there is a risk that this development project will be postponed or cancelled, this could impact the construction of the overall Borgarlína corridor. The alternative routing mentioned above could be made semi-permanent, or the services will have to operate on temporary streets for potentially a very long time.

Central Station and BSÍ

When a major redevelopment of the BSÍ bus terminal was originally proposed, it was planned to be a major transfer point not only between the Strætó/ Borgarlína routes, the Airport, and tourist routes, but also a key internal transfer point between the Strætó/ Borgarlína Routes. There was also a desire to relocate the route termini from Hlemmur to a less central location so that downtown Reykjavík is not cluttered with idling buses and Hlemmur can become a public plaza. As such, the initial service plans showed many routes terminating at BSÍ.

There are several challenges associated with using BSÍ as the central transfer point between many bus routes:

1. BSÍ is not located close to the point where many major routes would naturally diverge.

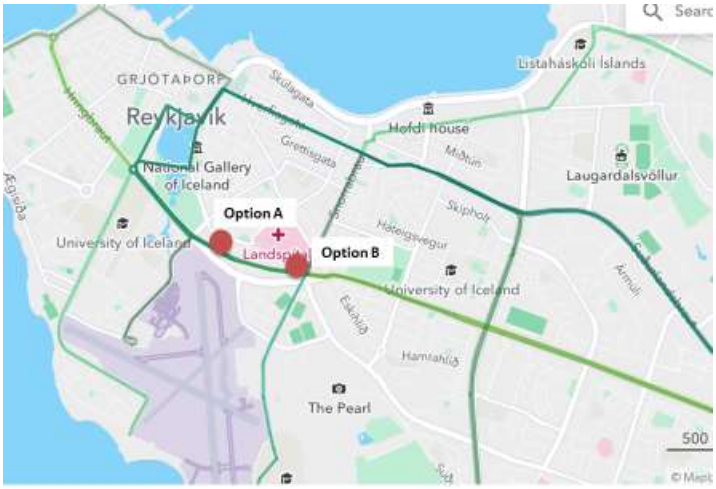

Figure 92: Location of Borgarlína downtown transfer terminal, Option A (BSÍ), and Option B (Hospital)

In the figure above, the Strætó-proposed high frequency Borgarlína routes are overlaid onto the two transfer hub locations, BSÍ (Option A) and the "Central Station" near Landspítalinn (Option B). It is likely that there will be people in the morning traveling west on Miklabraut who might like to turn north onto Snorrabraut, yet there is no service that makes this turn. As such, passengers on routes C and F would need to transfer to the G. Similarly, if passengers on Route A coming up from Karsnes are headed northwards on Snorrabraut, they would also need to transfer to the G.

If the transfer point is located at Option A, these passengers will be forced to travel some distance out of their way (approximately 300 meters x 2, or 600 extra meters) to make this transfer.

In fact, as a result, the COWI transit demand model showed a high volume of transfers at the Hospital BRT station, and a much lower volume at BSÍ. Roughly 1600 passengers would transfer at the Hospital while only about 1400 would transfer at BSÍ, and most of this is a forced transfer due to service patterns which use BSÍ as a transfer hub between routes when other locations may be available as well.

2. BSÍ is not near the natural terminus of any route that would directly connect high volume origin and destination pairs, so it is not an ideal terminus.

A route should terminate in a location where there is some space for buses to lay-over at least for a short while, in order to ensure service regularity. These termini should be located as near as possible to the natural high-volume trip origin or destination point in order to minimize dead kilometers. BSÍ is not a destination in its own right; it is a transfer point based on the assumed Strætó December 2019 service plan, and it is less important than the Hospital as a transfer point.

While the specific service proposals are still under discussion, as has been discussed extensively above, BSÍ is not particularly well suited as a location for internal transfers among Strætó / Borgarlína bus services. While BSÍ will remain an important destination for passengers going to the airport and on tourist trips, the volumes could be easily handled in a normal Borgarlína BRT station stop. Additionally, the tourist and airport buses could also be relocated to a more central location if their operators consent, which would be consistent with the aim to redevelop the BSÍ area.

In our review of the draft designs, there was an alternative location proposed for a Borgarlína Central Station located on or near the Miklabraut deck-over, as shown in the figure below. We endorsed this proposal as it would better serve internal Borgarlína transfers and would represent a more important destination in its own right than BSÍ.

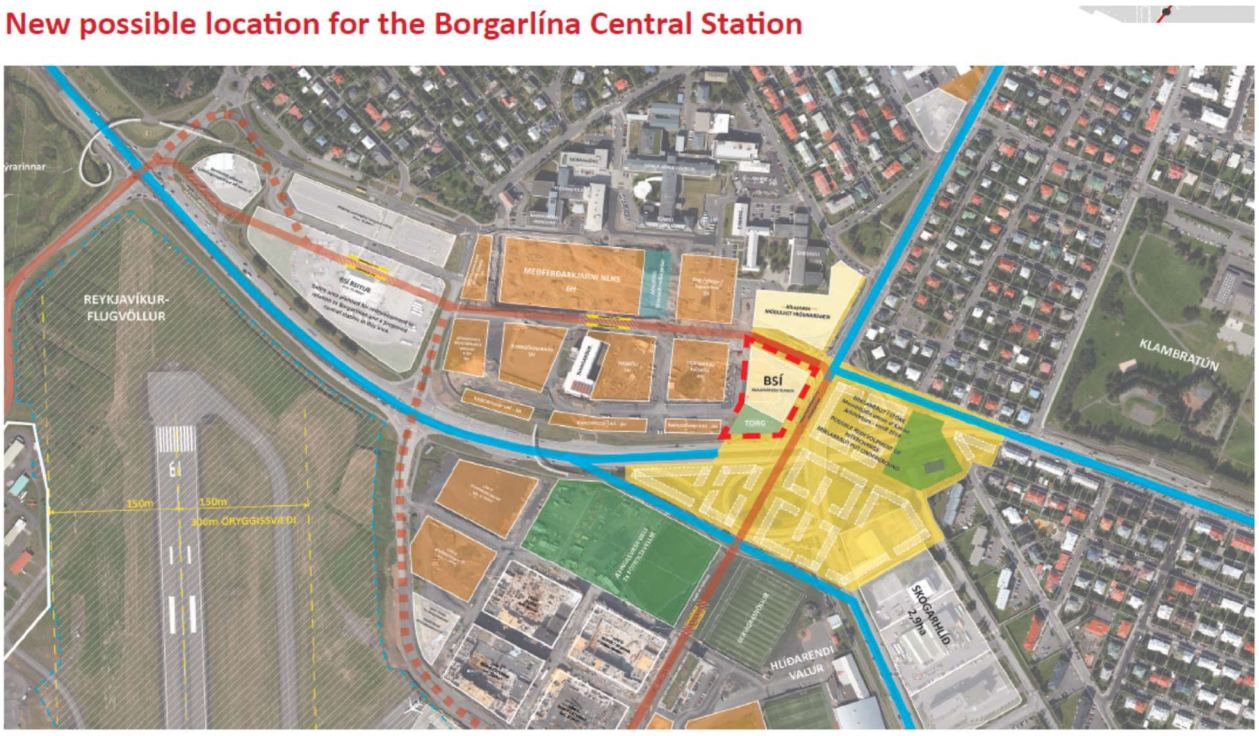

Figure 93: Proposed alternative location for Borgarlína Central Station shown inside the red dashed line marked BSÍ.

If the Central Station is built as indicated in Option B above, the Landspítalinn station would be replaced by the Borgarlína Central Station. Trips to the Hospital can use either BSÍ or Borgarlína Central Station. This would also resolve the problem of buses at the Landspítallin Station blocking ambulances as previously discussed though it would add some additional walking time for some hospital-bound passengers.

The Central Station is not included in the Conceptual Design, while the stop at Landspítalinn is retained. The Landspítalinn station is also located relatively close to the BSÍ station but far apart from the following station at Hliðarendi, yet another reason that the proposed Central Station location is preferential. This is shown in the figure below.

Figure 94: Locations of BSÍ and Landspítallin stations ~250m apart. The BRT Standard *recommends 300-800m spacing. If the new Central Station concept is accepted, the current BSÍ and Landspítallin stations could be consolidated into one.*

While Landspítalinn would certainly be a busy station, its location within the hospital complex makes it impractical as a transfer hub for routes operating north-south on Snorrabraut. ***We recommend that the detailed design consultants consider both options, one with the currently proposed station locations and another with the Landspitalínn station traded out in favor of the Central Station over Miklabraut for the aforementioned reasons.***

6. Kópavogur & Karsnes

The planned new bicycle, pedestrian, and bus-only bridge connecting Kópavogur & Karsnes to Reykjavík south of the domestic airport will create a very rapid connection between Kópavogur & Karsnes and downtown Reykjavík by these sustainable transport modes. This time advantage should give public transit a significant competitive advantage for trips into downtown.

Many of the roads through Kópavogur & Karsnes are narrow and primarily residential in nature, making a full BRT corridor with dedicated bus lanes quite difficult in some sections.

The cross sections are as follows:

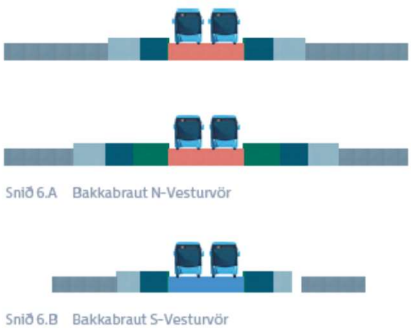

Figure 95: Cross sections for Kopavogúr & Karsnes on Bakkabraut in the Conceptual Design Report

As the buses exit the new bridge, they will join Bakkabraut until they reach Vesturvor and will have a dedicated BRT and bike/ped only street. From Vesturvor south to Borgarholtsbraut the busway will operate in mixed traffic. As there is no mixed traffic access to the bridge, traffic in the area should remain light.

There is currently no through connection between Bakkabraut and Borgarholtsbraut, but there is a limited access street up a fairly steep embankment which will be opened up to Borgarlína on a bus-only extension of Borgarholtsbraut.

The right-of-way on Borgarholtsbraut is very narrow and surrounded primarily by residential dwellings.

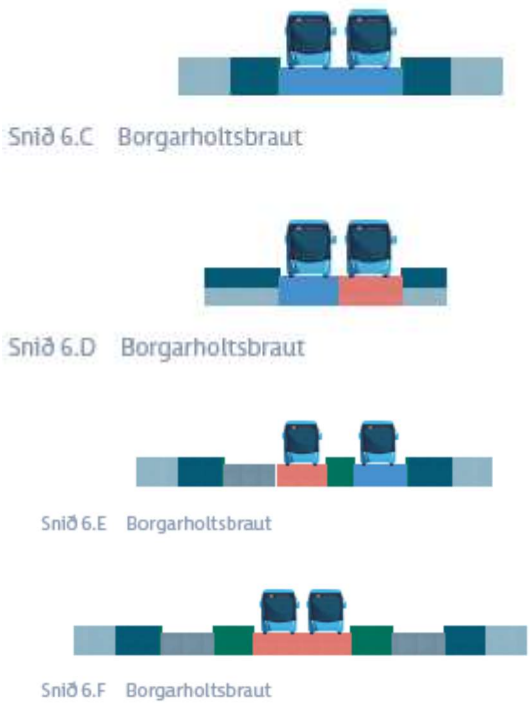

Figure 96: Excerpt of Conceptual Design showing cross-sections of Borgarholtsbraut

The buses are planned to move in mixed traffic on some segments, with a dedicated busway only in one direction in other segments, and the standard central median aligned BRT configuration as the roadway widens as the busway reaches closer to Hamraborg. There would be continuous bike routes throughout the corridor.

None of these roads are currently carrying much traffic and traffic is not expected to grow substantially in the foreseeable future.

Comments on the Cross Sections

As part of our review of the Conceptual Design for the Borgarlína project, we reviewed the Karsnes & Kópavogur sections of the corridor in March and then again in September as the final version of the

Conceptual Design was produced. At that time, there were numerous alternatives still being considered. Some of them were quite ambitious and involved road widening in certain sections.

The several sections of mixed traffic operation reduce *The BRT Standard* score both for dedicated right of way and cross section.

That said, we don't believe that the dedicated right-of-way is so critical in these sections, as the traffic volumes are low and risks of obstructions are not that high.

We recommended that station cross-sections be shown in the conceptual design, as the platforms would likely need to be offset due to the narrow width of the street. This would also aid in outreach efforts to residents of Kópavogur to clearly explain the configuration of the Borgarlína corridor in their neighborhood. Currently the cross-sections of Borgarholtsbraut only show the area between the stations and not the stations. ***We recommend developing some alternatives for the station locations so that community input can be taken.***

Traffic Routing

In our early review of these sections, we recommended clearly showing the traffic routing around the Karsnes peninsula. Borgarholtsbraut is currently a two-way street, which we understand may be reconfigured as a one-way mixed traffic access in the eastbound direction only.

We recommended that traffic routings on the peninsula be clearly shown to communicate to stakeholders which routes they will be expected to use to reach the primarily residential areas on Borgarholtsbaut. This would also communicate which side streets might be expected to see an increase in their traffic volume. ***We recommend that this be done by the detailed design consultants.***

Hamraborg

Not much is said in the report about the Hamraborg terminal. It seems like this is because the Team is not yet sure whether and where Borgarlína will be expanded in Phase 2. Nonetheless, some sort of design is critical for this important node. The center of Hamraborg is currently not that nice, and the Strætó-proposed route restructuring removes most of the route terminals in the middle of Hamraborg, which might free up some space for other urban improvements in the area. ***We recommend developing designs for Hamraborg with whatever Phase 2 constraints to consider are kept in mind.***

Chapter 5. Borgarlína's Roadmap to Gold-Standard BRT

There are several ways that Borgarlína could reach a BRT Gold under the *BRT Standard*. The following lays out the path that makes the most sense, given Borgarlína's specific context.

Corridor Name:	Borgarlína BRT, Reykjavík, Iceland - Based on August 2020 Conceptual Design		
Corridor Description			
Infrastructure Length	14.1	Approximated	
# of stations	24		
BRT Standard Scorecard			
Measure	**Total Points Available**	**LOW SCORE**	**BEST SCENARIO**
BRT Basics			
Dedicated right-of-way	8	6.59	7.29
Busway alignment	8	6.59	7.29
Off-board fare collection	8	4	8.00
Intersection treatments	7	4.2	5.60
Platform-level boarding	7	7	7.00
BRT Basics total	**38**	**28.4**	**35.2**
Service Planning			
Multiple routes	4	4	4
Express, limited, and local services	3	0	0
Control center	3	0	3
Located in top ten corridors	2	2	2
Demand Profile	3	3	3
Hours of operation	2	2	2
Multi-corridor network	2	2	2
Service Planning total	**19**	**13**	**16**
Infrastructure			
Passing lanes at stations	3	0	1
Minimizing bus emissions	3	1	3
Stations set back from intersections	3	0	3
Center stations	2	0	0
Pavement quality	2	0	2
Infrastructure total	**13**	**1**	**9**
Station Design and Station-Bus Interface			
Distance between stations	2	2	2
Safe and comfortable stations	3	2	3
Number of doors on bus	3	0	3
Docking bays and sub-stops	1	1	1
Sliding doors in BRT stations	1	0	1
Station Design and Station-Bus Interface total	**10**	**5**	**10**
Quality of Service and Passenger-Information Systems			
Branding	3	1	3
Passenger information	2	2	2
Quality of Service and Passenger-Information Syst	**5**	**3**	**5**
Integration and access			
Universal access	3	3	3
Integration with other public transport	3	3	3
Pedestrian access	4	4	4
Secure bicycle parking	2	0	2
Bicycle lanes	2	2	2
Bicycle-sharing integration	1	0	1
Integration and access total	**15**	**12**	**15**
Total		**62.4**	**90.2**

Figure 97. Preliminary BRT Standard scoring

Reaching BRT Silver

Critical to at least reaching BRT Silver are at least four out of the five following measures:

1. Off-board fare collection
2. Clean buses with multiple wide doors
3. Operational control system

4. Stations set back from intersections by 26 meters
5. Bike parking and bike sharing at stations

Off-board fare collection

Most important to securing a Gold rating and to improve the quality of service, is to commit to an off-board payment/validation fare collection system. We recommend off-board fare validation in areas within the bus stations designated as pre-paid zones enforced with CCTV cameras and occasional inspections. This would add 8 points. A proof-of-payment fare collection system with off board validation (enforcement happens with inspectors on the buses rather than in a pre-paid zone) would also be beneficial, as would on-board validation with proof of payment, as is typical of European tram systems and is already the direction in which Strætó is headed systemwide. This would be worth 4 points. If proof-of-payment with on-board validation is selected, then all five of the above listed items are necessary to reach silver. The approach to fare collection is best decided before doing detailed station design.

Clean buses with multiple, wide doors

It can probably be assumed that the Capital Area, with its high level of environmental consciousness will opt for a very clean bus, whether it be a Euro VI bus or an electric bus. It is also a relatively simple matter to specify that any 18-meter buses have at least 3 doors of 1 meter width or greater, and any 12 meter buses have at least 2 doors of 1 meter width or greater. The bus specification needs to be decided before finalizing the station design. This would be worth 6 points.

Operational control system

Giving Borgarlína a state-of-the-art operational control system would help ensure bus reliability and would be worth 3 points.

Stations set back from intersections by 26 meters

Ensuring that stations are set back at least 26 meters from the intersections on streets with long enough block lengths, could be a design parameter that would also help to ensure bus reliability and would be worth 2 points.

Bike parking and bike sharing at stations

Specifying that Borgarlína stations should have bike parking and bike sharing stations would also be worth 3 points.

These measures alone would assure Borgarlína of at least BRT Silver. If off-board fare collection in a prepaid zone is selected, these measures would give 75.4 points, and with on-board fare validation through multiple doors and proof of payment, 71.4 points would be achieved.

Reaching BRT Gold

To reach BRT Gold, all of the above would be necessary, in addition to which the following would need to be implemented:

1. Upgrade all pavement to concrete or other 30-year commercial life pavement treatment
2. Make Hverfisgata and the one-way loop around Lake Tjörnin fully dedicated to buses in both directions
3. Restrict additional left turns across the busway

4. Add sliding doors inside the bus stations
5. System wide branding

Upgrade all pavement to concrete or other 30-year commercial life pavement treatment

Upgrading the pavement quality to concrete or other long-lasting rigid pavement will reduce the risk of losing at-level boarding from sinking asphalt and needing to do major roadway repairs and cause service disruptions. This would add significantly to system cost but is a worthwhile investment in the future as it lowers ongoing maintenance costs.

Make Hverfisgata and the one-way loop around Lake Tjörnin fully dedicated to buses in both directions

Making Hverfisgata a dedicated busway in both directions instead of only one way would reduce the risks of delay on that corridor and improve the urban quality of Hverfisgata, an up and coming commercial/residential street. Making the one-way loop around Lake Tjörnin fully dedicated would also significantly reduce the risk of bus delay in this busy downtown area.

Restrict additional left turns across the busway

While the total number of left turns to be restricted has not been finalized, the more left turns across the bus lanes that are restricted, the more rapid and efficient the system will operate. The project should aim to restrict as many left turns as possible.

Add sliding doors inside the bus stations

The Capital Area can be very rainy, windy, snowy and cold much of the year. More fully enclosed stations with sliding doors would significantly add to the comfort of taking public transport in Reykjavík.

System wide branding

Once the Capital Area places both money and political capital into building the Borgarlína system, it is important to showcase the new project. Branding the Borgarlína routes with an integrated design will help to generate excitement among users.

Figure 98: Albuquerque, NM's new BRT system includes iconic branding at stations and on buses. Source: HDR

Further, a new, integrated brand will help provide system legibility so that passengers can count on certain routes to take them along the Borgarlína corridor. Finally, system branding offers a unique opportunity to create a memorable brand associated with the Capital Area itself, so that residents can identify with the new system and as a feature for tourists to identify with Iceland.

We believe these are the measures that would bring Borgarlína to BRT Gold and would make the most sense in the Capital Area. A BRT Gold in the Capital Area would not only make transit in the Capital Area more attractive, reliable and convenient, but it would also be a significant symbol that the Capital Area is serious about reducing its carbon footprint and creating more livable cities.