WSF Triangle Route: Analysis of Alternative Concepts of Operations

WA-RD 894.1

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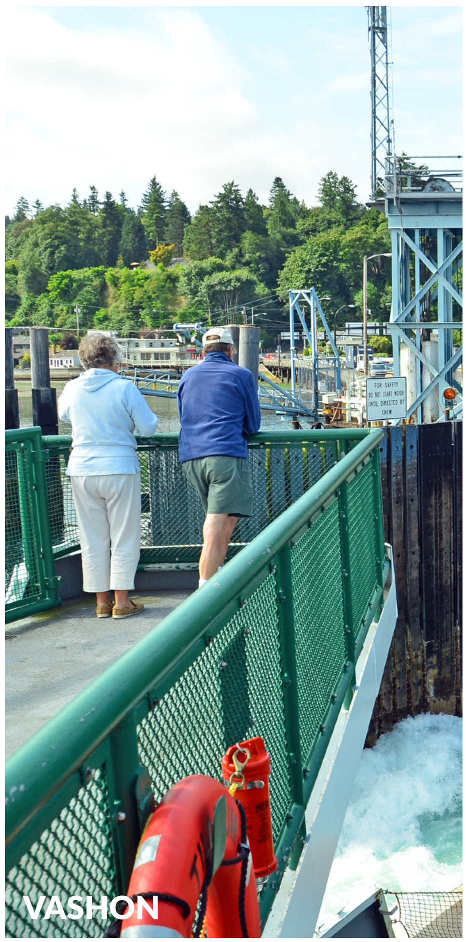
October 2019



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WSF Triangle Route
Analysis of Alternative Concepts of Operations

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16. ABSTRACT

The Washington State Ferry System Triangle Route (Fauntleroy – Vashon – Southworth), is heavily used and experiences a number of significant operational challenges. This report documents the outcome of a project tasked with examining different concepts of operation that would improve the performance of the Triangle Route, with a specific focus on the Fauntleroy terminal during periods of peak use. Each concept of operation describes operational procedures designed to improve the speed and efficiency of the terminal's operations, the vessels' load factor, the vessels' on-time performance during peak travel periods, and if possible, the peak period capacity of the route.

A variety of recommendations are made for consideration by Washington State Ferries for projects that might improve both the overall operational performance of the route and customers' overall satisfaction with their experiences when using the route.

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INTRODUCTION

Washington State Ferries (WSF) operates ten ferry routes, serving 20 terminals, across the Puget Sound and in the San Juan Islands. The Triangle Route serves Fauntleroy (West Seattle), Vashon Island, and Southworth (on the Kitsap Peninsula). It is one of only two routes in the system that serves more than two destinations. The Triangle Route is heavily used and experiences a number of significant operational challenges. To improve operation of the Triangle Route, WSF is interested identifying and evaluating different operational concepts for the route that would not only improve performance but that could be implemented within the budget constraints of the agency, with a specific focus on the Fauntleroy terminal during periods of peak use.

Customers using the three ferry terminals on the Triangle route are often frustrated by the service they experience. Many of the most significant operational challenges occur at the Fauntleroy Terminal, which is located in a residential neighborhood. The Triangle Route experiences a lack of vehicle capacity during periods of peak demand, in part due to the following factors:

- the limited size of the dock at Fauntleroy, which limits vehicle holding space,
- the existence of only one boat slip at Fauntleroy,
- a moderate speed of vehicle processing at ferry system ticket booths,
- the lack of a pedestrian loading bridge to the ferries from the dock,
- the complexity of having to load vessels so that they serve two different destinations
- a lack of real-time information on system performance that can be used by WSF staff and customers to make better decisions.

While long queues during peak travel periods are not unique to the Triangle Route, many of the factors above leave customers with an impression that improvements could be made. For example, for most routes, because an entire vessel's capacity can fit on the dock – and can be processed prior to the vessel's arrival, passengers are never given the impression that improvements in the speed of ticket processing could result in more sailings.

The result of the combination of the above constraints is that vessel dwell times are longer than they could be, and because the dock accommodates only one ferry at a time, the longer a vessel sits at the dock, the lower the total vehicle throughput. The current process also frustrates customers waiting in the ferry line, as they are slow to get through the ticket booth and, once they have gotten through the booth, are unsure whether they will get on the boat still sitting in the slip.

<u>ALTERNATIVE CONCEPTS OF OPERATION</u>

Five alternative operational concepts were examined as part of this project. In several cases, multiple variations of a given concept were examined. The five concepts explored include:

1) Adopt Good To Go! for fare payment - with multiple sub-options, including

- performing toll collection exclusively through Good To Go! (cashless tolling) with a simplified fare structure for both vehicles and passengers,
- performing toll collection exclusively through Good To Go! with passengers traveling for free in order to simplify and increase the accuracy of the automated toll collection process,
- performing toll collection exclusively through Good To Go! with increased use of pay by web and pay by kiosk options to limit the need for after-the-fact revenue collection
- maintaining the current ticket booths but allowing drivers the option of paying for the trip using their Good To Go! account and tag,
- maintaining the current ticket booths, but allowing drivers the option of paying for the trip using their Good To Go! account with increased use of pre-purchasing of tickets that are linked to that account.

2) Collect tolls only in the eastbound direction, along with removing toll collection at Fauntleroy

3) Increase the pre-sale of tickets (with two sub-options)

- sell tickets manually to vehicles stopped in the Fauntleroy queue
- increase the number of vehicles using pre-purchased Wave2Go tickets through better marketing and pre-sale capabilities

4) Increase the number of carpools while decreasing drive-alone vehicle use, and

5) **Improve traveler information** both to shift vehicles to less congested time periods and to provide customers with up-to-date expectations of current system on-time status and queue length.

Each of these operational concepts is discussed in detail in the main body of this report.

RECOMMENDATIONS

The recommendations from the project team are based on the evaluation of the alternative operational concepts with respect to three key factors.

- Budget: lower cost options were preferred due to the difficulty in securing funding for system improvements,
- System-wide Benefits: operational concepts that can scale easily to other WSF routes providing systemwide benefits are preferable, and
- Improve Route Performance on the Triangle Route: including improved customer satisfaction, increased ridership and reduced delay.

Recommendation 1: Engage in Programs to Encourage Carpooling

The project team recommends that the WSF engage with the UW Evans School of Public Policy and Governance to determine ways to increase carpooling on the Triangle Route. WSF could develop a project as part of the Evans Student Consulting Lab. These projects, known within the Evans School as Capstone Projects, pair three to five second-year Masters of Public Affairs students with a faculty advisor to work on a specific capacity building or data collection project identified and designed by a public or non-profit agency. The cost of such an effort is relatively small, typically on the order of $2,000. The Evans School collects proposals for this program in summer for projects to be completed during the academic year. WSF would have a consulting team working on a project about increasing rideshare use on the Triangle Route starting in January of 2020 with the project ending in June of 2020.

The focus of the project would be on sharing rides to/from the Fauntleroy dock, because it is generally possible to drive to the Vashon and Southworth docks and find parking. In contrast, there is no parking at Fauntleroy, and good transit alternatives (the passenger-only ferry or the Metro Route 119 and C-line bus routes) already provide good mass transit alternatives for reaching downtown Seattle. Therefore, decreasing drive-alone trips during the peak commute periods will require helping current driver-on travelers identify shared ride alternatives that reliably get them to and from their destinations on the Seattle side of their trip. In addition to helping people find these alternative travel options, it will be necessary to change travelers' habits so that they have both an interest in sharing rides and a willingness to do so.

Therefore, the Evans School project should focus on

- which existing carpool formation technologies can most effectively connect ferry riders with each other in ways that identify their common trip making requirements,
- how to increase the perceived value that travelers gain when they successfully share rides so that travelers look to participate, and
- affordable incentive programs for passengers and riders who routinely share rides.

Recommendation #2: Improve Traveler Information

The second recommendation is to collect and deliver better traveler information to ferry users. There are two major parts to this recommendation. The first is to place either Good To Go! toll tag readers or WiFi-Bluetooth readers on the approaches to WSF terminals and at the toll booths themselves to collect data on real-time ferry queue wait times. This information would then be delivered via API to interested software developers.

The second part of this recommendation is to build and deliver a customer-centric smartphone application that can deliver those wait times, along with a variety of other customer-oriented ferry information.

The smartphone application should be able to perform the following functions:

- report current queue durations at the ferry dock,
- report expected queue durations based on either future forecasts of current conditions or historical patterns
- deliver this information via screen display at the request of the user
- deliver this information via audio delivery at the request of the user when the vehicle is in motion
- deliver this information via audio delivery approximately one mile before vehicles arrive at the end of the queue when users have previously indicated their interest in obtaining that information
- deliver other ferry service alerts for routes used by the smartphone user

- pass to WSF staff the expected destination and desired sailing for which travelers are coming to pre-plan service levels, and
- provide a mechanism for ferry customers to give feedback to WSF.

The project team does not recommend a specific choice of queue duration collection equipment. The best technology choice will be a function of other decisions. The project team's preference is for the use of Good To Go! tag readers, but that is a more expensive option. However, if Recommendation #3 were to be adopted, then the added cost of using Good To Go! tag readers would be substantially reduced, and the greater data collection rate and resulting better queue length estimates would be worth the modest added cost. Alternatively, if Good To Go! was not be used, then using the less expensive technology currently used by the City of Seattle would be preferable.

This recommendation is expected to significantly improve ferry customers' level of satisfaction. The major downside of this recommendation is that it will require far more funding than the first recommendation. To reduce the initial cost of this system and to prove its value, it could be deployed on a single route (e.g., the Triangle Route) or even for a single terminal approach (e.g., Fauntleroy) as part of a demonstration project before being deployed to the rest of the ferry system.

Recommendation #3: Conduct A Pilot of Payments via Good To Go!

The third recommendation is to conduct a demonstration of the benefits of using Good To Go! technology to improve operations at the Fauntleroy dock. This recommendation is the most ambitious of the three project recommendations. It also requires the most funding—although there is potential for that funding to come from outside of WSF. Good To Go! offers the greatest potential for dramatically speeding up the processing of vehicle payments, which is necessary if additional sailings—and thus additional vehicle capacity—are to be provided during peak use periods. Use of Good to Go! also has the potential to significantly improve customer satisfaction, especially if the faster payment mechanism also provides other customer-oriented services that make it easier to ride the ferries. A pilot implementation of the technology is an excellent way to prove (or disprove) whether Good To Go! can actually deliver the required level of service improvements.

The downside of this recommendation is the complexity and cost of even a pilot demonstration of Good To Go!, let alone a full implementation of cashless tolling. Implementation of Good To Go! would require both the purchase and installation of hardware and the development of software. While the current back-office software upgrades include the ability to interact with other toll systems, the unique nature of the ferry system fare structure—especially if attributes such as on-dock and on-boat kiosks are added—will require WSF-specific software upgrades to the process of computing toll bills and transmitting them to the Good To Go! back office.

The complexity of the Good To Go! pilot could be mitigated in part by limiting the vehicles eligible to participate in the pilot to those that sign up for the demonstration. That could include both vehicles with and without current Good To Go! accounts. Testing could exclude implementation of automated vehicle length sensing equipment, or implementing only that function. (Vehicle lengths could be based on vehicle types associated with Good To Go! accounts and/or license plates entered about registration to participate in the test.) The specific features to include or not include would need to be identified as part of the pilot design.

This leads to the cost of the pilot.

The project team believes that some vendors are sufficiently interested in performing a demonstration of their automated tolling capabilities that they might be willing to fund the demonstration as a way of proving their technology and approach. This would be particularly true if vendors were allowed to approach the demonstration from the perspective of demonstrating not just the use of the Good To Go! technology but also the advantages of a Single User Account system that allows integration of Wave2Go, ORCA, and Good To Go! payments.

The single account mechanism (i.e., an account system passed through that vendor) would allow the demonstration to provide a single direct bill for each transaction to either or both the Good To Go! back-office and the Next Gen ORCA back-office. This would ease the task—for the Good To Go! back-office—of accepting such payment requests (the toll calculation would be performed by the vendor's software, and only the "invoice" would passed to the Good to Go! back office) thus reduce the work required for the Good To Go! back office to accept such invoices. This would lower risk to WSDOT and WSF, as well as limit changes to the back-office software. It would place more work on any vendor interested in performing the demonstration.

For the pilot, drivers that did not participate in the pilot would pay at the booth just as they do now. But drivers could also choose to sign up for the pilot based on their vehicle's license plate and pay through the single user account. Such an approach would allow quick expansion of the system and the ability to test the operational performance of license plate readers in a marine environment, as well as provide the vendor performing the pilot an opportunity to demonstrate its ability to supply customers with the benefits of a single user account system—thus providing the incentive for vendors to fund the pilot.

The project team recommends that WSF request proposals for a demonstration of such a system on the Triangle Route, with—at a minimum—the Fauntleroy dock used as a test site for such a demonstration. The project team believes that the potential market for helping to develop and deliver such a customer-centric payment system should drive down the cost of developing and delivering such a demonstration.

Combining this recommendation with the recommendation to measure, report, and deliver queue duration information would allow multiple benefits to be gained from such a demonstration project, while also providing considerable benefit to customers who participated in that demonstration. That is, the Good To Go! pilot vendor would be given the opportunity to establish customer accounts that linked (at the customer's discretion) a customer's Wave2Go, ORCA, and Good To Go! accounts. The smartphone application described in Recommendation #2 would then not only be used to deliver ferry information but would allow customers to manage their accounts, purchase ferry tickets, and indicate when they were traveling and to which Triangle Route destination they were headed, thus allowing each customer to control when they received ferry queue information and providing WSF with advance notice of expected route volumes. The traveler information benefits available through the smartphone application, along with the convenience of the single account system and the convenience and speed of the Good To Go! payment system, would be used by the pilot demonstration vendor to encourage use of the pilot system. This in turn would result in meeting the goals of faster vehicle processing and greater pre-purchasing of ferry tickets, which would lead to shorter queue wait times and potentially shorter vessel dwell times.

For this recommendation, the smartphone application described in the second recommendation would expand in functionality to include

- the purchase of ferry tickets, and

- connection of those ferry tickets to vehicle license plates and Good To Go! Tags.

This third recommendation has the potential to lead to the greatest long-term benefit to WSF. It would also offer a path that has the potential to decrease up-front costs to WSF while demonstrating both the customer service improvements and ferry system operational improvements possible through adopting both a more customer-centric approach to fare collection and information delivery. The “pilot demonstration” approach would also allow WSF to shift the risks associated with the demonstration (i.e., development costs and system performance) to the private sector. This assumes that the private sector saw sufficient benefit in the pilot to accept those risks. Whether that risk/reward relationship was acceptable would become obvious based on the response to the RFP. WSF would also benefit from such an approach because the agency would reserve the right to decide to not perform the pilot if the cost of that pilot was too high.

INTRODUCTION

Washington State Ferries (WSF) is a government agency that operates automobile and passenger ferry service in Washington state as part of the Washington State Department of Transportation (WSDOT). WSF runs ten routes serving 20 terminals across the Puget Sound and in the San Juan Islands. The Triangle Route is heavily used and experiences a number of significant operational challenges. The Triangle Route serves Fauntleroy (West Seattle), Vashon Island, and Southworth (on the Kitsap Peninsula). It is one of only two routes in the system that serves more than two destinations. To improve operation of the Triangle Route, WSF is interested to identify different operational concepts for the route that would not only improve performance but that could be implemented within the budget constraints of the agency.

This report is structured as follows.

- Introduction
- Problem Statement
- Project Objectives
- Current Operating Performance
- Alternative Concepts of Operation
- Recommendations.

The next section describes the problems experienced on the Triangle Route. These problems affect both the route's performance and its customers' experience. The objectives of the project are then described, followed by a discussion of current operating conditions, given changes made to the weekday sailing schedule in Spring 2019. On the basis of that information, the project team describes a variety of different operational concepts that were developed to address the identified problems and to improve both route performance and customer experience. The strengths and weaknesses of each of those alternative operational concepts are presented. Finally, on the basis of the review of those alternatives, the project team makes recommendations for how WSF should move forward to improve route performance and customer experience.

PROBLEM STATEMENT

The Washington State Ferry System Triangle Route (Fauntleroy – Vashon – Southworth), is heavily used and experiences a number of significant operational challenges. Customers using the three ferry terminals on the route are often frustrated by the service they experience. Many of the most significant operational challenges occur at the Fauntleroy Terminal, which is located in a residential neighborhood of West Seattle. Operational constraints at Fauntleroy include the following:

- a lack of vehicle capacity on the route during periods of peak demand, caused in part by the following factors:
- the limited size of the dock at Fauntleroy, which limits vehicle holding space,
- the existence of only one boat slip at Fauntleroy,
- a moderate speed of vehicle processing at ferry system ticket booths, in part due to the complexity of the fare structure and at times to customers being unfamiliar with how to use the ferry system,
- the need to either
  - load vessels for two destinations, which requires separating vehicles bound for the different destinations from each other and ensuring that vehicles bound for the first destination are not blocked from leaving the boat by vehicles bound for the second destination, or
  - load only one of the two destinations on a boat, in which case, vehicles for the second destination must be stored on the small dock while vehicles bound for the destination being served by the current trip must be extracted from the long, single-lane vehicle queue and sent through the toll booth and onto the current ferry,
- the lack of a pedestrian bridge to the ferries, which requires all vehicle loading and unloading to wait while pedestrians have boarded/departed the boat, and
- a lack of real-time information on system performance, which in turn results in
  - a lack of information to support decisions regarding dock and vessel management, and
  - a lack of traveler information for customers, which increases levels of customer anxiety and frustration.

These factors combine to both limit the vehicle carrying capacity of the route during peak periods and affect the level of service experienced by Triangle Route customers.

The small size of the dock at Fauntleroy limits vehicle holding space, which in turn limits how quickly a ferry can be loaded. Built in the 1950s, the Fauntleroy dock is one of the oldest and among the smallest in the WSF system. The dock holding capacity of approximately 80 vehicles (depending on vehicle length) was built to serve smaller boats that have since been decommissioned. Dock capacity is only roughly two-thirds of the current vessel capacity, meaning that to leave the dock with a full ferry, one-third of each vessel's capacity must be processed through the ticket booths after the ferry has started to load vehicles.

The need to process one-third of the boat's vehicle capacity after the ferry has started loading is only one of several factors that limit total vehicle throughput at the dock during periods of peak demand. A second factor is the lack of a pedestrian bridge that would allow separate passenger loading and thus faster vehicle loading, as both could be loaded simultaneously. The lack of pedestrian separation means that, for safety reasons, vehicle loading must wait until after pedestrians have loaded, increasing the time that vessels must spend at the dock.

Next, because there is only one boat slip, only one vessel can be served at a time. Therefore, one boat cannot load while another unloads. If one vessel is delayed at the dock, a second vessel often has to sit off-shore until the slip is free, making that second vessel late and further degrading both system performance and customer experience. Thus, total vehicle capacity on the route is constrained by the total dwell time of boats at the Fauntleroy dock. This includes unloading time for pedestrians and bicycles, unloading time for vehicles, loading time for pedestrians and bicycles, loading time for vehicles, and any additional time needed for security checks.

Of the constraints, the most "obvious" point of delay in ferry loading times that route customers observe is how quickly vehicles are processed through the toll booths. Fauntleroy has a single queuing lane that leads to two toll booths. At times, customers can use either booth, regardless of their desired destination. At other times, a single booth is allocated to each of the two directions. This is done to safely direct vehicles to the proper holding area on the dock or directly to the vessel being loaded, which may have space remaining for one destination but not the other. When one destination's holding area is full, only vehicles bound for the other destination can be processed through the booths. This requires that vehicles bound for that destination be extracted from the single vehicle queue and sent to the toll booth. This both complicates and slows vehicle processing.

Finally, the complex ferry fare structure, in which price varies on the basis of vehicle length and number of passengers, and which offers a variety of passenger discounts (e.g., seniors and youth), combined with the availability of multiple payment mechanisms (cash, credit card, pre-purchased multi-ride ticket, pre-purchased Wave2Go, ORCA passenger fare card), slows processing through the booth. WSF staff must interact with customers, compute the appropriate fare, and then process the fare payment, at times with multiple physical transactions (e.g., a credit card for the vehicle and driver, with a separate ORCA card transaction for the second person in the vehicle).

Fare processing can also be affected by outdated technology. The handheld scanners that staff currently use to process pre-purchased tickets and ORCA cards for vanpools, motorcycles, and bicycles were deployed in 2008 and have been in use for over ten years. The devices have withstood substantial wear and tear that reduce the reliability of the physical hardware and even result in lost revenue for WSF. Additionally, recent efforts to update the devices have been delayed by the fact that devices now available on the market are incompatible with the regional electronic transit farecard (ORCA), a system that is also in the process of being replaced with more modern technology.

Finally, once vehicles have been processed through the ticket booth, they must be loaded onto the vessel. This is complicated by the fact that most vessel sailings from Fauntleroy serve two destinations. Vehicles sitting on the dock bound for Vashon load first, followed by Southworth vehicles, except for the one weekday afternoon sailing when vessels go to Southworth first, in which case the loading order is reversed. The two vehicle groups are loaded in a pre-planned fashion so that Southworth bound vehicles do not block Vashon vehicles from off-loading. The vessel loading constraint occurs once the dock has been cleared and the sailing must wait for vehicles just coming through the ticket booth to finish the ferry loading. At that point, staff loading the ferry do not know how many of the "just processed" or "soon-to-be processed" vehicles are bound for Southworth and how many are bound for Vashon. This makes loading the "just arriving" vehicles difficult, as the requirement to not block Vashon bound vehicles still exists. The crews handle this situation by collecting small groups of vehicles bound for each destination and loading them in turn. The last few spaces are thus loaded with individual vehicles on the basis of when the vehicles pass through the ticket booths and the ability of the crew to load them in a way that lets them exit as needed. This process slows the loading process.

The result of all of these constraints is that vessel dwell times are longer than they could be, and because the dock accommodates only one ferry at a time, the longer a vessel sits at the dock, the lower the total vehicle throughput. The current process also frustrates customers waiting in the ferry line, as they are slow to get through the ticket booth and, once they have gotten through the booth, are unsure whether they will get on the boat still sitting in the slip.

In light of these constraints, most of the focus of the proposed operational concepts is to either speed the processing of vehicles through the ticket booths, decrease vessel loading time through other means, or give both staff and customers better information about which vehicles will get on which boats.

PROJECT OBJECTIVES

The objective of this project was to create, describe, and examine different concepts of operation that would improve the performance of the Triangle Route, with a specific focus on the Fauntleroy terminal during periods of peak use. Each concept of operation describes operational procedures designed to improve the speed and efficiency of the terminal's operations, the vessels' load factor, the vessels' on-time performance during peak travel periods, and if possible, the peak period capacity of the route. Importantly, any recommended improvements at Fauntleroy should not shift operational problems to other docks on the Triangle Route to ensure that the operational changes decrease overall system delays and improve customer satisfaction with ferry system performance.

The operational concepts were developed and evaluated by using available payment processing data, vessel loading schematics, and interviews with WSF and other WSDOT employees and stakeholders.

CURRENT OPERATING PERFORMANCE

As this project was getting under way, WSF updated the Triangle Route weekday sailing schedule to address some of the performance issues at the Fauntleroy dock. These changes resulted in different operational patterns at Fauntleroy and different overall route performance. Consequently, this section starts with a description of the schedule change and then discusses current operating conditions.

Although small adjustments are made periodically, WSF had not made major changes to the Triangle Route sailing schedule in several years. On March 31, 2019, after a two-year public process informed by riders, terminal staff, vessel crew, the Triangle Improvement Task Force, and local Ferry Advisory Committees (FACs), WSF developed and deployed a new sailing schedule that, among other things, would accommodate a third 124-car Issaquah Class vessel, assigned to the route starting in the spring.

PRE SCHEDULE REVISION PERFORMANCE

Previously, the Triangle Route had two Issaquah Class vessels and one 90-car vessel, the Sealth. For that schedule, the majority of sailings out of Fauntleroy in the weekday-afternoon commute period (approximately 3:00 to 6:00 PM) were single destination sailings from Fauntleroy to either Vashon or Southworth. This provided direct service to each destination, in theory providing better customer service. However, because of the size of the Fauntleroy dock, it was not possible to store on the dock a full boat load of vehicles bound for a single destination, especially because the dock also needed to store vehicles bound for the second destination. (There is no good way to separate vehicles bound for the two destinations before the ticket booths, so vehicles bound for both destinations needed to be processed and stored on the dock to limit the length of the queue on Fauntleroy Way SW.) As a result, half the dock was filled with vehicles bound for the alternate destination, and the other half of the dock—while full—contained only about 32 percent of the vehicles needed to fill an Issaquah class ferry. This produced long queues of vehicles waiting to pass through the ticket booths and board the loading ferry, which only served one destination.

Once half of the dock was filled with cars waiting for a boat to the alternate destination, vehicles bound for that destination could no longer pass through the toll booth, as they had nowhere to park on the dock, and thus had to wait prior to the toll booth. This blocked access to the ticket booths. In response, staff would reserve one booth for the destination currently being served, and hold waiting vehicles short of the booths. To process more vehicles bound for that destination, the on-site traffic police officer would walk up the single holding lane that runs north up Fauntleroy Way SW, identify vehicles headed to the current destination, and send them directly to the open toll booth. This procedure worked to get vehicles bound to the correct destination through the toll booths, but it slowed vehicle processing and thus loading time, resulting in frequent late sailings and boats with empty spaces. It also created dangerous and confusing vehicle movements on Fauntleroy Way SW.

The dwell time required to load the boat was determined in large part by how fast the ticket booths could process vehicles through the ticket sale/redemption process, especially because only about half of the dock could be used to store vehicles bound for a single destination, meaning that two-thirds of the vehicles needed to fill the ferry had to pass through the toll booths after the ferry had started loading.

The result of all of these issues was a combination of partly full boats—even with cars waiting in the queue on Fauntleroy Way SW—and delays to ferries leaving the dock.

POST SCHEDULE REVISION PERFORMANCE

The Spring 2019 weekday schedule revision, summarized in Table 1, focused on improving afternoon peak commutes westbound from Fauntleroy and adjusting sailing times eastbound in the morning from Southworth to better serve commuters. At Fauntleroy, two big changes occurred. The first change allows all sailings to serve both destinations, although one trip (the 4:10 PM trip) serves Southworth before Vashon to provide priority service to a large number of Southworth-bound vanpools. This allows all vehicles stored on the dock to board each ferry, thereby halving the number of vehicles that need to be processed through the toll booths after the ferry starts loading and decreasing the time required to load a ferry to its vehicle capacity.

The second major change added some dwell time to the schedule. This allows the schedule to incorporate the time required to process a sufficient number of vehicles through the toll booths to fill each vessel. Under the new schedule, given both changes, WSF dock crew are able to process vehicles in the order they show up, sort them on the dock, and load them onto the next available sailing without routinely falling behind the published sailing schedule.

Table 1: Changes with the new spring weekday schedule

	Old Schedule	New Schedule
Structure	Majority direct sailings during peak commute hours	Majority dual destination sailings during peak commute hours
Dwell Time	Designed for three 90-car vessels, shorter dwell-times	Designed for three 124-car vessels, one less sailing out of Fauntleroy in peak hours, but with increased dwell-times providing the ability to process/load more vehicles for each sailing
Vehicle Processing	Police officer sorted vehicles in the holding lane up Fauntleroy Way. (The ability to extract vehicles bound for a selected destination was limited by how far/fast the officer could walk up the queue, given that the officer's primary responsibility was to direct traffic at the dock entrance to ensure vehicle safety during the unloading of boats.)	Ticket booth staff processes vehicles in the order they show up. The dock crew then sorts them on the dock and loads them onto the next available sailing.
Capacity Bottleneck	On Fauntleroy Way and at the tollbooth	At the tollbooth and during loading
Trade-offs	Direct sailings provided quicker crossing times for Southworth customers and ensured a set amount of dedicated capacity for Southworth or Vashon riders	Dual destination sailings provide more frequent sailings to Vashon and Southworth, and provide vehicle capacity to each destination based on the number of vehicles that arrive at the dock in time for each sailing

CURRENT PERFORMANCE

Since the roll-out of the new schedule, dock and boat crews have been able to fill the boats more consistently during the afternoon peak. While a holding line (vehicle queue) still forms up Fauntleroy Way SW, the line appears to clear faster and is often entirely diminished by 5:30 or 6:00 PM. This is earlier than the queue previously dissipated.

At public meetings held in the late Spring 2019 at both Southworth and Vashon, public opinion was strongly in favor of the new schedule. While the public still expressed desire for a wide variety of improvements, the combination of dual destination sailings and slightly longer scheduled dwell times does a better job of filling boats. This addresses the customer perception of "unfilled boats" leaving the dock while long queues still exist on Fauntleroy Way SW, and it does so without delaying the published schedule.

Information presented by WSF staff at the Vashon and Southworth public meetings did not show any improvement in schedule reliability. After the new schedule had been deployed for two months, on-time performance in April 2019 was slightly worse than that of April 2018. It was not possible for the project team to review the details of the reliability statistics within the time frame of this project to add context to that performance. The measured delays could easily have been due to the time required to train dock crews, boat crews, and customers on the new loading procedures, or the fact that the Chimacum was being used on the route. Other disruptions due to issues external to basic ferry operations may also have affected the reported schedule unreliability. The public reaction expressed during the public meetings did not reflect unhappiness with on-time performance in the Spring relative to the past.

Given the generally positive reviews provided during the public meetings, it may be that the perception of filled boats is a more important performance metric to customers than whether the vessels leave within 11 minutes[1] of the scheduled departure time.

A Shifting Bottleneck in the Vehicle Loading Process

As mentioned above, the shift from one- to two-destination sailings allows both toll booths to process vehicles once the dock starts to clear as the ferry begins loading. This change has also moved the sorting of cars from Fauntleroy Way SW (with police extracting vehicles

[1] WSF defines a "late departure" as being 11 minutes or more behind the scheduled departure in their routine reports to the state legislature.

bound for a given destination) to the dock itself and has complicated vessel loading procedures during the peak period. As noted above, the 80-car dock cannot fill an entire 124-car boat, and because there is currently no way to know the composition of the last ~40 vehicles that will arrive on the dock, the WSF staff loading the vessel must organize those vehicles on the fly, making important decisions under the pressure of meeting on-time performance goals.

The result is that currently after the dock starts to empty, the ticket booths process vehicles slightly faster than the dock and boat crews can organize and place them on the boat. This means that, in terms of the time required to load a boat, the ticket selling and redemption process is no longer the primary bottleneck in the vessel boarding process, given the current method with which vessels are loaded.

However, there is an expectation that the tollbooth may once again become a bottleneck to boat loading during the busy summer months when the composition of users shifts from Vashon/Southworth residents and daily commuters (who often purchase multi-ride tickets in advance) on weekdays during the evening commute period to tourists and infrequent riders who do not know how to approach the holding line, purchase tickets, or follow holding and loading instructions from crew members, and who travel from Fauntleroy during the weekends and on Thursday and Friday evenings.

Analysis of Current Toll Booth Processing Times

To understand ticket processing speeds better, the project team examined sales and redemption data available from the revenue collection system to determine the time required to process vehicles through the toll booths. This gave the team a very good estimate of the time currently required to pass vehicles through the toll booth, a task that has been, and may well be again, key to improving the Ferry System's ability to reduce vessel dwell time, improve schedule reliability, and offer more peak period sailings.

The data from the current sales and redemption activity at each toll booth provide a timestamp for every transaction that occurs at each booth. The transaction record also includes the type of transaction (sale or redemption of a previously sold ticket) and a description of the vehicle or passenger. In the data provided by WSF, separate records are included for each individual in a vehicle. When more than one passenger is in the vehicle, each of those passenger records has the same timestamp. This allows tracking when different passengers pay with different fare media, for example an ORCA card versus cash.

The researchers then processed these raw transaction records to provide a single transaction record for each vehicle, with a new variable, the number of passengers in that vehicle, being added. The timestamps were then sorted in date-time order by toll booth. This allowed the headway between vehicles passing through each booth to be computed. The headway variable allowed the team to determine the time required to process each vehicle through the toll booth. That time was defined to include both the time required for the vehicle to arrive at the booth after the previous vehicle had left and the time to process the transaction.

The problem with using these headway values directly was that multiple factors can affect the speed with which vehicles are processed. The most important of these variables is whether a vehicle is waiting to enter the dock. Late at night, for example, the headway between vehicles might be quite long, not because it took a long time for a transaction to be processed but because there were no vehicles waiting—or arriving—at the toll booth.

At the Fauntleroy dock, once the dock space is full, no vehicles can be processed through the booth. This results in a moderately long headway between the vehicle that takes the final waiting space on the dock and the next vehicle to be processed, even when another vehicle is sitting in the queue outside the ticket booth, simply because there is nowhere for that next vehicle to go. Once the boat at the dock has started to load and space opens up on the dock, then vehicles are processed as quickly as possible through the booth.

Therefore, to estimate "processing time," it was necessary to select only the time periods when vehicles were likely to be in the queue and then select only the vehicles passing through the booth immediately after space became available on the dock. Those processing times were assumed to be good estimates of the time actually required to interact with the vehicle's driver. That is, these measurements included all the human factors that create variation in processing time (e.g., a driver can't find his wallet, or drops her credit card, or simply wishes to chat with the staff in the booth) but not the factors that reflect only low levels of demand.

To make this selection at the Fauntleroy dock, two data sets were created, a weekday data set (assumed to represent typical commute period transaction processing), and a weekend data set (assumed to represent times when more vehicles unfamiliar with using the ferry were in the vehicle stream). For the weekday data set, queues were assumed to occur only between 2:00 PM and 7:00 PM. Next, docks were considered “full” when the headway between vehicles was greater than 5 minutes. When these gaps were found, the next 15 vehicles through that booth were selected to represent the time actually required to process vehicles. These records were then checked for transaction times of greater than 5 minutes. If such a gap was found, all data from that 15-minute period, starting with that gap, were removed from the analysis, as it was assumed that the gap was caused by a lack of vehicles rather than a slow transaction. The northern booth and southern booth were analyzed separately.

For the weekend analysis, only data between 9:00 AM and 6:00 PM were considered. In addition, a gap in payment transaction of 9 minutes was required to indicate that a queue had formed. As with the weekday analysis, once a queue had been identified, only the next 15 records were selected for analysis. And again, a 5-minute break in the transactions was used to indicate a break in the vehicle flow rather than a very slow transaction.

The headway data selected as described above allowed the project team to examine actual vehicle processing rates when queues were present. This was assumed to be indicative of “typical” vehicle processing speeds, given the current fare structure and the current fare collection process and equipment.

Figure 1 shows the distribution of these vehicle processing time requirements. Figure 1 differentiates between pre-sold ticket redemptions and cash/credit sales transactions at the booth. Figure 1 shows the fraction of all headway transactions that occurred within each 10-second time interval for these two transaction types for weekdays and weekends. The percentages shown are based on the fraction of each type of transaction (e.g., the percentage of all pre-ticketed redemptions occurring on weekdays by 10-second interval). Figure 1 allows a comparison of the time required to process vehicles with pre-sold fares and those that paid for their trip at the booth. Weekdays are split from weekends because of the very different nature of customers traveling on weekdays (mostly commuters) and weekends (many more people unfamiliar with the ferry system).

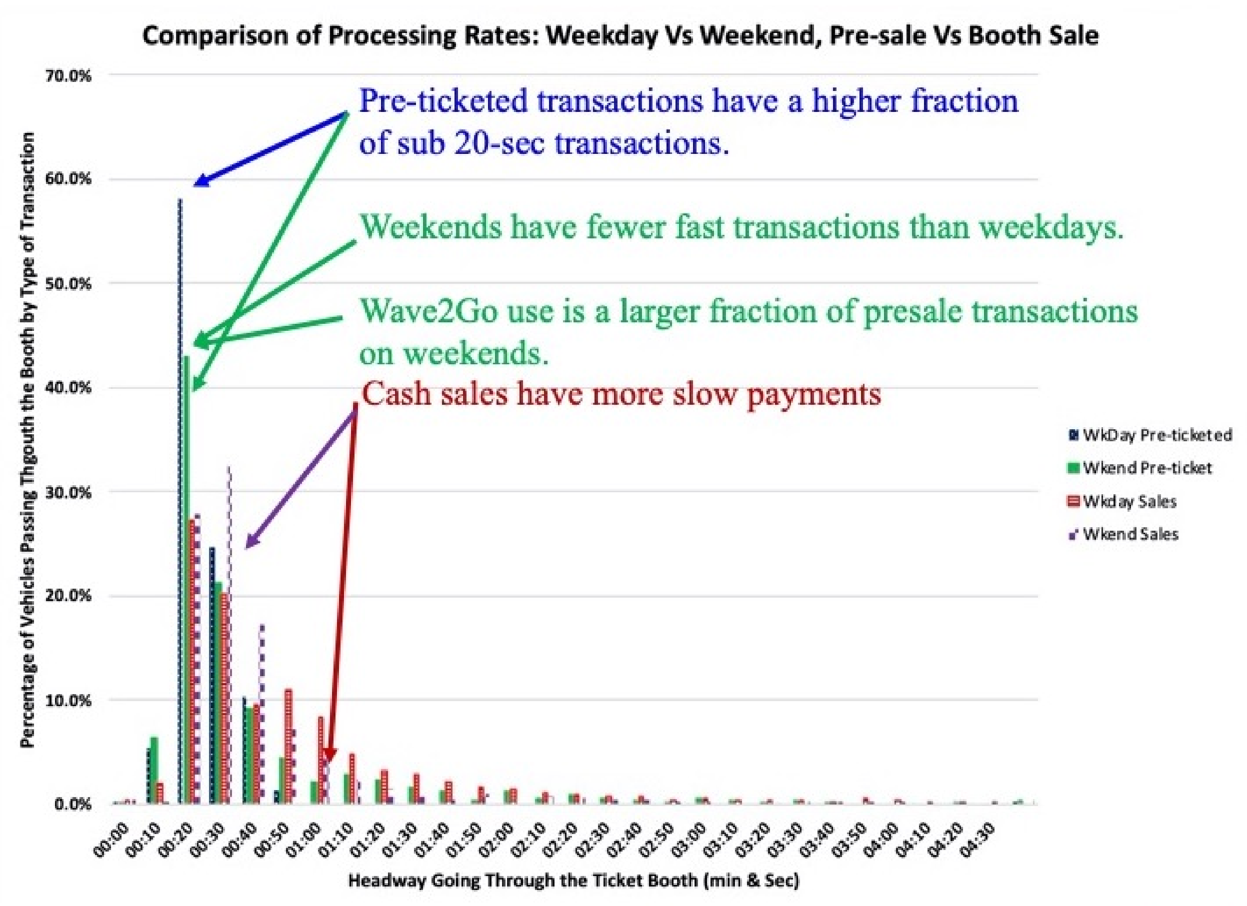

Figure 1: Distribution of vehicle transaction processing times

"Pre-ticketed" redemptions were defined as redemptions of both multi-ride tickets and Wave2Go tickets purchased on line. "Sales" included both cash and credit card payments for a vehicle and any passenger(s) for the trip, as well as purchases of multi-ride passes.

What can be seen from the distribution of processing times in Figure 1 is that pre-selling vehicle fares provides an advantage in terms of the speed with which vehicles can be processed at the toll booth. A large percentage of transactions that involved the redemption of pre-sold fares took 20 seconds or less (60 percent of pre-sold tickets weekdays, 50 percent of pre-ticketed vehicles on weekends). In contrast, cash and credit sales had a much larger fraction of transaction times of greater than 40 seconds.

Figure 1 also illustrates the fact that weekdays had a higher proportion of fast transactions from pre-ticketed users than weekends. This is in part due to the much higher number of single occupant vehicles using multi-ride tickets on weekdays and to the fact that on weekends a higher fraction of pre-paid trips used pre-sold Wave2Go tickets.

Not shown in Figure 1 is the fact that during the weekday commute period a much higher percentage of vehicles arrived at the booth pre-ticketed. On weekdays during the commute period, 68 percent of vehicles were pre-ticketed. On weekend afternoons, only 28 percent were pre-ticketed. This is why weekday vehicle processing was faster than weekend processing, both because weekdays had a higher percentage of pre-sales and because users were more familiar with ferry operations. These results are seen in the basic ticket processing statistics shown in Table 2.

Table 2: Weekday versus weekend vehicle processing speeds

Sale-type	Weekday (average processing speed)	Weekend (average processing speed)
Pre-ticketed	23.4 seconds	33.5 seconds
Sale at Dock	34.1 seconds	36.5 seconds

These basic processing speed estimates provide a good idea of the potential size of time savings that could be achieved with faster vehicle processing techniques. By encouraging customers to pre-purchase ferry tickets while also providing information on what to expect when arriving at the dock, at least 10 seconds per vehicle could be removed from the basic ticket processing time. (Note that many commuters who drive alone and use multi-ride tickets can move through the toll booth in less than 15 seconds.) The calculation shown in Table 3 illustrates that the combination of increased ticket pre-sales and better traveler information could lower toll booth processing times for weekend travelers to that of the typical weekday commuter. Table 4 assumes 120 vehicles are loaded onto an Issaquah Class boat, and it compares the time required to process vehicles through the booth if all were processed at the current speed of a weekday pre-ticketed customer and if they were processed at the speed of a current weekend customer.

The result of faster toll booth processing is a potential dwell time savings of 12 minutes per sailing. Table 4 suggests that a dwell time of at least 25 minutes is needed to process through the toll booths all of the vehicles required to fill a boat. That time requirement rises to over 35 minutes on weekends, both because fewer vehicle drivers have pre-paid fares and because some of those drivers are unfamiliar with the payment process.

Table 3: Time required for processing pre-ticketed vehicles at toll booths

Pre-ticketing Transaction Times	
Weekday Pre-ticketed customer	23.4 seconds per transaction
Weekend all customers	35.6 seconds per transaction
Savings	12 seconds

Table 4: Time required for processing an Issaquah Class vessel's auto capacity (120 spaces)

Weekday Pre-ticketed		**Weekend all customers**
23.4 seconds	Processing Time Per Vehicle	35.6 seconds
2	Number of Booths	2
1404	Total Time in Seconds	2190
23.4	Total Time in Minutes	35.6 minutes

While these estimates do not include consideration of the time required to organize vehicles on the dock or to load vehicles onto the boat for efficient unloading at the two destinations, it does provide considerable insight into the current expectations for vehicle fare processing with the current technology.

ALTERNATIVE CONCEPTS OF OPERATIONS

This report section describes several different concepts of operations meant to provide improved levels of service to people using the Triangle Route. Five suggested changes to operations were examined as part of this project. These are as follows:

1. Adopt Good To Go! for fare payment (with three sub-options)
    - with no changes to the current fare structure
    - with a new fare structure that does not require separate payments for each passenger in the vehicle
    - with more pay by web and pay via kiosk options to limit the need for after-the-fact revenue collection
2. Collect tolls only in the eastbound direction, along with removing toll collection at Fauntleroy
3. Increase the pre-sale of tickets (with two sub-options)
    - sell tickets manually to vehicles stopped in the Fauntleroy queue
    - increase the number of vehicles using pre-purchased Wave2Go tickets through better marketing and pre-sale capabilities
4. Increase the number of carpools while decreasing drive-alone vehicle use
5. Improve traveler information both to shift vehicles to less congested time periods and to provide customers with up-to-date expectations of current system on-time status and queue length.

Note that while increases in vehicle capacity during periods of peak demand are desirable from the perspective of ferry system users, they are typically problematic from the WSF's perspective because of the costs involved. Customers would certainly use these vehicle capacity improvements if they were provided during periods of peak demand. However, the costs to WSF (e.g., an additional ferry, larger docks, etc.), and the fact that the revenue gained from increased peak period utilization would not cover those costs, make vehicle capacity improvements unrealistic, unless improvements in ferry operations allowed more vessel sailings during the peak periods using the same vessels and the same staff resources.

Therefore, this study concentrated on examining specific operational concepts that could result in faster vehicle throughput at the Fauntleroy terminal, as a precursor to faster vessel loading times, which could potentially allow shorter dwell times and thus faster vessel cycle times. Changes in vehicle loading procedures would also be needed to produce shorter dwell times. Those loading procedure changes are possible given very different vehicle processing procedures, but are not part of this analysis. For example, if a vehicle queue existed outside the dock and no fare payment processing time was required, it would be possible to "refill" the dock area as quickly as it emptied as a vessel was being loaded. This would provide different opportunities for organizing and loading the last 1/3 of a vessel than are currently possible, as by the time the initial dock queues were loaded, sufficient vehicles would be already be organized and queued on the dock - with their destinations known based on where they were queued - to fill the remaining vessel space with whichever combination of Vashon and Southworth vehicles could be placed on that vessel quickly. This would eliminate the need to "piecemeal load" the last vehicles onto the vessel, reducing the overall loading time. This is not currently the case, because the speed with which vehicles pass through the fare payment points prevents the "new" on-dock queue from being large enough to allow this quick "how to load the back of the boat" decision. Without very fast fare processing (or advanced information about queue make-up), crews do not have the information needed to speed up the current loading process.

Thus, very fast fare processing could (but might not) result in more sailings along with an increase in vehicle capacity during peak periods. It could also provide other improvements that would allow customers to more effectively use existing WSF services and increase their level of satisfaction with those services. However, to gain additional peak period sailings requires both much faster fare processing and changes to the current loading process. This report does not deal with the ferry loading process, because it is unclear at this time whether the fare processing task can be improved to the point where changes to the loading process make sense.

The five operational concepts developed or examined by the project are discussed below. The operational concepts are first described in modest detail. Only after that operational description has been completed are the strengths and weaknesses of that operational scenario discussed.

1. USE THE GOOD TO GO! TOLL PAYMENT SYSTEM FOR WSF FARE COLLECTION

The first operational concept was previously studied in depth by the State Transportation Commission, with input from the State Legislature, WSF, WSDOT, and the ORCA transit agencies. Multiple reports describe the detailed tasks required to allow use of Good To Go! for WSF fare payment. Among the more important studies are the following:

- *Fare Media Study* conducted for the Washington State Legislature's Joint Transportation Committee and published in 2012[2]
- the *2018 Transit Integration Report*, conducted for the Puget Sound Regional Council in 2018[3]
- *Joint Toll and Ferry Customer Service Center Feasibility Study* (2014)[4] conducted for WSDOT.

The operational concept is simple on its face. The WSDOT electronic toll collection system already is in widespread use in the Puget Sound region, and it collects tolls of up to $10 per transaction per car on four different toll facilities. Tolls are collected by the system at highway speeds, and they can be collected using financial accounts connected to electronic toll tags or vehicle license plates. Tolls can also be collected by reading license plates on vehicles that do not have accounts and billing the owners of those vehicles at the address where the vehicle is registered. Good To Go! can collect tolls that differ on the basis of both the type of vehicle (e.g., trucks versus cars) and whether the vehicle is a carpool or single occupant vehicle. These same revenue collection procedures could be used for the ferry system.

However, despite the flexibility currently built into the Good To Go! system, it is not capable of collecting the current WSF fares without modification. The current toll collection system is not capable of identifying the number of passengers in a car, let alone the different

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[2] Fare Media Study, Final Report, by the Cedar River Group, et. al., for the Joint Transportation Committee of the Washington State Legislature, 2012. (available at: http://leg.wa.gov/JTC/Documents/Studies/Fare%20Media/FareMediaFINALReport_032912.pdf as of June 30, 2019)

[3] Transit Integration Report, Puget Sound Regional Council, 2015 (available from: https://www.wsdot.wa.gov/publications/fulltext/LegReports/15-17/TransitIntegrationReport5-12-15.pdf, as of June 30, 2019)

[4] Joint Toll and Ferry CSC Feasibility Study, for Washington State Department of Transportation, January 2014, available at: https://www.wsdot.wa.gov/publications/fulltext/LegReports/JointTollAndFerryCSCFeasibilityStudy.pdf as of June 30, 2019)

passenger discounts offered by WSF. Neither is it currently able to identify vehicle length and height, which are used in the WSF vehicle fare calculation. While it is possible to purchase and operate equipment that is capable of automatically measuring vehicle length and height, that equipment is not currently part of the Good To Go! toll collection system.

In addition, previous work performed by WSF in 2013 showed that implementation of the length measuring equipment available at that time was problematic due to lack of a sufficiently straight approach to some terminal booths. This project did not explore the cost of the physical changes need to make that equipment work for WSF's approaches. Neither did the project team perform a market analysis of current technology to determine if technology advances, such as with modern lidar systems, have removed these concerns.

Therefore, unless WSF (and the State Transportation Commission) change the fare structure, Good To Go! cannot collect all WSF fares automatically. At a minimum, its implementation would require manual input at the toll booths, even if the actual revenue transfer was performed with Good To Go! electronic transponders, automated license plate readers, and the Good To Go! back-office. In addition, use of Good To Go! for WSF revenue collection would require not only changes to the Good To Go! back-office software but also changes to the WSF ticketing and revenue software.

Given the need to make some changes to the existing Good To Go! system, it is useful to examine a number of ways in which Good To Go! could be used by WSF. There are really two basic options for adopting Good To Go!. These are to 1) make all payments through the Good To Go! system, or 2) make Good To Go! an optional payment method, with users also allowed to choose to pay with cash or credit. Each of these two options could have additional potential features that could either simplify the use of Good To Go!, enhance revenue collection, or provide additional customer service benefits. The Good To Go! options considered by this project are the following:

- All revenue collected via Good To Go! (cashless tolling)
    - with simplification of the WSF vehicle fare structure to speed revenue collection and reduce the cost of Good To Go! deployment, operation, and maintenance
    - with removal of, or simplification of, passenger fare collection, to eliminate the difficulty of automatically determining passenger fares

    - with on-dock and on-vessel kiosks added and used to allow customers without a Good To Go! account to pay their fares via these kiosks, rather than having to track down these payments after the fact via mail
    - with an increase in the use of on-line sales, increasing the pre-purchase of tickets that are then tied to vehicle license plates read by the Good To Go! license plate readers at the ticket booth.
- Good To Go! as a payment option but not a requirement (ticket booths are otherwise unchanged)
    - with the ticket booth staff determining the required payment but the payment charged to a Good To Go! account
    - with an increase in the use of on-line sales, and pre-purchased tickets tied to vehicle license plates read by the Good To Go! readers at the ticket booth.

These alternative operational concepts are described below, followed by a summary that describes each concept's strengths and weaknesses.

All Revenue Collected via Good To Go! (Cashless Tolling)

This operational concept assumes that all fare payments would be made through Good To Go!. This would be similar to all toll roads in the state, except for the Tacoma Narrows Bridge. Under this approach to fare collection, Good To Go! electronic tag readers would be installed at the WSF toll booths along with license plate readers.

All vehicles passing the booth location would then be identified via one or both of these methods. As with WSDOT-operated toll road facilities, if the vehicle had a Good To Go! account, that account would be charged the appropriate fare. If the vehicle did not have an existing Good To Go! toll account, the registered owner of the vehicle would be determined by querying the appropriate state's or province's vehicle registration database, and a bill would be mailed to that owner for the appropriate ferry fare plus an added processing cost associated with the search and mailing tasks. If that fare was not paid when due, a fine would be added to that amount, and eventually, unpaid debts would be turned over to a collection agency.

This operational concept has the potential to save both time (because of the faster processing speed due to automated revenue collection) and money (because of the potential decrease in labor costs associated with lower staffing at the toll booths). If the appropriate fares could be calculated and applied automatically, the adoption of “cashless tolling” could eliminate the need for toll collection personnel, allowing WSF to stop using toll booths altogether significantly decreasing personnel costs. If that occurred, the physical removal of the toll booths could also be performed if repurposing of that land was worth the cost of the removal of the current booth infrastructure.

However, calculating the appropriate fare in an automated way is a difficult task. WSF fares are a combination of vehicle and passenger fares, and the WSF fare structures for both are complex. Consequently, additional operational concepts designed to make those tasks more manageable are discussed below. Combinations of the concepts discussed below could make automated toll collection more accurate, easier to perform, and less costly, increasing the opportunity to move away from staffed toll booths.

Simplified Vehicle Fare Structure

This operational concept would simplify the WSF vehicle fare structure to decrease the cost of automatically identifying the correct vehicle fare, thereby allowing the automated processing of vehicle fares and speeding up the fare collection process. The operational concept assumes that the WSF fare structure would be revised to align with the type of fare structure used by WSDOT toll roads.

WSF currently charges multiple vehicle fares on the basis of vehicle length and height. This differs from the criteria used to determine road tolls for vehicles. WSF vehicle fares change on the basis of vehicle length, which includes the length of any trailers towed by the vehicle. Changes in fare price occur at the following lengths: less than 14 ft, 22 ft, 30 ft, and then every additional 10 ft until 80 ft, at which price is computed as an 80-ft vehicle plus an additional charge per foot. Tall vehicles (higher than 7 ft, 2 in) pay an additional charge. Motorcycles are charged a different rate. Bicycles (not carried on a vehicle) are also charged a fare.

Although automatic determination of the appropriate WSF vehicle fare would be possible, performing that task would require the installation and use of reasonably expensive and complex equipment. That equipment would need to be installed at each fare collection location (e.g., the ticket booths). Without such equipment, vehicles would have to stop at the existing ticket booths to allow staff to manually determine and enter the appropriate vehicle fare category, forfeiting a significant portion of the potential speed improvement that moving to Good To Go! could provide.

Vehicle fares are also structured to include the fare for the driver. Consequently, discounts to standard vehicle fares are available if the driver is a senior or has a qualifying disability. These discounts are applied to the human (driver) portion of the vehicle fare but must still be addressed by the toll collection system. Additional passengers in the vehicle are also charged a fare, and these passengers too are eligible for fare discounts.

Ferry riders can also obtain discounts by purchasing a multi-ride pass. Multi-ride vehicle passes are good for 90 days from purchase.

The current WSF vehicle fare structure is based in part on the space required to carry each vehicle on the boats (because larger vehicles reduce the number of vehicles each boat can carry, and thus the revenue each trip might generate, if all vehicles paid the same amount). The fare structure was the outcome of a set of policies developed in the 1990's and modified by Legislative direction in 2007, as part of an effort to create a long-term, sustainable funding strategy for the ferry system.[5] The fare structure was specifically designed to account for the impacts of vehicle size on boat capacity, route equity, and the relationship of passenger to vehicle fares. WSF fares also differ by route and include a seasonal surcharge, although these differences could be easily handled by the existing Good To Go! technology.

Unlike WSF prices, rates for WSDOT toll roads are based on the number of axles on each vehicle. The number of axles on a vehicle is a proxy for the amount of pavement damage each vehicle causes (heavier vehicles, with more axles to carry that weight, cause more pavement deterioration) and thus the cost of the maintenance the toll road will need. Higher rates are charged for three-axle, four-axle, five-axle, or six- or more axle vehicles. Vehicle height is not considered. So, with the exception of roads where carpool discounts are applied, all passenger cars are charged the same rate, regardless of vehicle size or length. This pricing structure makes sense for roads, as road capacity is not much affected by the length of vehicles, so vehicle length makes little sense as a road pricing mechanism.

On some toll roads, discounts are available for carpools (which can be defined as either two or more people in a car or three or more people in a car) and transit vehicles. These, like the WSF passenger discounts, are designed to encourage specific policy outcomes. Currently,

[5] Long-Term Ferry Funding Study, Washington State Transportation Commission, February 2009.

carpool designations for toll rate setting are based on self-reporting by drivers. Enforcing these self-reports is an area of concern for WSDOT. Enforcement is performed on a spot check basis by the Washington State Patrol, with significant fines being issued to violators. Unfortunately, automated vehicle occupancy counting is technically very difficult, and no system on the market has yet been able to meet the accuracy requirements required for automated enforcement.

As can be seen by the above discussion, Good To Go!—as currently used as a toll payment mechanism—is not designed to collect the data required to determine and apply the appropriate WSF vehicle fares. It would be possible to purchase equipment capable of automatically determining vehicle height and length. It would also be possible to change the automated Good To Go! fare computation process to accept those inputs and compute the appropriate fare; however, that equipment is far more costly than the simple axle detectors needed to collect road tolls. If this equipment was procured, installed, and operated and the appropriate software was written, then the vehicle portion of the current WSF fare structure could be automatically computed and applied without having vehicles stop at WSF toll booths.

Simplifying the WSF vehicle fare structure to mimic the WSDOT toll road fare structure would significantly reduce the cost of implementing Good To Go! for vehicle fare revenue collection, unless WSF required vehicles to stop at a toll booth for manual input of the vehicle fare. However, retaining manual entry of fares would not only slow vehicle processing but would eliminate the cost savings that would result from using fewer staff to collect those fares.

What this operational concept would not accomplish would be determining and collecting the passenger fare portion of the current WSF toll. This could be addressed by the following operational concept.

Removal of All Passenger Fares

The next major simplification that would greatly ease the implementation and speed of fare payment in using Good To Go! would be the elimination of passenger fares. Ferry rides, like bus and rail transit use, require a fare to be paid for each adult passenger, and the need to count passengers in each vehicle and classify those passengers by fare payment category to compute the correct fare payment considerably complicates the use of Good To Go! for WSF fare collection.

This operational concept examines the removal, or significant simplification, of passenger fares. The goal of the operational concept is to make it far easier to automatically collect the entire fare required from vehicles arriving at the dock, thus allowing more effective implementation of the Good To Go! fare payment technology and reducing or eliminating the need for toll booth staffing. Without a passenger fare payment requirement, the installation and operation of the equipment needed to automatically determine the required vehicle fare payment, as described in the previous section, would allow removal of WSF toll booths, producing a reduction in staffing costs at terminals, as revenue could be collected accurately without human intervention at the approaches to the ferry terminals.

The resulting Good To Go! toll collection process used by WSF would also be more compatible with the other WSDOT toll collection systems.

On-Dock and On-Vessel Kiosk Sales

One of the downsides of going to "cashless toll collection" using Good To Go! would be that a large fraction of ferry system users are not active Good To Go! account holders. Therefore, without other changes, the adoption of Good To Go! would result in a fairly substantial increase in the number of fare payments – and "expensive" fare payments relative to current toll payments - that would have to be collected "after the fact" by the Good To Go! back-office through the vehicle registration address search and bill mailing processes.

This operational concept attempts to address this limitation in Good To Go! adoption by increasing the ease with which customers can pay for their ferry rides. It borrows from techniques used by most toll road authorities, which allow on-line payment of tolls. Customers are given a discount (over the more expensive "bill me later" price) if payments are made before a trip, or if payment is made within some time period (e.g., 24 hours), which allows the toll authority to avoid conducting the vehicle registration search and bill mailing tasks.

In this version of that operational concept, WSF should install and operate payment kiosks both on the dock and on-board vessels, allowing customers either waiting for their ferry or riding the ferry to pay for their trip with cash or a credit/debit card. The kiosk software would need to be purpose built for this task. The kiosk would allow customers to enter their license plate, obtain the cost of the trip, and pay that amount. Because most customers arrive many minutes before a boat leaves, time is available for most customers to pay at the dock before boarding the vessel. For those that arrive just before their sailing, they would be able to pay on-board. If customers paid for their trip at the kiosk on the dock, they would be charged the same rate as a Good To Go! customer. If they paid on the boat, they might be charged a slight surcharge (because their payment took place "after the fact").

The key to this operational concept is the speed with which the kiosks would need to process the required payment value. To do this, the local computer network at the dock would have to be upgraded when the Good To Go! system was installed. The payment calculated by that equipment, the license plate read at the time that payment determination was made, and the license plate image associated with that payment, would need to be loaded onto the kiosk system within a minute of the vehicle passing through the toll booth / revenue collection point.

This fast processing speed for posting the payment record in the kiosk database would be needed so that when customers used the kiosk after they had parked their vehicle on the dock, they would be able to look up their fare record and pay the required amount. These payment records would also need to be passed to the kiosks located on-board the ferry so that drivers could locate those records on board and pay their fares from that location.

Because most ferries are not in cell service range at some point in their trip across Puget Sound, the on-board kiosks would need to be able to store and forward these payments. The on-board kiosks would need to load all payments required before that ferry completed its vehicle loading and to store any payments that were made after the vessel left cell coverage. When the ferry then reconnected with either cell coverage or the dock WiFi, the on-board kiosks would have to upload payment records created during that sailing. (The alternative to this would be to provide for satellite-based communication – or improved cell phone communication – on board the vessel, so that the vessel was never out of communication.

Signs—both fixed and variable message (VMS)—would need to be added to each of the ferry docks to inform riders of this option. Ideally, a variable message sign would be placed at each entry point to the dock indicating the fare to be paid, whether that fare was being charged to a Good To Go! account, and whether that account currently had sufficient funds in it. If that fare was not charged to an existing account or if the fare exceeded the Good To Go! account balance, then the VMS would indicate to drivers that additional funds were needed for that trip and indicate the kiosk locations that they could use to make those payments.

Kiosks should also allow customers to add funds to their Good To Go! accounts or purchase other ferry products, such as multi-ride tickets, as this functionality would both improve customer service and help increase the number of pre-paid ferry fares.

It is expected that multiple kiosks would be needed at each ferry dock and on each vessel, and these kiosks would need power, shelter from the elements, and high speed, secure communications.

Increased Pre-Sale and On-line Sale of Tickets Connected to License Plates

An even better option than kiosks for connecting payments to license plates would be to encourage a substantial increase in the number of ferry tickets sold on-line prior to a trip. By connecting these presold tickets to specific vehicles via license plates or Good To Go! tags, WSF could decrease the number of times it would be required to "chase down" fare payments. This would be essentially the kiosk process described above, but with sales occurring before vehicles arrived at the ticket booth.

WSF already has this basic functionality through its Wave2Go program. The current Wave2Go system produces a scannable code that can be printed and shown to the ticket booth staff. (The code can also be read directly off a smart phone or other portable electronic device.) WSDOT Tolling also has this functionality within Good To Go!, by which customers can create a temporary account and pre-pay tolls even if they do not have a Good To Go! electronic tag. For WSDOT toll roads, these payments are based entirely on license plate numbers.

This operational concept would differ slightly from the current Wave2Go system in that it would not only provide customers with a scannable bar code (as proof of payment and as a back-up in case of license plate scanning problems) but would attach that payment to the license plate of the vehicle used for the trip and then use the vehicle plate (rather than the scannable code) to recognize the payment when the vehicle arrived at the toll collection point. This would allow Good To Go! to operate "at speed" while reducing the number of after-the-fact payments to be pursued. Combining this capability with good marketing of the pre-payment option could result in both much more use of fare pre-payment and faster vehicle processing at the terminals.

The process of on-line payments and the assignment of those payments to license plates is already a function performed by Good To Go!, which lets customers who do not have a Good To Go! account sign up on line for a "guest account" that allows them to pay for a trip, either before the trip or immediately after. This allows them to pay a lower toll than the standard "pay by mail" billing amount.

In this operational concept, if upon passing the payment location the license plate of a vehicle was not correctly read—or if a different vehicle was used than the vehicle designated for the pre-payment—then the pre-paid ticket could not be associated with that fare. If this happened, the variable message sign at the point of payment would indicate the failed payment attempt and would direct the customer to the on-dock kiosks. At the kiosk on the dock, the customer would be able to manually associate the pre-paid ticket to the vehicle being used. The driver would use the expected plate number and the images of the license plate and car to locate the missing payment and then enter the payment record from the on-line transaction receipt. Note that account security would be an important consideration in the design and use of the kiosks to ensure that only account holders were able to access and assign payments to specific vehicle trips.

Discussion: Cashless Tolling Options

This subsection discusses the strengths, weaknesses, and other operational impacts of all the operational concepts described above applied to achieve effective, efficient, cashless tolling. It concludes with a recommended initial design of the concepts needed for WSF to adopt cashless payments for all vehicles, and summarizes the changes that would be required.

On its face, the adoption of Good To Go! for ferry system fare payments makes good sense. "Allow ferry users to pay with their Good To Go! accounts just like on WSDOT controlled toll roads." Allow non-Good To Go! account holders to be billed via their license plates, without having to stop at a toll booth, just like is done on SR 520, Sr 167, and I-405.

If this approach allows the removal of the need to stop at physical toll booths, vehicle processing times would drop to near zero, and vehicle boarding could occur at the speed at which vehicles could safely approach the vessel and load onto the boat. For a dock such as Fauntleroy, this increase in vehicle processing speed could potentially allow changes in vessel loading procedures, which result in significantly decreased vessel dwell times and consequently, both reduce customer wait times and increase system capacity by allowing more sailings to occur during periods of peak demand.

Just as importantly, if accurate toll collection can happen automatically, WSF would likely be able to eliminate at least some staff positions, producing significant operational cost savings.

Unfortunately, as noted in the operational concepts described above, the adoption of Good To Go! would be a complex undertaking, and resolving the issues associated with adoption of cashless tolling would require both time and money. Many of the needed features are part of planned Good To Go! upgrades to their back-office system. Some of these upgrades are planned, but not currently funded. Other required changes, such as the hardware and software needed for WSF specific toll computations need to occur as part of the design and implementation of Good To Go! at the WSF docks. Exactly what hardware is needed and what software improvements are needed is a function of the fare payment rules applied and which of the operational concepts described above are adopted.

The most important limitation with adopting Good To Go! is the inability of current technology to automatically compute and apply the current WSF fare structure. While available hardware (while potentially expensive) can compute the appropriate current vehicle cost, available technology does not permit the automated determination of vehicle occupancy, let alone the fare discounts to which some passengers are entitled. Therefore, the implementation of cashless tolling would require one of four actions

- elimination of the passenger fare,
- dramatic simplification of the passenger fare to something similar to the “carpool / not carpool” designation commonly used on WSDOT toll roads,
- the continued use of staffed toll booths, or
- no enforcement of passenger fare collection.

All of these actions would require Transportation Commission and possibly Legislative approval for full implementation. All of these options would also require a substantial change to the current WSF policies. Finally, all of these options impact the specifics of the software and hardware that need to be provided at the dock to operate the system.

Charging passenger fares is a fee for service transaction. It provides a significant revenue source that helps pay for that service, and encourages economic behavior from customers. The 2012 Fare Media Study reported that passenger fares contributed 25 percent of the total WSF fare revenue, and that total fare revenue paid for 70 percent of WSF operational costs. Thus, passenger fares pay for roughly 17.5 percent of WSF's operating costs.

The use of discounts provides specific support for important public policies, in particular reducing the cost of mobility for disadvantaged groups of travelers. The elimination of those fares would be beneficial for those same communities, unless that revenue was simply replaced via an increase in vehicle fares and those same individuals also use the ferries with their vehicles. In this case, the loss of a discount would be detrimental to the groups currently receiving that discount. If the elimination of passenger fares increased passenger ridership, that increase would have little cost impact on the ferries because the marginal cost of carrying passengers on a vehicle ferry is essentially zero. <u>However</u>, the loss of revenue would substantially decrease WSF's revenues, thereby significantly increasing the need for other revenue—either through increased vehicle fare prices or through an increased state subsidy.

If it was not feasible to replace the lost passenger revenue with other revenue sources, WSF could consider simplifying the passenger fare collection process in ways that would allow fares to be collected automatically. Unfortunately, automatically computing the number of passengers in a vehicle is very difficult. Toll roads throughout the world have been researching vehicle occupancy sensors for many years. WSDOT's Tolling Division has explored this technology multiple times and has attempted to gain funding for testing potential technologies, but tests have not been funded. As part of the literature review done to request those tests, WSDOT determined that the best reported technological success in this area (in a road toll environment) is in the range of 90 percent accuracy. Toll payments based on that level of accuracy would not survive a legal challenge. Therefore, the available technologies are not currently suitable for automated toll collection. Research on vehicle occupancy sensors continues to be performed in large part because of the significant demand for this type of information from toll road authorities. Therefore, it is possible that such a technology will emerge that can perform this task with sufficient accuracy in the future, but currently one is not available.

Therefore, if passenger payments were to be retained, the most likely procedure for determining and collecting passenger fares would be to retain the toll booths and toll booth staff. This would allow a human to view the inside of the vehicle and confirm the number of passengers. This process would also allow a vehicle's passengers to request any qualifying discounts and to provide any proof of qualification for those discounts. Unfortunately, these tasks would reduce the speed at which vehicles could be processed and would essentially remove the potential cost savings that can be achieved by eliminating staff positions.

If some level of passenger fare was to be retained, the best alternative appears to be adopting the WSDOT carpool definition. In this case, vehicles would be designated as either single occupant vehicles or carpools. Unlike toll roads on which carpools often receive a discount, at WSF, carpools would be charged an additional passenger fare. However, that fare might be a single additional passenger fare, regardless of how many adult individuals were in the vehicle. This would limit the revenue loss due to the reduction in passenger fare collection and would provide a financial incentive for cars to carry more than two adults, potentially reducing vehicle demand during peak periods. (However, many current walk-on passengers might simply join cars sitting the vehicle queue to avoid paying the passenger fee associated with walking onto the ferry, further reducing passenger revenue.)

The available vehicle occupancy sensors appear to be more able to reliably determine "two or more adults," than to accurately count the actual number of people in a vehicle. Whether the available equipment could meet the accuracy standard needed for revenue collection at this level of precision would have to be field tested.

However, the adoption of even this approach to passenger revenue raises questions about the level of enforcement needed and the process by which customers could contest a toll automatically applied to their vehicle. One way this might be accomplished in a semi-automated way would be to use variable message signs at the toll point to describe the toll being applied (e.g., describing both vehicle length and the number of passengers) so that drivers could see the proposed payment and the reason(s) for it at the time of payment. If a vehicle driver disagreed with the toll rate (e.g., only one adult, not two or more, was in the car), that driver could roll down the window and "protest" the rate to WSF staff. The WSF staff member could then confirm the correct price (number of people in the car) and use a hand-held terminal to correct that toll record.

This concept has promise for resolving the passenger tolling dilemma but would involve the development of new hardware and software, and also would assume that the physical process (e.g., where WSF staff would stand, how vehicles moved on the dock, and how staff would direct traffic) could be safely designed and implemented. Without having a mechanism to allow customers to identify incorrect fare computations and easily fix those errors, the WSF would put itself at risk of legal actions, which it would likely lose. The required development of hardware and specialized software would also increase the cost of system development, implementation, and maintenance.

The alternative would be to set the algorithm used by the passenger counting system to act in such a way that whenever the technology was even remotely in doubt as to the number of passengers, it would err on the side of the customer. This would reduce revenue collection but would lower the likelihood of a legal challenge.

The other issue that would need to be addressed is enforcement. The use of automated technology—and lack of human oversight—would also make it easy for customers to “cheat the system.” For example, upon approaching the toll point, passengers could duck below the seat backs to deceive a camera attempting to count passengers. Without enforcement—and depending on the technology used and robustness of its settings—it could be reasonably easy to cheat the system. WSDOT regularly works with the Washington State Patrol (WSP) to enforce carpool and high occupancy toll lane violations, where enforcement is also a significant issue. Providing financial incentives to “cheat the system” would increase toll evasion, and WSF would need to either accept the revenue loss or develop an effective enforcement mechanism, which would likely involve manual enforcement of fare computations. (For example, a law enforcement officer might periodically be tasked with watching the fare computations from a discrete location at the dock and visually determining the true number of people in vehicles.) This would also likely require Legislative approval of new fines for individuals intentionally mis-representing the number of people in each vehicle.

The last difficulty with collecting passenger fares automatically via Good To Go! is the fact that passengers can currently pay their fares using their ORCA card and account. To maintain this functionality, ORCA and Good To Go! accounts would need to be linked. Studies such as the Fare Media Study have explored this option. The outcome of these studies has been a desire by many in the region for a single public transportation financial account that customers could use to pay for trips regardless of mode (ferry, bus, light rail, bike-share, toll road). The Next Generation ORCA card is being designed with this specific capability in mind, although that feature is not part of its initial deployment. Neither is it a funded activity within the planned improvements to Good To Go!, although the creation and use of such a single user account is a feature in long range plans for Good To Go! Linking a “random” ORCA account (i.e., your friend's account who happens to be traveling with you on the ferry today, but who doesn't normally share a ferry trip with you) to a Good To Go! account is more difficult, and would require considerable work both in the Good To Go! and Next Gen ORCA back-office's as well as the development of specific interfaces for customers trying to temporarily link accounts. This might better be done by an outside vendor providing single user-account features that allowed easy, secure linking of multiple transit/toll accounts. Considerable work would be needed to determine the cost of adding such functionality, depending on how the linkage between Good To Go! and Next Gen ORCA was accomplished.

All of these options will require that the State Transportation Commission change the passenger fare structure. And all of the above options are likely to result in some loss of revenue to WSF. This would need to be made up with some other revenue source, likely an increase in vehicle fares, and that, too, would require Transportation Commission approval.

However, without these changes, the challenges to adopting Good To Go! in a manner that allowed fast, automated revenue collection might be unresolvable in the foreseeable future, unless Good To Go! simply acted as an optional, convenient mechanism for collecting vehicle and passenger fares, and where WSF would need to continue handling cash and credit at the terminal toll booth. That is, if it were an option (meaning Good To Go! tag readers were present and connected to the WSF toll system) as a customer service option, drivers might choose to tell the WSF booth operator to "charge my Good To Go! account." This would be a useful customer service option, but will not result in measurable improvements in fare collection speed.

The task of automatically computing the appropriate vehicle toll is less daunting than the task of collecting passenger fares. Hardware currently on the market is able to accurately compute vehicle height and length. This would allow the toll collection system to maintain the current WSF fare structure. The 2012 Fare Media Study recommended the implementation of this technology, including the elimination of the over-height surcharge, and estimated that the cost of the hardware required to collect vehicle length data automatically would be roughly $900,000[6] for the all terminals in the state.

The removal of the current over-height surcharge would result in some loss of revenue for WSF. If the conclusions reached by the Fare Media Study were revisited, additional analysis would be needed to determine the trade-offs between the costs of purchasing, installing,

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[6] Fare Media Study, Executive Summary, page viii,

operating, and maintaining height sensing equipment versus the revenue generated by that equipment to determine whether retaining the fare surcharge would result in a positive return on investment.

One of the major issues associated with changing to cashless toll collection is the fact that a large percentage of customers using the system do not have Good To Go! accounts. The 2012 Fare Media study concluded on the basis of surveys that many customers who do not have Good To Go! accounts would get such accounts if the system was used to pay for ferry tolls. The Triangle Route was listed as one of the better routes for expected adoption of Good To Go!. In that 2012 study 34 percent of South Sound ferry users already had access to Good To Go! tags, and 84 percent said they would get one if a discount was associated with it.[7] However, this would still leave a substantial number of payments that would have to be pursued "after the fact." This entails searching for vehicle registration addresses from multiple states and provinces, mailing bills, and then undertaking collection activities if those bills are not paid. This is both a difficult and expensive task, and one that can easily generate customer dissatisfaction.

In addition, WSF serves a large fraction of customers who reside in areas where they have no knowledge of, or reason to sign up for, Good To Go!. This is particularly true for out-of-state customers. Consequently, <u>if WSF adopted Good To Go! as the only payment mechanism for vehicles</u>, it would behoove WSF to make it far easier for customers to interact with the Good To Go! system to pay fares. The two options suggested previously would both make it easier for customers to pay their fares and could be implemented independently of each other. Both would involve connecting payments to the license plates of vehicles boarding the ferry.

One option would be to increase on-line sales of ferry fares while also improving customer service. This option is a simple improvement to the existing WSF Wave2Go process. It would involve more effective outreach to individuals visiting WSF's website to obtain information about ferry services (e.g., ferry schedules and prices). More pro-actively displaying "buy your ticket now" messages would make it easier for non-routine ferry users actively exploring how to use the ferries to find the prepayment site. The biggest technical challenge would be to connect the Wave2Go ticket sale to the Good To Go! system, although Good To Go! already has a web-based feature that allows a toll payment to be linked to a vehicle license plate, so this change is not too significant a departure from the existing Good To Go! back-office.

[7] Fare Media Study, page 22

The second option for expanding payment options in a license plate-based revenue collection system would be an expansion of the current terminal kiosk system used by WSF. Currently, customers can access kiosks inside terminal buildings at the docks. An expansion of the capabilities of those systems, the number of kiosks, and their locations would go a long way toward making it easier for ferry users to "pay at the dock" rather than at a toll booth. Most vehicles arrive at the dock with time to spare before they board. Customers who had not pre-paid could often use that time to pay for their trip at a kiosk. However, WSF would need to make this task easy, and it would need to provide messaging and discounts (e.g., no "added fee" for being billed in the mail via their license plate) that encouraged customers to take advantage of the opportunity.

Thus, while it would cost money to place additional covered kiosks on the dock, doing that would greatly increase the number of people paying at the dock and would reduce the number of license plate searches required by the Good To Go! back-office. The inclusion of kiosks on the ferry boats themselves would also improve the customer experience, especially for vehicles that arrived just before the ferry left, and would further decrease the number of payments that WSF would need to pursue "after that fact".

The kiosk operational concept also solves one very major problem. Customers do need to be able to pay with cash because some customers may not have bank or credit card accounts or a Good To Go! account. A mechanism must exist for those individuals to pay for their trip. Kiosks would provide that mechanism. Consequently, kiosks would need to be able to accept cash as well as credit/debit cards, and they would need to be able to associate a cash payment with a specific vehicle.

Resolving the issues associated with automated payment of vehicle and passenger fares would be worthwhile only if there was benefit to WSF. There would be three primary benefits from adopting Good To Go! as part of a cashless tolling system:

- improved customer satisfaction,
- faster vehicle processing, and
- reduced labor costs.

The first of these would occur only if the Good To Go! process actually improved customer satisfaction. If ferry loading speeds improved, individuals with Good To Go! tags would likely have an increased level of satisfaction. However, this would not be the case if payments did not process smoothly for all vehicles and if dock operations did not function smoothly.

For the Triangle Route, this means that vehicles would have to be able to easily declare which destination they were bound for and then follow directions based on that information to either select the correct payment line, or identify the correct destination in the payment process to have the correct fare charged, and then be routed to the correct waiting queue. This task would require careful redesign of the dock operations and the addition of the appropriate signage.

For non-Good To Go! account holders, customer satisfaction would also be tied not only to their experience entering the dock waiting area, but also to how smoothly dock operations occurred and the experience they had with the new on-line and kiosk-based payment procedures. Currently, these customers are able to interact with a staff person who not only can help them determine the correct payment and direct them to the correct vehicle queueing area, but also provide additional information about ferry operations. The removal of staff at the toll booth would save WSF money, but it would increase the difficulty that customers unfamiliar with ferry operations would have when interacting with WSF dock workers and WSF signage. Therefore, improvements to support functions (vehicle directing, signage, etc.) would be crucial to the successful adoption of Good To Go! as the only method for payment, especially if toll booth staffing was reduced or eliminated.

Maintaining the required level of customer service and vehicle directing might limit the staffing reductions that could be achieved by adoption of Good To Go! as the only fare payment method. For example, one of the tasks that toll booth staff perform is initially sorting vehicles at multi-destination terminals such as for the Triangle Route. For a dual destination dock such as Fauntleroy, this is an essential task, as vehicles bound for the two destinations must be sorted into different queues. In addition, use of the limited dock space can change from sailing to sailing depending on the destination of the next ferry, as well as the actual demand for the two destinations. Therefore, even if the revenue collection function was no longer needed, WSF staff would still be needed at Fauntleroy to direct traffic. However, this project did not have the resources to determine whether the existing, non-toll booth staff could handle those tasks without support from by the ticketing staff.

In addition, WSF staff might have to help customers use the kiosks. Currently, the WSF kiosks are not staffed. Most transit kiosks (e.g., those used to purchase Link light rail tickets) are also unstaffed. However, given the large number of customers during the peak season who are infrequent or first-time ferry system users, unless the kiosk system worked very easily, staff might be required for assistance. This need, combined with the potential need to redesign dock staff work tasks to handle the operational changes due to the removal of toll booth workers, requires more detailed analysis of operational outcomes than could be conducted in this study. The amount of staffing savings that could obtained from the shift to cashless payments is therefore unclear.

Good To Go! as a Payment Option

The Good To Go! payment concepts discussed above are all intended to achieve "cashless tolling." That is, all staffed toll booths would be removed, and all payments would be made through the Good To Go! back-office system, as is the case on SR 520, the I-405 Express Toll Lanes, and on the SR 167 HOT lanes. That approach to Good To Go! would achieve the fastest vehicle processing through the fare collection point. However, as noted above, this would create a number of difficulties, the most notable being the correct assignment of passenger fares and the loss of customer service/interaction used to both identify the correct vehicle fare and direct incoming traffic to the correct waiting areas.

Staffed Toll Booths

To address these issues, this concept of operation assumes that the toll booths would remain in place and staffed. This could be a transitional phase, until Good To Go! was routinely used by customers and/or until legislation or transportation policy decisions permitted operational or pricing changes that would allow WSF to more effectively adopt cashless tolling. By keeping toll booths in operation, this operational concept could take advantage of any or all of the operational concepts discussed above (e.g., simplified fare structures) while still allowing direct payments by customers (e.g., cash or credit paid at the toll booth). The major differences between this concept and the cashless tolling concept are that the toll booths would remain in place, would be staffed, and each vehicle would be required to stop at the booth, although in many cases, those stops could be quite short.

WSF would still need to install Good To Go! tag and license plate readers and have software developed that allowed payments computed in the toll booths to be charged to Good To Go! accounts. Unlike the cashless tolling concept, charging WSF fares to Good To Go! would occur only at the request of the user and after a specific action was taken by the WSF staff in the booth.

In this operational concept, Good To Go! readers (both electronic tag and license plate) would identify when a vehicle arriving at the booth had a Good To Go! account. If automated vehicle length measuring equipment was present, the booth operator would also be informed of the expected price for the vehicle and whether Good To Go! was an option for payment. If no automated vehicle length equipment was present, the booth operator would make this determination, just as they do now. The booth operator would then determine the number of adults in the car and deduct other payments that passengers in the vehicle wished to make separately (e.g., ORCA payments for passengers in the car could be deducted from the total vehicle payment). The booth operator would then determine the total cost for that transaction and enter that cost into the payment terminal/cash register system.

On-line Prepayments

If on-line prepayments for non-Good To Go! account holders were available, the prepayment would appear on the booth operator's screen (having been extracted on the basis of the license plate or Good To Go! tag) so that the operator could connect that earlier payment to this transaction.

For Good To Go! account holders who had enough money in their Good To Go! account, the booth operator would then ask drivers if they wished to pay the transaction with their Good To Go! account or if they wished to pay with cash/credit. If the customer wished to pay via Good To Go!, the booth operator would select this option from the terminal, and the cost of the trip would be billed to the Good To Go! account. (Note that this feature is planned for implementation in the new Good To Go! back-office system but is not yet on-line.) Even if the customer had a Good To Go! account, the customer could choose to pay via cash or credit. With changes to the current Wave2Go web site, on-line payments for upcoming ferry trips system could be – at the option of the user - connected to either Good To Go tags or license plates, in order for those payments to be identified automatically at the booth, speeding the passage of the customer through the booth.

Discussion: Good To Go! as a Payment Option

The option of keeping toll booth staff in place, rather than changing to fully automated tolling, would be a good way to operationally test the use of Good To Go! as a payment mechanism for WSF. The downside of this concept is that many of the benefits expected by changing to Good To Go! would be minimized, but all of the costs would need to be incurred. That is, because vehicles would have to stop and the number of passengers must be manually entered, improvements in vehicle processing speed would be limited, although the mean processing time for these transactions would likely be below 10 seconds, similar to the fastest processing speeds currently observed with single occupant vehicles using multi-ride tickets. The lack of benefit would be particularly true for individuals who wished to pay with cash or credit, since those procedures would not change at all. In addition, the expected labor cost savings would not occur, as all toll booth staff would still be required.

Therefore, the primary benefit of this operational concept is that WSF would be able to gain experience with setting up, operating, and maintaining Good To Go! equipment in a salt-water environment, without relying on that equipment for all revenue collection. This would allow WSF to gain a better understanding of the true costs of system deployment and operation before expanding the system to all terminals.

If this test was performed on just one route—such as the Triangle route—the cost of purchasing and deploying the Good To Go! equipment could be limited to just one or two terminals. Unfortunately, the software development costs would still be required, limiting the cost savings to just equipment savings. However, such a demonstration would help the Transportation Commission and the Legislature understand the true costs of the system, and it would give Triangle Route customers the chance to experience paying with Good To Go!, potentially leading to even greater public support for its adoption—or a better understanding that the system was not truly beneficial for WSF use, thus saving considerable deployment expense.

2. REMOVE TOLLING AT FAUNTLEROY, SHIFTING TO EASTBOUND ONLY TOLLING

In this operational concept, tolls would no longer be collected at the Fauntleroy dock. However, tolls would be collected at Vashon for all travel headed to Fauntleroy. It would also be necessary to switch the direction of toll collection on the Pt. Defiance-Tahlequah route to prevent people from traveling from Fauntleroy to Vashon without paying and then leaving via the south end of the island, again without paying.

The intent of this operational concept is to significantly improve the loading process at Fauntleroy by tolling/ticketing only eastbound, on Vashon and at Southworth, instead of westbound at Fauntleroy. Removal of ticketing/tolling at Fauntleroy would allow cars to proceed directly from the holding lane on Fauntleroy Way to the proper staging lane on the dock, thus greatly increasing vehicle processing speeds, reducing boat loading times, and consequently reducing vessel dwell times. Dock workers would still have to sort cars on the dock on the basis of destination to ensure proper loading of dual destination boats. The sorting task would likely occur in the space occupied by the ticket booths. A modest number of additional vehicle storage spaces might be gained by using the current "splitter" location that is found just before the current booth location and allowing the current booth spaces to be used for vehicle storage (see Figure 2).

Operations at Fauntleroy would require one or more workers to be located before the split, at the entrance to the dock. They would ask drivers for their destination and then direct vehicles to the appropriate lane storage location. Overhead signage would also be useful for this process. It might be possible to reduce the number of dock workers assigned to Fauntleroy by using more on-dock signage, although the complexity of the vehicle storage and traffic directing task would likely require more than just the one dock worker directing the traffic split.

Additional work will be needed to design and test the staffing tasks required to operate this dock if no fares were collected. Such work could not be completed within the timeframe of this study.

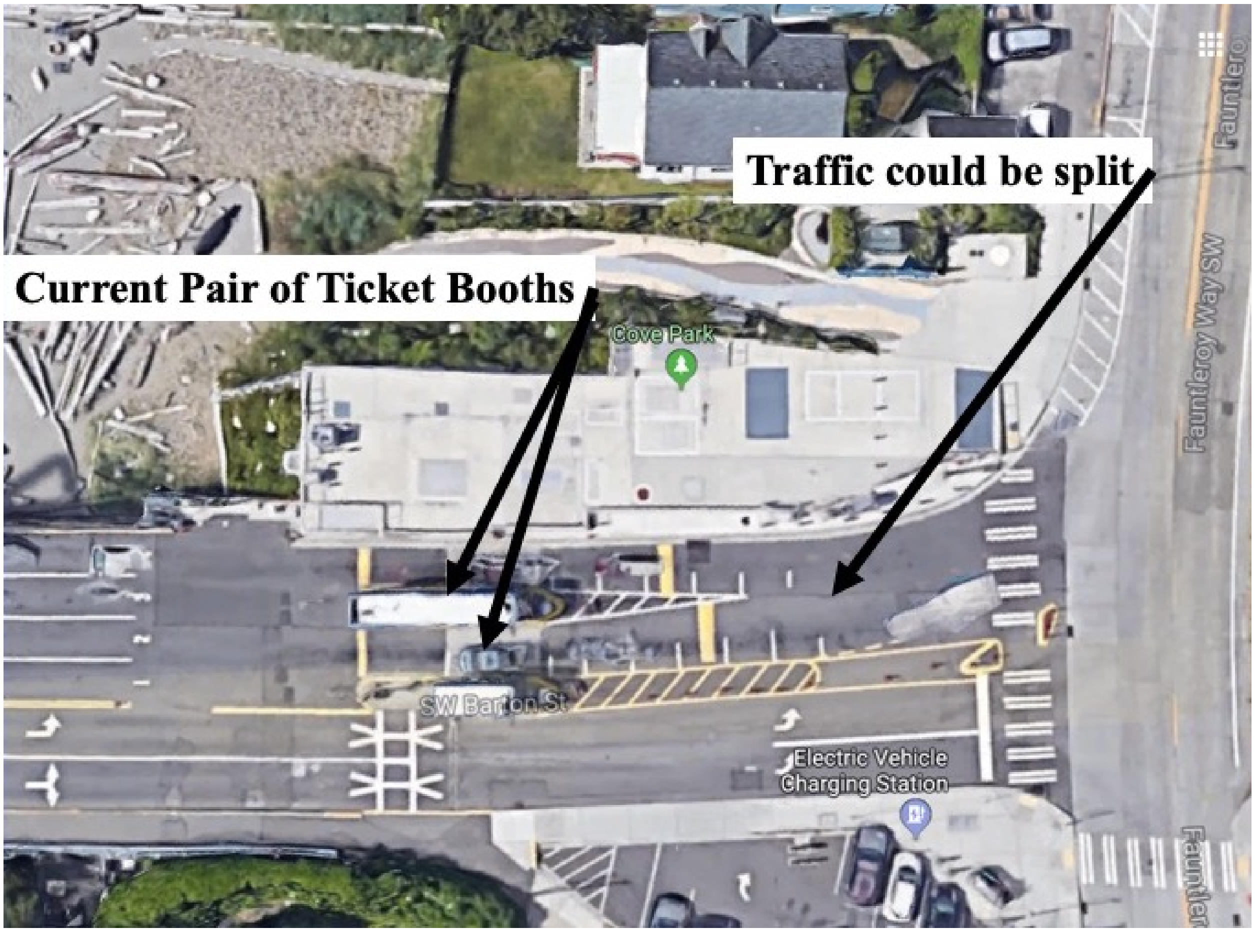

Figure 2: Aerial image of Fauntleroy dock

To implement this operational concept, more significant changes would be needed on Vashon Island. These would consist of both the installation of new hardware and the addition of more staffing. The actual description of operational tasks on Vashon Island would change depending on whether revenue collection occurred

1) using staffed toll booths,
2) exclusively via the fully automated, vehicle-based Good To Go! system used on WSDOT operated toll roads, or
3) with some combination of these two systems.

The Vashon terminal does not, currently, have the physical infrastructure (toll booths), the staffing, or the technology for ticketing. Ticket booths or toll collection equipment (either on new gantries or on a new at-grade installation) would need to be installed at the Vashon terminal.

Vashon vehicle processing, like current Fauntleroy vehicle processing, is complicated by the two destinations served. Vehicles headed to Southworth would not be required to pay, while vehicles headed to Fauntleroy would need to pay. Therefore, staffing would be needed to ensure that Fauntleroy bound vehicles were charged and that drivers who said they were headed to Southworth did not change lanes and get on the Fauntleroy-bound vessel.

All vehicles approaching the Vashon dock would need to be asked for their destination and either charged money or allowed to board without payment. The current dual street approach to the Vashon dock (see Figure 3) would need to be maintained to help separate traffic for the two destinations. However, as shown in Figure 3, these two streams of traffic merge at the entrance to the dock, which is where the new toll collection process would need to occur. This is a very constrained space with very limited room to place the toll booth that would be required as part of this operational concept. WSF staff would need to maintain this separation on the dock while also allowing emergency vehicle access, transit bus access, and other priority vehicle movements onto the dock. The placement of the toll collection point on Vashon would be one of the major constraints with this operational concept and is discussed in more detail below. Toll equipment would also need to be placed at the Tahlequah dock on the southern end of the island. This requirement is also discussed in more detail below.

The Southworth dock would require the least operational change of the three terminals. Riders traveling from Southworth to Vashon or Southworth to Fauntleroy already pay a one-way fare, so the physical infrastructure, staffing, and technology (for the current toll booth ticketing model) are already in place. The main operational change for ticketing eastbound only from Southworth would be the fare structure. Under the current toll booth ticketing model, fares would have to be adjusted to charge for the round-trip. Even if Good To Go! was used to collect revenue from all or a subset of vehicles, operational changes at Southworth would be minimal, outside of those specifically addressed above with adoption of Good To Go!.

Figure 3: Aerial image of Vashon dock, illustrating possible tolling locations, and Southworth vs Fauntleroy approaches to the dock area

Therefore, this basic concept of operations, designed to speed vehicle throughput at the Fauntleroy dock, would require considerable change to both of the Vashon Island docks. Constraints around implementation of eastbound tolling would include the need for significant new physical infrastructure and changes to staffing levels, technology, and fare structure. The relevance of each constraint would vary depending on location and the mechanism used to collect revenue.

These constraints and how they might be addressed are briefly discussed below.

Discussion: Fauntleroy Terminal Changes

In this operational concept, significant physical and operational changes to both the Fauntleroy and Vashon terminals would be required. At Fauntleroy, the dock and terminal area would become less complicated. The toll booths would no longer be needed and should be removed, although that removal would add to the cost of implementation. Unfortunately, as can be seen in Figure 2, the removal of the two toll booths would not add appreciably to the amount of available vehicle storage on site, and as noted above, WSF staff would still need to be present to help direct traffic into the appropriate vehicle lanes for efficient loading.

While the adoption of this option would significantly decrease vehicle processing time at this dock, the current Spring schedule has shown that other time constraints exist in loading a dual-destination sailing. These constraints limit the total dwell time savings that could accrue from this change. If it is assumed that vehicles can travel in single file from the queue on Fauntleroy Way SW and split into the appropriate Vashon and Southworth lines with a 4-second headway (roughly twice the headway of road capacity, and three times as fast as vehicles driven by frequent route users can currently pass through the booths when using pre-paid multi-ride tickets), a total of between 17 and 27 minutes could be removed from the time required to process vehicles for an entire Issaquah class ferry. Even if vehicles took twice as long to enter the dock area because of delays from people starting their engines or not paying attention, the likely savings in ticket processing time would be above 10 minutes per sailing.

However, not all of this savings would be available to reduce dwell time. Observation of the current Spring schedule has shown that with added dwell time having been inserted into the schedule to ensure the boats are fully loaded during peak commute periods, the current ticketing system can process vehicles faster than the boat can be loaded after the stored vehicles have been loaded onto the boat.

The delay currently being observed is caused by the need to load the boat in a manner that does not block vehicles bound for Vashon behind vehicles bound for Southworth.

This required vessel loading step would not change when ticket processing at Fauntleroy was removed.

The process currently used by vessel and dock crews to load these dual destination sailings is as follows.

Vehicles that have passed through the ticket booths are segregated into Vashon and Southworth queues. Vessels are then loaded with one destination's stored vehicles. (This opens up space on the dock, which allows the ticket booths to start processing more vehicles bound for that destination. These vehicles join the end of the queue of the pre-processed vehicles.) When the "pre-processed" vehicle queue for the first destination has been exhausted, the dock crew halts that destination's loading process and loads the on-dock queued vehicles for the second destination. While the second destination's on-dock cohort is processed, the ticket booths continue to process more vehicles, now for both destinations.

When that second destination's queue has been exhausted, the crew must take stock of the vessel's loading condition. Because the dock holds roughly 80 vehicles and the boat holds roughly 120 vehicles, an additional 40 vehicles must be processed through the ticket booths to fill the boat once the boat starts loading. This would still be true for the "no ticket booth" scenario if tolls were only paid eastbound.

Because these "last 40 vehicles" can be bound for either destination, WSF staff must determine how to load the last 1/3 of the boat in a way that allows Vashon vehicles to exit without having to move Southworth vehicles. Currently, the dock crew takes stock of the remaining vehicles on the dock and decide both how many vehicles bound for each destination can be loaded onto the boat, and the manner in which those vehicles can be loaded without blocking Vashon-bound vehicles with Southworth-bound vehicles.

This mental computation and one-by-one vehicle loading process can take several minutes.

This is also why current weekday commute period ticket processing, when most customers are intimately familiar with the ticket processing steps, can occur as quickly as the actual vessel loading process.

After discussion with WSF staff, the project team believes that giving the dock staff and boat crews advance knowledge of the destinations of the "last 40 vehicles" would allow this final loading process to speed up considerably. Without that information, more than desired of the savings obtained in having the "last 40" vehicles skip the ticket booth processing step would be lost.

More work is needed to actually develop plans to perform these tasks more quickly, given advance notice of the final vessel load.

Discussion: Vashon Terminal Changes

While the Fauntleroy dock would gain benefit from the eastbound-only toll collection operational concept, much of the operational cost of those Fauntleroy benefits would be “paid” by the Vashon dock. To start, the Vashon dock would have to begin collecting vehicle tickets. This would slow Vashon loading considerably.

In addition, dock space on Vashon is just as limited as dock space at Fauntleroy. The Vashon dock is roughly the same size as the Fauntleroy dock. Both contain roughly 435 linear feet of vehicle storage and are six lanes wide, with two lanes reserved for traffic exiting the arriving ferries and four lanes used to store vehicles waiting to board ferries.

As at Fauntleroy, the Vashon vehicle holding area is split so that vehicles bound for the two different destinations are stored in separate queues. Unlike Fauntleroy, only one lane at Vashon is reserved for Southworth vehicles. This is because only about 10 percent of vehicles using the Vashon dock are bound for Southworth. However, at Vashon, one lane is reserved for carpools in the morning. This lane also helps provide safe access to emergency vehicles and buses.

Even if the available dock space was used as efficiently as possible, the Vashon dock would still experience many of the same toll booth operating constraints currently found at Fauntleroy. That is, unless access to the dock was restricted for Southworth bound vehicles, only roughly 60 vehicles would have been processed through the toll booths when a vessel arrived headed to Fauntleroy. Therefore, the fastest that a boat could be filled would be constrained by how fast the remaining vehicle spaces could be filled by vehicles that still had to pass through the toll booths and pay their fare after the ferry had started loading.

Vashon does have two loading speed advantages over the current Fauntleroy system.

- At Vashon, the actual vessel loading process would not be slowed by the need to load two different destinations onto the boat. For eastbound ferries, all vehicles boarding would be going to Fauntleroy (with the exception of the current 4:05 AM weekday sailing which serves Fauntleroy before Southworth but is the fastest trip to Southworth from Vashon at that early hour.)

- The ferry would arrive partly loaded with vehicles going from Southworth to Fauntleroy. Thus, Vashon would need to load fewer vehicles onto the ferry before it was full, making the 60-vehicle storage limit less of a constraint (with the current exceptions of the 5:40 AM and 6:35 AM sailings which are Vashon only.)

One major constraint at Vashon is the difficulty in finding a place on the Vashon dock for the ticket booths. One location (the lower location shown in Figure 3) would allow electronic signs placed on the booth to indicate whether vehicles from the Fauntleroy or Southworth lane should approach the booth. This location does not appear to be large enough to allow two toll booths unless the two exit lanes were restriped to one lane.

If the toll booths were placed slightly farther north on the dock—for example, under the current sign bridge (the upper location shown in Figure 3)—then there would be sufficient room to place two toll booths without restricting the number of exit lanes. However, this location is set back from the intersection where vehicles turn into the dock. This would limit the ability of the toll booth to help direct and manage traffic approaching the dock. This could easily result in one of the toll booths being blocked by vehicles headed to a destination for which no space existed on the dock, thus limiting traffic flow through the booth when trying to fill a ferry. This has historically been a problem at Fauntleroy.

Because of the space limitations at the Vashon dock, neither of these toll booth locations is considered ideal, but there are no "ideal" options available without considerable expense, such as expanding the right-of-way leading to the dock.

As with the Fauntleroy dock, the use of Good To Go! for revenue collection could speed the processing of vehicles. (See the section above on using Good To Go!.) The Vashon dock does have two gantries on which cameras and toll tag readers could be mounted to scan tags and read license plates. These devices would be needed only for the Seattle-bound lanes, because riders heading to Southworth would not pay at Vashon.

<u>Discussion: Pt. Defiance-Tahlequah Route Changes</u>

Perhaps the biggest downside of the eastbound-only toll collection strategy would be the likely need to collect tolls at Tahlequah rather than at Pt. Defiance to avoid a significant toll evasion problem. The Pt. Defiance terminal has a dual lane parking area that holds roughly 60 vehicles bound for the Tahlequah dock, after those vehicles have passed through the single toll booth entry point. In contrast, the Tahlequah terminal has essentially no vehicle storage capability within the terminal property (see Figure 4). Vehicles waiting for the ferry at Tahlequah simply queue on the side of the road. While the location of the queue is similar to that at Fauntleroy or Vashon, at Tahlequah, essentially no vehicles queue on the dock, while at Vashon and Fauntleroy around 80 vehicles can be parked on the dock.

Figure 4: Aerial image of the Tahlequah dock

Therefore, if a toll booth was placed at the entrance to the WSF facility, almost the entire ferry load would need to pass through the ticket booth after the ferry had docked and unloaded. This is what happens currently, but because the vehicles do not have to stop to pay, the single vehicle queue moves without further delays. Adding toll payment would slow vessel boarding considerably.

Finally, shifting toll collection to Tahlequah would require construction of a toll booth, physical barriers to protect that booth, (potentially) electronic toll collection capability, and the design effort required to determine how to effectively operate the dock and terminal.

3. INCREASE THE PRE-SALE OF TICKETS

Two different mechanisms were considered to increase the pre-sale of tickets:

- manually sell ticket to stationary vehicles stopped in the Fauntleroy queue, and
- increase the number of vehicles using pre-purchased Wave2Go tickets through better marketing and pre-sale capabilities.

The first of these options was considered to take advantage of the fact that once the Fauntleroy dock has filled, the vehicle queue no longer moves. The productivity of the ticket booth stops because no vehicles can be processed. But fares could likely be collected safely from vehicles sitting in the stopped queue. The second option is intended to make better use of the internet to encourage presale of tickets. This would both speed processing at the ticket booth and potentially giving WSF better knowledge of expected arrivals. These operational concepts are discussed below.

Ticket Sales to Queued Vehicles at Fauntleroy

This operational concept is that during peak periods, when the Fauntleroy dock experiences queuing, a WSF staff member could walk up the sidewalk next to the queue and perform the ticket booth functions, both selling tickets and validating presold tickets. Once a vehicle in the queue had been processed, the staffer would hand a plastic card (e.g., red for Vashon, blue for Southworth) to the driver, indicating that they had been processed. Fares would not be collected from cash paying customers waiting in line to avoid requiring staff outside of the booth to handle cash. These cash paying customers would have to stop at the ticket booth and would not be handed a card.

When space opened up on the dock and the queue started moving again, drivers in the queue would simply hand the card to the ticket booth staff, who would then direct the driver to the appropriate queue on the dock. On the basis of the current vehicle processing data, it is expected that this approach would reduce the headway to less than 10 seconds per vehicle, the current processing rate of the fastest of the pre-paid tickets. If a sufficient number of vehicles could be preprocessed in this manner, the 40 additional vehicles required to fill a boat could be processed through the ticket booths and onto the dock in 3 minutes and 20 seconds (40 veh. * 10 secs / 2 booths = 200 seconds = 3.33 minutes).

The constraints on this operational concept would be

- the need to have staff available to walk up the sidewalk and interact with drivers through the passenger window
- the need for the WSF staff member to carry at least one handheld device—or possibly two devices—process both credit cards and pre-sold tickets.

The current WSF “traffic splitter” staff person who directs the traffic queue to the correct ticket booth would be used to staff this position. That dock staff position is used only during peak periods. So, s/he would already be present at the dock. S/he would walk up the sidewalk to avoid walking in the street, which would be a significant safety hazard.

The WSF staffer would need to carry a handheld, mobile point-of-sale device capable of processing credit card transactions. S/he would also need to carry a device capable of validating multi-ride ferry tickets, Wave2Go tickets, and ORCA cards.

The individual filling this staff position would act as a splitter and traffic control assistant until the dock filled. S/he would then pick up the handheld devices and walk up the stopped vehicle queue. S/he would sell tickets until the boat crew called on the radio to state that the last vehicles on the boat were preparing to exit the boat. The splitter would then walk back to the ticket booths. (The exact timing of this radio call would need to be adjusted on the basis of field experience to provide the splitter time to return to the booth area before the queue started to move.)

Between the radio call to the splitter/ticket seller and the start of the queue moving, the final security clearance of the boat would be performed, and the vehicles on the dock would prepare to load.

Discussion: Ticket Sales to Queued Fauntleroy Vehicles Via the Sidewalk

This concept has the advantage of being relatively simple and requiring only modest hardware improvements. However, there are a number of issues with this concept, which are described below.

The first concern is whether WSF staff would be legally able to work outside of the WSF ferry dock, including whether there were specific Labor and Industry rules that precluded such activity. Multiple WSF staff mentioned this concern. It is possible that the belief that “selling tickets up the road is not allowed” is due to earlier WSF experience with this concept at the Coupeville terminal, where there is no safe shoulder for WSF staff to use to sell and validate tickets. In such a case, staff would be in danger from passing vehicle traffic, and it would make sense that such a sales task would be prohibited. However, no WSF staff member the team interviewed could point to a specific labor restriction or legal ruling that prohibited WSF staff from working on the sidewalk, and the project staff was unable to obtain any specifics about this concern. In addition, WSF staff at the Port Townsend dock currently walk up the sidewalk in order to interact with vehicle drivers and pull vehicles with reservations from the queue outside of the dock.

WSDOT staff routinely work in areas that are not WSDOT-owned right-of-way, so it is expected that WSF staff could also work outside of the state-owned right-of-way at Fauntleroy, as the sidewalk is City of Seattle right-of-way. (WSF may require permission from the City to work in the City’s right-of-way.) Proper training would definitely be required of staff. This training would be performed at the same time as training on the sales process. Other training topics would include not working with vehicles moving within the queue, and when to stop selling and return to the “splitter” position to support vehicle movements for the dual destination sales process. It is unclear whether the current labor agreements would allow the splitter staff to be used in this dual role. If not, the changes to this position’s responsibilities (and its labor costs) would need to be negotiated with the appropriate WSF labor unions.

In any case, if this operational concept was adopted, additional information from the Department of Labor and Industries would be needed before this task could be undertaken.

The second major issue would be the equipment required to make this concept operational. The current handheld devices used by WSF are capable of redeeming Wave2Go, ORCA, and multi-ride ferry tickets. They are not capable of cash or credit card sales. The WSF dock wireless communication system used by these devices is currently restricted to the terminal and dock areas and does not reach up the street. Therefore, new handheld devices and new communications hardware (e.g., new, secure WiFi sites) would need to be installed to provide coverage up the street.

WSF has tried to purchase new, more capable handheld devices in the recent past. Unfortunately, that purchase was not successful. The current ORCA system uses old technology, which is no longer being actively marketed and is being replaced with more capable technology. This means that it has not been possible to purchase new handheld devices that can both read the current ORCA technology and meet the required performance metrics.

As a result, WSF has delayed purchasing new handheld ticket redemption devices until Next Generation ORCA (NG ORCA) has been implemented. As NG ORCA is delivered in 2021 or 2022 WSF will replace its current handhelds. Therefore, if this operational concept was implemented, the WSF staff making sidewalk sales would need to carry two devices, one of the existing handhelds and a new point-of-sale terminal. WSF management is not in favor of this particular outcome, as it would place considerable burden on the staff.

Adding additional WiFi coverage would be the easiest of the constraints to resolve. Fauntleroy Way SW is lined with telephone and electric utility poles. WSF would need to run ethernet wire along those poles and place WiFi hotspots on those poles to provide secure WiFi connectivity to the handheld devices. This would require permission from the City of Seattle, as well as the cost of purchase and installation of the hardware, but no significant obstacles would limit WSF's ability to provide secure communications to handheld devices used on the sidewalk.

Increasing the Fraction of Travelers Buying Tickets In Advance (Online Sales)

One potential way to speed traffic through the ticket booths and consequently speed the boarding of ferries at the Fauntleroy dock would be to increase the number of pre-sold tickets. With quick scanning of pre-sold WAVE2Go tickets, WSF could greatly speed up processing of vehicles, especially vehicles driven by individuals who were not familiar with the ferry system.

Over 70 percent of vehicle boarding ferries at the Fauntleroy dock during peak times on the weekends purchase their vehicle passage at the toll booth. That differs markedly from weekday peak periods, when just 37 percent of vehicle passages are paid for at the booth.

Processing pre-sold tickets is faster than payments at the dock. While on weekdays the savings would be modest, there is considerable potential for speeding up the booth process. In addition, pre-sale of tickets to a wider set of users would allow better potential use of Good To Go! automated vehicle processing, without the need to find and charge vehicle users after their ride. (That is, connecting a pre-payment to a vehicle ID, whether a Good To Go! electronic tag or a license plate number, would allow automated payment using Good To Go! technology, decreasing the time required at the booth.)

While WSF does include links to the Wave2Go payment site on its website, this feature is not well marketed on that website. Given the large fraction of customers who continue to pay at the booth, especially during periods of highest demand, improvements in the rate at which customers pre-pay for their ferry rides should be possible.

<u>The primary suggestion for this option of increasing the pre-sale of ferry ride tickets is to build a smartphone app</u> (iPhone and Android versions) that encourages the pre-sale of ferry tickets. A ticket sale-enabled smartphone application would also be a superb mechanism for allowing WSF to deliver important customer information while also obtaining information that could be used to improve ferry operations. The smartphone app could also reduce the number of payments at the booth by allowing re-valuation of tickets to easily occur before vehicles reached the booth.

<u>Discussion: Improved Marketing of Pre-Paid Tickets</u>

In this concept of operations, the app would serve three functions:

- enabling and encouraging easy ticket sales,
- providing useful traveler information to app users, and
- collecting information that described the destinations of travelers before their arrival at the ferry dock, thereby allowing advance planning for vessel loading.

The desired outcome of the smartphone application would be an improved relationship with WSF customers. A key aspect of this would be the ability of customers to purchase tickets when it was convenient to them (potentially even while they sat in an unmoving queue waiting to reach the ticket booth). Therefore, the phone application would need to provide a seamless, easy to use mechanism for inputting credit card information and purchasing ferry tickets, much as with the current web-based Wave2Go system. However, use of the app would also allow multiple other customer-oriented functions, improving both customer satisfaction and ferry operations.

For example, if users purchased a single or round-trip ticket, it would be possible to ask riders when they intended to travel. Given that information, the app could push information to a phone several hours before a trip that described the current or forecast ferry queue length.[8] This would allow ticket holders to adjust their travel plans if necessary. It would also give them advance notice of the queueing conditions they should expect.

The app could also geo-fence the ferry dock to be used and push current queue information to the app as the phone (and vehicle) approached the dock. The phone could also directly measure the time required for the phone to reach the dock from the time it entered the geo-fenced area around the ferry dock. Thus, the geolocation information collected from the phone could be used to compute the time "in queue" required to reach the dock. This information could then be aggregated with other queue information and passed along to other ferry users.

Other important customer information could also be pushed to these ferry system users when desired. For example, disruptions at a specific dock could be pushed directly to users who had indicated that they were intending to travel to that dock in the next few hours, thus directly providing important information to the customers who needed it, in a timeframe when it was most important that they receive that information. (App users could choose to opt out of these messaging features, should they not wish to receive them.)

For app users who purchased multi-ride tickets, the app could keep track of the number of rides used and the time remaining to use them. (Multi-ride vehicle tickets have to be used within 90 days of purchase.) The app could provide reminders to users when a new multi-ride ticket package was required. Users could then purchase that multi-ride renewal while sitting on the dock or even while sitting in a non-moving queue.

Customers who used the app to obtain advance notice of the queue length would also be providing WSF with advance notification of their intended destination before their arrival at the dock. For the Triangle Route, if a large fraction of riders used the app, this would give WSF a

[8] Note that this assumes that ferry queue length information is available. The app could be used to collect such information, although the project team recommends that WSF collect that information through the installation and operation of new hardware and software on the roads leading to the terminals. See the concept of operations section on Improving Traveler Information.

good grasp of expected destinations for users sitting in queue. This should help in pre-planning how the boat needed to be loaded, allowing crews to speed up the loading process.

For example, if the app indicated that 80 percent of all app-equipped vehicles were headed to Vashon, the terminal crew could plan on using three lanes on the dock for Fauntleroy vehicles, and only one lane for Southworth. This same advance information could be passed along to the crew loading the boat, as advance knowledge of the destinations desired by vehicles arriving at the very end of the boat loading process is needed to correctly load those last few vehicles.

Therefore, the greater the use of the app, the greater the knowledge of vessel loading requirements earlier in the loading process.

Finally, the customer service aspect of the app would be key, as the benefits to be gained from the app would be what encouraged people to download and use it. The greater the number of customers who used it, the faster the ticket processing and the better informed the ferry customers. This would be a win-win situation for both the Ferry System and its customers. (See more about this in the Traveler Information System section later in this report.)

4. INCREASE CARPOOLING TO AND FROM VASHON

While vehicle capacity is heavily constrained on the Triangle route, considerable passenger capacity remains during all vessel sailings. Consequently, the lowest public cost option for increasing ferry usage would be to carry more passenger traffic while still carrying the same level of vehicle traffic. That is, if the current single occupant cars using the system could be converted to carpools, total ridership would increase at essentially no cost to WSF.

The Fauntleroy routes along with the Pt. Defiance-Tahlequah route, have the lowest vehicle occupancy rates in the ferry system. In 2018, the Fauntleroy-Southworth route averaged 1.66 passengers per vehicle.[9] The Fauntleroy-Vashon route averaged 1.81. The average for the entire system is 2.29 (see Table 5). If some single occupant vehicle traffic could be converted to carpools, then the reduction in vehicle traffic during peak commute hours would reduce vehicle queues, increase peak period system use, and improve customer satisfaction at all Triangle Route terminals.

[9] 2018 Annual Washington State Ferry Traffic Statistics

Table 5: Average vehicle occupancy by WSF ferry route

Route	Total Ridership	Vehicles Carried	Passengers Per Vehicle
Seattle- Bremerton	2,893,235	718,398	4.03
Seattle-Bainbridge	6,355,278	1,888,865	3.36
Fauntleroy – Vashon	1,954,778	1,079,088	1.81
Fauntleroy-Southworth	992,280	596,774	1.66
Southworth – Vashon	207,286	112,604	1.84
Passenger Only Ferry Vashon - Seattle	249,398	0	N.A.
Total Triangle Route Plus Vashon Passenger Ferry	3,403,742	1,788,466	1.90
Tahlequah - PT Defiance	868,612	500,788	1.73
Edmonds Kingston	4,225,624	2,186,747	1.93
Clinton -Mukilteo	4,174,263	2,290,462	1.82
Port Townsend – Coupeville	838,739	379,452	2.21
Anacortes – Lopez	323,532	163,795	1.98
Anacortes - Shaw	31,332	15,644	2.00
Anacortes - Orcas	676,969	313,270	2.16
Anacortes - Friday	904,886	361,999	2.50
Anacortes Sydney	108,471	37,670	2.88
Friday - Sydney	21,532	6,052	3.56

WSF could improve peak period ferry utilization by increasing the number of regular riders who participated in existing rideshare programs, or by adopting new carpool programs that more effectively addressed travelers' needs. For WSF to encourage a change in rider behavior, it would need a more detailed understanding of the travel patterns of Vashon's regular commuters and occasional riders, a better understanding of how commuters interacted with existing technology (i.e., carpooling apps, online platforms etc.), and programs that effectively marketed carpooling and the software platforms that help identify, form, and support carpooling.

WSF has some, but not extensive, survey data from travelers who use the Triangle Route. The most recent traveler origin/destination survey was conducted in 2013. That survey was insufficient for developing a WSF-specific carpool formation program. Better information on both routine and real-time travel that included a ferry trip, along with a greater ability to communicate with Vashon riders, could help WSF reduce SOVs on the Triangle route and achieve many of the aforementioned goals.

In a system with 20 terminals and myriad competing demands for limited resources, this kind of detailed data collection, focused on just one community, was beyond this project's scope and likely exceeds WSF's available resources. However, resources are accessible through other institutions that could help with this effort. For example, on the technical side of carpool formation, a number of efforts are currently under way in the region.

King County Metro has the Trip Pool[10] pilot program designed to help commuters solve the first mile/last mile problem of getting to or from high frequency transit routes. This program could be highly beneficial for both the on-island and post-ferry portions of the trip.

The state and regional transit agencies created and operate the RideshareOnline[11] program to increase both the number of people participating in carpooling matching efforts and the likelihood that those participants will find matches. A number of private technology companies have also entered the carpooling field. Some operate independently, while others operate in concert with specific employers or local transit agencies. For example, both iCarpool and Scoop are currently operating in the Puget Sound region. These potential partners can provide the technical tools that help generate the information needed to form carpools.

In addition to the technical problem of understanding what shared ride options exist, there is the cultural problem of changing traveler behavior. Many people drive by themselves because they have always done so, are not aware of other options, and do not actively look for those other options. Carpooling is never considered by these individuals, and so they never carpool, even if a carpool might work well for them. Consequently, increasing carpooling requires a cultural/behavioral shift as well as the ability to deliver information about the availability of other rational travel options.

One way for WSF to leverage existing resources for better data collection would be for it to partner with a group such as the UW Evans School of Public Policy and Governance to craft a project as part of the Evans Student Consulting Lab requirement for graduating second-year MPA students. These projects, known within the Evans School as Capstone Projects, pair three to five second-year MPA students with a faculty advisor to work on a specific capacity building or data collection project identified and designed by a public or non-profit agency. The scope of these projects varies widely. If WSF were to partner with the Evans School to create a project, deliverables might include the following

[10] https://kingcounty.gov/depts/transportation/metro/travel-options/rideshare/programs/trippool.aspx
[11] http://rideshareonline.com/

- a literature review to unearth theories about how governments can affect cultural shifts around transportation choices,
- a comprehensive cataloguing of existing rideshare programs in the Seattle area with identified successes and challenges for each,
- a survey designed for and administered to Vashon and Southworth residents about opportunities for rideshare expansion and potential ways to increase use of technology to do so,
- a quantitative analysis of existing origin/destination data and, potentially, Streetlight data (or other new data source) to reveal, in greater detail, the travel patterns and needs of Triangle Route riders and to support the qualitative data that will come from the aforementioned survey tool,
- a comprehensive list of data-informed recommendations that would include a ranking of alternatives based on criteria such as cost, feasibility, and projected timeline.

The cost of partnering with the UW Evans School is relatively small (a six-month commitment from a group of three to five MPA students costs under $2000), and the project design process is relatively short, meaning WSF could have a consulting team working on a project about increasing rideshare use on the Triangle Route from January-June of 2020. The Evans School will be collecting proposals in June-September 2019 for projects to be completed in the 2019-2020 academic year.

Discussion: Increasing Carpooling

Sharing rides requires 1) that two or more individuals have similar time-of-day and destination requirements for their travel, 2) that those individuals are willing to share rides, and 3) that they are aware of the other individual’s travel plans and willingness to share rides. If any one of these three attributes is missing, ridesharing does not occur. In addition, if an individual chooses to forgo the use of their personal vehicle to carpool on the first leg of a trip (e.g., from their home to work), they must also be confident that they will be able to get home, either by meeting that same carpool for the trip home, by having another carpool available, or by having alternative travel options. For work commutes, this often means that the two individuals sharing a ride have not just compatible outbound trips but also compatible return trips, or else the passenger in the carpool must find a second option for the return ride home. When the second half of the trip is not reliable, both individuals drive by themselves.

Several barriers to increased passenger ridesharing on the Triangle Route exist. The first problem is that the land uses surrounding all three terminals are low density. The terminals themselves do not generate trips. The terminals are simply a transfer point. The low-density nature of Vashon Island, Southworth and West Seattle/Fauntleroy means that trips are generated over a wide area, making it less likely that two travelers will wish to start a trip at the same time and in close proximity to each other. In many low density areas, this barrier is overcome by the use of park and rides. These allow travelers from large geographic areas to concentrate their trip making by driving to these parking spaces and taking transit from the concentrated trip space to their shared destination. While both Southworth and Vashon have some parking, the Vashon terminal routinely overflows into the streets around that parking facility. No substantial parking is available at the Fauntleroy terminal.

The low density also means that when ferry users exit a boat, they are generally bound for destinations that are not near the terminals. Unlike Colman Dock in downtown Seattle, where a large fraction of ferry passengers can walk or take a short transit ride to their destination, Triangle Route users frequently need to travel a substantial distance to their final destination—at all three stops. While the King County Metro C-line and 116 bus routes provide reasonable transit alternatives to get to downtown Seattle from Fauntleroy, many people going downtown now take the King County operated, passenger-only ferry from Vashon directly to downtown. The King County ferry saves an average of 40 minutes going from Vashon to downtown in comparison to the vehicle ferry and the KCM route 116. This means that many of the remaining passengers on the Triangle Route are bound for destinations other than downtown Seattle. These destinations are typically widely distributed across the metropolitan area, reducing the opportunity for riders to identify rational carpooling partners.

Origin and destination data collected in 2013 showed that 53 percent of Southworth travelers had destinations south of the West Seattle Bridge, and 47 percent went north of that bridge. From Vashon, 59 percent had destinations south of the bridge, and 41 were north of the bridge.[12] In addition, 65 percent of riders drove to the ferry, and 22 percent were passengers in a private vehicle, for a total of 87 percent of all passengers.

To learn whether rides can be shared requires effort on the part of travelers. It also takes effort for commuters to find information about travel options, often flexibility in their work schedules and social interaction, and having a guaranteed return trip home. Technology is starting to reduce the effort required to gather all this information.

King County Metro has crafted several programs to encourage ridesharing (outlined in Table 6); however, the process of finding the program that best fits a rider's needs is complicated. For example, three pilot programs are currently underway which partner with private firms. In addition to encouraging potential riders to sign up for RideShareOnline, as part of these pilot programs, interested carpoolers are encouraged to use one of several third-party carpooling apps. But this environment is complex, and that complexity serves as a significant barrier to the adoption of carpooling.

[12] 2013 Origin-Destination Travel Survey Report, Washington State Department of Transportation Ferries Division, August 2014

Table 6: King County ride sharing programs

Program	Program Attributes
Vanpool	• One-seat ride to work and back. • Monthly fare (based on mileage) pays for the van, fuel, maintenance, insurance, roadside assistance, guaranteed ride home.) • Five members required per van (at least two drivers plus a bookkeeper.) • Logistics determined by needs of the members.
Vanshare	• Commuter vans connect riders to or from a transit center/park and ride and for getting the last mile or so to your worksite or school destination from your transit stop. • $185 flat fare (fee pays for fuel, maintenance, insurance, roadside .assistance, guaranteed emergency ride home). • Minimum five members per van.
Carpool	• Encourages commuters to carpool with personal vehicles. • Free carpool app(Scoop, Waze Carpool), or sign up through RidesshareOnline.com.
SchoolPool	• Encourages families to rideshare or bike/walk to school • Sign-up through RideshareOnline.com or call Metro Rideshare phone number
TripPool *Pilot Program*	• Riders pay for trips through iCarpool 'ride credits' – only $1.50 for first five miles • Riders can link iCarpool and RideshareOnline.com accounts to be reimbursed for charges above $2.75 (one-zone peak). An ORCA monthly pass holder can be reimbursed 100%. • Vans for volunteer drivers willing to use an online app to match with and pick-up fellow commuters along the way to catch transit.
Community Van *Pilot Program*	• Designed to provide residents with customized options for getting around when bus service can't meet their needs.
Real-Time Rideshare *Pilot Program*	• KC partnering with Smart Ridershare using iCarpool.com • Drivers use a third party mobile app (free to download or join) and their own vehicles to share trips with other riders going their way. • Riders purchase ride credits and drivers are reimbursed for trips they offered, and rides taken through the mobile app.

5. IMPROVE TRAVELER INFORMATION

The fifth and final concept of operations explored in this report involves improving ferry rider satisfaction and customer experience by greatly improving the level of traveler information customers receive. This operational concept includes

- the need to collect more information on current ferry wait times,
- the delivery of information to customers when they want and can use that information, and
- increasing the ease with which customers can buy tickets and obtain information about the ferries.

One reason for the current level of dissatisfaction with ferry system service is that customers lack information about the current operating status of that service. While frequent commuters can estimate when they need to arrive at the ferry queue to catch a specific sailing, the variability in performance (e.g., length of vehicle queue, departure delays due to bad weather, mechanical failure, or other event) can produce outcomes other than expected. The nature of the WSF loading process—long queues, a lack of information on which sailing a vehicle will board, customers' perceived lack of control over their "fate"—can create levels of anxiety, unhappiness, and frustration or anger that are not present in many other forms of travel. For travelers who are not routine users of specific routes, the lack of information about when to arrive to catch a specific sailing or the length of the wait they can expect can produce both considerable anxiety and late arrivals at their destination.

This same phenomenon is a factor in riding the bus. Research has shown that transit riders perceive the time spent waiting for a bus at twice the actual time spent waiting, because of the anxiety they feel wondering when the bus will come.[13] Research conducted at the University of Washington with the development of the OneBusAway traveler information system showed that simply giving bus riders information on when their bus would arrive caused the perception of that time to drop to less than the actual time spent waiting. The result was a significantly improved perception of transit system performance, even when the actual on-time performance did not change.[14]

WSF customers would greatly benefit from a similar system. If that information was provided—even if it was imperfect, as is the case with the bus arrival times provided by OneBusAway—the level of satisfaction with WSF's performance would also improve.

The most important piece of information needed by ferry riders is the duration of the current (or expected) queue at the ferry terminal. This information allows users to plan their trip, helps them expect how long they will be in the queue, and gives them insight into when they will arrive at their destination.

Historically, WSF has lacked the equipment to compute and provide queue duration information. A number of technologies now allow time in a queue to be computed with relative

[13] Mishalani, R., M.M. McCord, and J. Wirtz (2006) Passenger Wait Time Perceptions at Bus Stops: Empirical Results and Impact on Evaluating Real-Time Bus Arrival Information. Journal of Public Transportation 9, 89-106
[14] Using Technology to Revolutionize Public Transportation, PhD Dissertation, by Kari Watkins, University of Washington, 2011.

ease. For example, Seattle DOT (SDOT) operates a travel time computation system on city arterials using “WiFi sniffing” technology. This technique observes the MAC addresses of passing smartphones and other electronic devices. By comparing the times and locations of two observations of the same MAC address, it is possible to determine the travel time between those two locations. Multiple variations of this technique exist and could be used to measure the time spent in a queue approaching a ferry dock.

Once queue duration information was available, it could be delivered to ferry customers through a variety of media. WSDOT currently makes a number of traveler information data feeds available to companies via Application Programming Interfaces (APIs). This allows software companies and developers to obtain travel information that they then deliver to the public. These companies include Google, WAZE, Apple, Inrix, HERE, and all of the major news outlets. These companies could all provide WSF information to customers through this same process. This would be done by companies that had registered for the WSF API, allowing them to extract data from the API and package that information to deliver to their customers at no added cost to WSDOT.

For this operational concept, the project team recommends that in addition to the public API, WSF build, operate, maintain, and promote a smartphone application. The smartphone application would perform the following tasks:

- allow for purchase of ferry tickets (Wave2Go) and multi-ride tickets,
- allow for display of pre-purchased tickets when arriving at ticket booths,
- assuming that Good To Go! was implemented as a payment option at WSF, connect tickets purchased on the app (at the customers’ choosing) to customers’ Good To Go! vehicle tag, allowing for faster vehicle processing at the ticket booth,
- deliver queue duration information on routes of the customers’ choice, as “push notifications” prior to their trip departure, to help them catch specific sailings,
- deliver queue duration information to customers upon their arrival at the back of the queue,
- deliver queue information on demand (as “pull” notifications),
- deliver other ferry system alerts (e.g., cancelled sailings, major delays, emergency notifications) when appropriate,
- collect “time in queue” information,

- provide a mechanism for customers to deliver feedback to the ferry system, including allowing customers to perform periodic surveys.

Business-specific smartphone applications are common and allow companies to effectively deliver better customer experiences. These applications allow direct interaction with customers. Information can be "pushed" to customers (i.e., sending information at the discretion of the company when the company believes that information is of interest of the customer—such as delivery of sailing cancelation notices or low balance warnings) and "pulled" by the customer to specifically request information (e.g., ticket purchases, current queue information).

The operational concept would be for WSF to build this application (which could be done by multiple different organizations for WSF) and then promote it heavily on its website. Essentially, a banner on every WSF web page should encourage customers to download the application. The banner would tell customers that they could obtain notifications of current queue durations at times of their choosing and could use the app to purchase tickets and manage their Wave2Go and multi-ride ticket accounts.

Customers should be able to obtain both iPhone and Android versions of the app.

If customers used the app to buy a ticket, they would be asked whether they would like queue information delivered before their trip. They could then enter the date and sailing they planned to use. This would set the app to deliver queue information to them. Queue information could be given up to five hours before a sailing, if queues on that route were expected to be heavy (e.g., on a summer weekend). Because the purchased ticket would indicate the route to be used, it would also be possible to use the phone's GPS to "ring fence" the terminal area and push queue information to the phone as the vehicle approached the queue leading to the dock.

This type of early information delivery would provide customers with better information for planning and executing their trips and would give them updated information on current conditions when they needed that information. This should help reduce anxiety about ferry wait times and give customers more control of their travel outcomes.

For a route like the Triangle Route, pre-arrival notifications from phones would also give the dock staff information about expected Vashon versus Southworth destination volumes. If a high percentage of users could be encouraged to use the app because of its information delivery function, the dock crews at Fauntleroy would have sufficient information to pre-plan vessel loading, speeding the final boarding process.

Customer information delivery is perhaps even more important for infrequent users. WSF experiences large increases in demand during the summer vacation months. Many of the users in the summer are not familiar with the ferry system. Because of that, many of them go to the internet when developing their travel plans. When they visit the Ferries page on the web, WSF should encourage them to 1) download the app, 2) pre-pay for tickets, and 3) sign up for queue information, and it should 4) provide access to other traveler information, such as images and information about the terminals they would be using to help them prepare to ride the ferries. Better informed customers would result in faster vehicle processing and happier customers.

Having a software system that allowed customers to interact with the ferry system would also give WSF an excellent mechanism for interacting with those customers. This could be accomplished through surveys of customers delivered through the app, or through simple feedback mechanisms such as comment functions. This would allow WSF to obtain information from users routinely and at lower expense.

The app would also be a good mechanism for linking customer accounts, if/when the Puget Sound region moves to link the multiple travel accounts they now support. WSDOT and the Puget Sound Region transit agencies already maintain customer accounts, Good To Go!, and ORCA. WSF supports Wave2Go accounts. Work has been conducted to examine how these account systems can be linked.[15] The WSF App could help speed that process, by allowing customers to directly link their ORCA and Good To Go! accounts to their WSF tickets and Wave2Go accounts. However, linking of accounts would not be a requirement of the system.

Discussion: Better Traveler Information

A key to the ferry app concept would be for WSF to obtain queue duration information. The recommended approach would be for WSF to place devices that observed vehicles approaching ferry docks and calculate how long those vehicles were in line. Common versions of these systems are operated by WSDOT and SDOT. Technologies that are used, or have been used, by these agencies include WiFi MAC address matching, automated license plate (ALPR) matching, Bluetooth MAC address matching, and Good To Go! toll tag matching. (Note that toll tag-based travel time computations are not connected in any way with revenue collection.) In all

[15] Fare Media Study, by Cedar River Group, for Washington State Legislature, Joint Transportation Committee, January 2012.

cases, devices are observed at specific locations and times along a corridor. When these devices are observed later on that corridor, it is possible to compute travel times from the first to the second point.

To preserve the privacy of travelers, all device IDs are hashed and discarded after travel times have been computed. State law prohibits use of this information for speed enforcement purposes. Computer algorithms are then applied to the travel time data to identify invalid travel time data (e.g., from vehicles that stopped to buy coffee before continuing) and compute and extract the desired travel time statistics (e.g., mean travel time). For WSF to compute the expected ferry wait times at a terminal such as Fauntleroy, these algorithms would need to separate vehicles traveling Fauntleroy Way SW to a destination somewhere in the neighborhood from vehicles sitting in the ferry queue on Fauntleroy Way SW. Multiple device identification points are typically placed in sequence along a route being monitored for travel time in order to more quickly identify changing queue conditions.

All of the technology types listed above work. The primary difference between the technologies is the fraction of passing vehicles that are observed by each technology, and the capital, installation, and operating costs of the different technologies. In general, WiFi- and Bluetooth-based systems are the least expensive, but they also capture the lowest fraction of passing vehicles. Toll tag readers capture the highest fraction of vehicles but cost the most to buy and install. ALPR devices capture high quantities of vehicles but have the highest operational costs. WSDOT has generally moved away from ALPR-based collection in favor of the other three approaches.

The report author favors the use of toll tag readers for two reasons. The first reason is that tag readers capture the vast majority of toll tags passing by. If a sufficient number of vehicles were tag equipped, this would lead to a very robust queue duration computation. If an insufficient number of vehicles could be identified, the system would not be able to report queue duration reliably. (The lack of a reliable queue computation would be an acceptable outcome late at night when few vehicles were present and the queue was known to be of negligible length. It would not be an acceptable outcome during periods of heavy use.) The 2012 Fare Media Study indicated that in 2011, 34 percent of households using the Triangle Route had Good To Go! accounts. This number is expected to increase as Washington state expands the use of tolling in the region. The coming toll facilities on southern I-405, SR 509, and SR 167 suggest that tag penetration will continue to grow substantially on all routes, especially on the southern routes in the WSF system. In addition, 84 percent of respondents from the South Sound in the Fare Media Study said that they would get a toll tag if its use would allow them to obtain a discount when paying ferry fares.

The second reason for selecting toll tags is that long-range plans for the region expect to allow Good To Go! to be used for paying for ferry fares. If this is the case, having "advance readers" located before the dock would allow for pre-selection and review of vehicle accounts. This would allow faster processing at the booth (if toll booths were still used) by caching account information for those accounts before the vehicle's arrival at the booth. This would allow one piece of equipment to perform multiple purposes.

Note that until the above connection have been made, toll tag-based travel time computations will not be connected in any way with revenue collection. The tag readers observe any passing RFID tag that uses the 6C tag protocol used by Good To Go!, as well as any other 6C-based electronic tag identifier, and compute a travel time based on those tag reads. In practice, these systems are maintained as entirely separate systems, and the tag IDs are hashed upon receipt to preserve privacy. In practice, tag readers also observe a large number of RFID tags that are not toll tags. This actually benefits the travel time computation process.

The downside of the toll tag approach is the upfront cost of the hardware. Quotes provided to the project team suggest a per reader cost in the neighborhood of $10,000 to $15,000 per location, inclusive of installation and the communications needed.

The second choice for queue duration measurement technology would be the same system used by SDOT. That is a WiFi-based system sold by Acyclica. The primary advantage of the system is that data could be shared with SDOT, allowing SDOT to provide better arterial information to city residents, thus providing direct benefit to the Fauntleroy neighborhood. These systems are estimated to cost in the neighborhood of $2,000 to $3,000 per location, inclusive of installation and the communications needed.

PROJECT RECOMMENDATIONS

The recommendations of the project team are based on several factors. The first is budget. WSF lacks the discretionary funds to implement many of the operational improvements described above. Obtaining those funds is difficult, given the resource constrained environment in which the state's transportation agencies must operate, and may require legislative approval. We therefore have prioritized lower cost options and those that can generate increases in revenue. The second major factor is the ability of WSF to benefit systemwide from changes made specifically in response to this study of the Triangle Route. The third major factor is how the adopted changes can improve route performance, where "improvements" are defined to include any combination of improved customer satisfaction, increased ridership and reduced delay on the Triangle Route.

Increased ridership can occur in three ways,

1) increases in the number of passengers per vehicle (which is most effectively achieved by increasing ridesharing during peak commute periods),
2) decreases in vessel dwell time that allow an increase in the number of fully loaded vessels to sail during periods of peak demand, and
3) increases in vessel utilization outside of the peak periods, when existing ferry vehicle capacity is not fully used.

Unfortunately, it was not possible within the timeframe of this project to fully examine how changes in fare collection processes would affect dwell time, or how those dwell time reductions could result in schedule changes that would facilitate increased vessel sailings during the peak period. That task would require access to vessel scheduling software and discussions with both WSF staff and Triangle Route stakeholders to examine different vessel scheduling options. The Spring weekday schedule appears to maximize vehicle loads on vessels during the peak period, given the current operational environment. If savings could be achieved by decreasing vehicle processing times, then some dwell time reductions could be achieved, but it is not clear from this project how those savings could translate into increased sailings during the peak.

Therefore, the best near-term options for increasing ridership will be obtained through increases in passenger ridership during peak periods or increases in vehicle and passenger ridership during off-peak periods.

RECOMMENDATION 1: ENGAGE IN PROGRAMS TO ENCOURAGE CARPOOLING

The project team recommends that the WSF engage with the UW Evans School of Public Policy and Governance to determine ways to increase carpooling on the Triangle Route. WSF could develop a project as part of the Evans Student Consulting Lab. These projects, known within the Evans School as Capstone Projects, pair three to five second-year Masters of Public Affairs students with a faculty advisor to work on a specific capacity building or data collection project identified and designed by a public or non-profit agency. The cost of such an effort is relatively small, typically on the order of $2,000. The Evans School collects proposals for this program in summer for projects to be completed during the academic year. WSF would have a consulting team working on a project about increasing rideshare use on the Triangle Route starting in January of 2020 and ending in June of 2020.

To increase the peak period ratio of passengers to vehicles using the Triangle Route it is most important to increase the sharing of rides to/from the Fauntleroy dock. This is because it is generally possible to drive to the Vashon and Southworth docks and find parking. In contrast, there is no parking at Fauntleroy, and good transit alternatives (the passenger-only ferry or the Metro Route 119 and C-line bus routes) already provide good mass transit alternatives for reaching downtown Seattle. Therefore, decreasing drive-alone trips during the peak period will require helping travelers identify shared ride alternatives that reliably get them to and from their destinations on the Seattle side of their trip, within a travel time that is comparable to their drive-alone travel time. Current drive-alone customers need to be able to identify other people going to (or close to) their destinations when they wish to travel. In addition to helping people find these alternative travel options, it will be necessary to change travelers' habits so that they have both an interest in sharing rides and a willingness to do so.

Therefore, the Evans School project should focus on

- which existing carpool formation technologies can most effectively connect ferry riders with each other in ways that identify their common trip making requirements,

- how to increase the perceived value that travelers gain when they successfully share rides, and
- affordable incentive programs for passengers and riders who routinely share rides.

RECOMMENDATION #2: IMPROVE TRAVELER INFORMATION

The second recommendation is to collect and deliver better traveler information to ferry users. There are two major parts to this recommendation. The first is to place either Good To Go! toll tag readers or WiFi-Bluetooth readers on the approaches to WSF terminals and at the toll booths themselves to collect data on real-time ferry queue wait times. This information would then be delivered via API to interested software developers.

The second part of this recommendation is to build and deliver a customer-centric smartphone application that can deliver those wait times, along with a variety of other customer-oriented ferry information.

The smartphone application should be able to perform the following functions:

- report current queue durations at the ferry dock,
- report expected queue durations based on either future forecasts of current conditions or historical patterns
- deliver this information via screen display at the request of the user
- deliver this information via audio delivery at the request of the user when the vehicle is in motion
- deliver this information via audio delivery approximately one mile before vehicles arrive at the end of the queue when users have previously indicated their interest in obtaining that information
- deliver other ferry service alerts for routes used by the smartphone user
- pass to WSF staff the expected sailings and destination for which travelers are coming to pre-plan service levels, and
- provide a mechanism for ferry customers to give feedback to WSF.

The project team does not recommend a specific choice of queue duration collection equipment. The best technology choice will be a function of other decisions. The project team's preference is for the use of Good To Go! tag readers, but that is a more expensive option. However, if Good To Go! toll collection were to be adopted, then the added cost of using Good

To Go! tag readers would be substantially reduced, and the greater data collection rate and resulting better queue length estimates would be worth the modest added cost. Alternatively, if Good To Go! was not be used, then using the less expensive technology currently used by the City of Seattle would be preferable.

This recommendation is expected to significantly improve ferry customers' level of satisfaction. The major downside of this recommendation is that it will require far more funding than the first recommendation. To reduce the initial cost of this system and to prove its value, it could be deployed on a single route (e.g., the Triangle Route), or even for a single terminal (e.g., Fauntleroy) as part of a demonstration project before being deployed to the rest of the ferry system.

In addition, further cost reductions in the initial demonstration of this system could be achieved if it was conducted as part of the third project recommendation.

RECOMMENDATION #3: CONDUCT A PILOT OF PAYMENTS VIA GOOD TO GO!

The third recommendation is to conduct a demonstration of the benefits of using Good To Go! technology to improve operations at the Fauntleroy dock. This recommendation is the most ambitious of the three project recommendations. It also requires the most funding—although there is potential for that funding to come from outside of WSF. Good To Go! offers the greatest potential for dramatically speeding up the processing of vehicle payments, which is necessary if additional sailings—and thus additional vehicle capacity—are to be provided during peak use periods. Use of Good to Go! also has the potential to significantly improve customer satisfaction, especially if the faster payment mechanism also provides other customer-oriented services that make it easier to ride the ferries. A pilot implementation of the technology is an excellent way to prove (or disprove) whether Good To Go! can actually deliver the required level of service improvements.

The downside of this recommendation is the complexity and cost of even a pilot demonstration of Good To Go!, let alone a full implementation of cashless tolling. Implementation of Good To Go! would require both the purchase and installation of hardware and the development of software. While the current back-office software upgrades include the ability to interact with other toll systems, the unique nature of the ferry system fare structure—especially if attributes such as on-dock and on-boat kiosks are added—will require WSF-specific software upgrades to the process of computing toll bills and transmitting them to the Good To Go! back office.

The complexity of the Good To Go! pilot could be mitigated in part by limiting the vehicles eligible to participate in the pilot to those that sign up for the demonstration. That could include both vehicles with and without current Good To Go! accounts. Testing could exclude implementation of automated vehicle length sensing equipment, or implementing only that function. (Vehicle lengths could be based on vehicle types associated with Good To Go! accounts and/or license plates entered about registration to participate in the test.) The specific features to include or not include would need to be identified as part of the pilot design.

This leads to the cost of the pilot.

The project team believes that some vendors are sufficiently interested in performing a demonstration of their automated tolling capabilities that they might be willing to fund the demonstration as a way of proving their technology and approach. This would be particularly true if vendors were allowed to approach the demonstration from the perspective of demonstrating not just the use of the Good To Go! technology but also the advantages of a Single User Account system that allows integration of Wave2Go, ORCA, and Good To Go! payments.

The single account mechanism (i.e., an account system passed through that vendor) would allow the demonstration to provide a single direct bill for each transaction to either or both the Good To Go! back-office and the Next Gen ORCA back-office. This would ease the task—for the Good To Go! back-office—of accepting such payment requests (the toll calculation would be performed by the vendor's software, and only the "invoice" would passed to the Good to Go! back office) thus reduce the work required for the Good To Go! back office to accept such invoices. This would lower risk to WSDOT and WSF, as well as limit changes to the back-office software. It would place more work on any vendor interested in performing the demonstration.

For the pilot, drivers that did not participate in the pilot would pay at the booth just as they do now. But drivers could also choose to sign up for the pilot based on their vehicle's license plate and pay through the single user account. Such an approach would allow quick expansion of the system and the ability to test the operational performance of license plate readers in a marine environment, as well as provide the vendor performing the pilot an opportunity to demonstrate its ability to supply customers with the benefits of a single user account system—thus providing the incentive for vendors to fund the pilot.

The project team recommends that WSF request proposals for a demonstration of such a system on the Triangle Route, with—at a minimum—the Fauntleroy dock used as a test site for such a demonstration. The project team believes that the potential market for helping to develop and deliver such a customer-centric payment system should drive down the cost of developing and delivering such a demonstration.

Combining this recommendation with the recommendation to measure, report, and deliver queue duration information would allow multiple benefits to be gained from such a demonstration project, while also providing considerable benefit to customers who participated in that demonstration. That is, the Good To Go! pilot vendor would be given the opportunity to establish customer accounts that linked (at the customer's discretion) a customer's Wave2Go, ORCA, and Good To Go! accounts. The smartphone application described in Recommendation #2 would then not only be used to deliver ferry information but would allow customers to manage their accounts, purchase ferry tickets, and indicate when they were traveling and to which Triangle Route destination they were headed, thus allowing each customer to control when they received ferry queue information and providing WSF with advance notice of expected route volumes. The traveler information benefits available through the smartphone application, along with the convenience of the single account system and the convenience and speed of the Good To Go! payment system, would be used by the pilot demonstration vendor to encourage use of the pilot system. This in turn would result in meeting the goals of faster vehicle processing and greater pre-purchasing of ferry tickets, which would lead to shorter queue wait times and potentially shorter vessel dwell times.

For this recommendation, the smartphone application described in the second recommendation would expand in functionality to include

- the purchase of ferry tickets, and
- connection of those ferry tickets to vehicle license plates and Good To Go! Tags.

This third recommendation has the potential to lead to the greatest long-term benefit to WSF. It would also offer a path that has the potential to decrease up-front costs to WSF while demonstrating both the customer service improvements and ferry system operational improvements possible through adopting both a more customer-centric approach to fare collection and information delivery. The “pilot demonstration” approach would also allow WSF to shift the risks associated with the demonstration (i.e., development costs and system performance) to the private sector. This assumes that the private sector saw sufficient benefit in the pilot to accept those risks. Whether that risk/reward relationship was acceptable would become obvious based on the response to the RFP. WSF would also benefit from such an approach because the agency would reserve the right to decide to not perform the pilot if the cost of that pilot was too high.